PROJECT MANUAL

FOR

CENTRAL ILLINOIS REGIONAL AIRPORT CHILLED WATER SYSTEM UPGRADES

Bloomington, IL

Project No: 0191346.00

December 13, 2019

Owner:
Central Illinois Regional Airport
3201 CIRA Dr.
Bloomington, IL 61704

Engineer:
Farnsworth Group
200 W. College Av.
Suite 301
Normal, IL 61761
The portion of this technical submission described below was prepared by me or under my direct supervision and responsible charge. I am a duly licensed Mechanical Engineer under the laws of the State of Illinois.

SIGNATURE:

NAME: Jason Coffman
DATE: 12/13/2019
LICENSE EXPIRES: 11/30/2021

NAME: Brian Snyder
DATE: 12/13/2019
LICENSE EXPIRES: 11/30/2021

The portion of this technical submission described below was prepared by me or under my direct supervision and responsible charge. I am a duly licensed Electrical Engineer under the laws of the State of Illinois.

SIGNATURE:

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Central Illinois Regional Airport

Chilled Water System Upgrades

INVITATION FOR BIDS

Sealed Bids for the construction of the CIRA Chilled Water System Upgrades will be received by the Owner, at the Central Illinois Regional Airport Administrative Offices at 3201 CIRA Drive, Suite 200, Bloomington, IL 61704, until 2:00pm local time on Tuesday January 7, 2020. Bids will be publicly opened and read aloud.

A non-mandatory Pre-Bid conference is scheduled for 12/20/19 at 1:30 pm at the CIRA Board Room, Main Terminal Office, 3201 CIRA Dr., Bloomington, IL 61704. NOTE: Because of the restricted access to site, other site visits will not be accommodated.

CIRA Chilled Water System Upgrades:
The Project consists of the replacement of two air-cooled chillers with remote evaporators and associated refrigerant piping between indoor and outdoor components. Chilled water pumps will also be replaced, resulting in increased chilled water system capacity.

The Issuing Office for the Bidding Documents is: Farnsworth Group, Inc., 200 W. College Av., Normal, IL 61761, (309) 663-8436. Contact Jason Coffman, jcoffman@f-w.com with project questions. Prospective Bidders may examine the Bidding Documents at the issuing office.

Bidding Documents may be viewed and ordered online by registering with the Issuing Office at, http://bidlist.f-w.com/. The Bidder may register for this project at the website in order to receive a username and password to access, view and print the Bidding Documents. For any questions or issues accessing the Bidding Documents from the website, contact the Engineer at the Issuing Office.

Bid security shall be furnished in accordance with the Instructions to Bidders.
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Defined Terms

1.01 Terms used in these Instructions to Bidders have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below:

A. Issuing Office – The office from which the Bidding Documents are to be issued.

Farnsworth Group, Inc.
200 West College Avenue, Suite 301
Normal, IL 61761
309.663.8436
ARTICLE 2 – COPIES OF BIDDING DOCUMENTS

2.01 Complete hard copy sets of the Bidding Documents may be obtained from the Issuing Office in the number and format stated below and in the advertisement to bid.

A. The Bidding Documents are available at the Engineer’s project bidding website, http://bidlist.f-w.com/. The Bidder may register for this project at the website in order to receive a username and password to access, view and print the Bidding Documents. For any questions or issues accessing the Bidding Documents from the website, contact the Office of the Engineer.

Terms and Conditions will need to be accepted by the planholder prior to obtaining an electronic copy of the Bidding Documents on the Project Bidding website. Electronic Document access will be provided to general contractors by invitation. Electronic copies are provided at no cost. Printing of such documents will be the responsibility of the planholder in accordance with the website Terms and Conditions.

2.02 Complete sets of Bidding Documents shall be used in preparing Bids; neither Owner nor Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

2.03 Owner and Engineer, in making copies of Bidding Documents available on the above terms, do so only for the purpose of obtaining Bids for the Work and do not authorize or confer a license for any other use.

ARTICLE 3 – QUALIFICATIONS OF BIDDERS

3.01 To demonstrate Bidder’s qualifications to perform the Work, after submitting its Bid and within 10 days of Owner’s request, Bidder shall submit written evidence establishing its qualifications such as financial data, previous experience, and present commitments, and such other data as deemed necessary by the Engineer.

3.02 Bidder is advised to carefully review those portions of the Bid Form requiring Bidder’s representations and certifications.

ARTICLE 4 – SITE AND OTHER AREAS; EXISTING SITE CONDITIONS; EXAMINATION OF SITE; OWNER’S SAFETY PROGRAM; OTHER WORK AT THE SITE

4.01 Site and Other Areas

A. The Site is identified in the Bidding Documents. By definition, the Site includes rights-of-way, easements, and other lands furnished by Owner for the use of the Contractor. Any additional lands required for temporary construction facilities, construction equipment, or storage of materials and equipment, and any access needed for such additional lands, are to be obtained and paid for by Contractor.

4.02 Existing Site Conditions

A. Subsurface and Physical Conditions; Hazardous Environmental Conditions

1. The Supplementary Conditions identify:
   a. those reports known to Owner of explorations and tests of subsurface conditions at or adjacent to the Site.
   b. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities).

2. Owner will make copies of reports and drawings referenced above available to any Bidder on request. These reports and drawings are not part of the Contract Documents, but the Technical Data contained therein upon whose accuracy Bidder is entitled to rely, as provided in the General Conditions, has been identified and established in the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion
Bidder draws from any Technical Data or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings.

B. Underground Facilities: Information and data shown or indicated in the Bidding Documents with respect to existing Underground Facilities at or contiguous to the Site are set forth in the Contract Documents and are based upon information and data furnished to Owner and Engineer by owners of such Underground Facilities, including Owner, or others.

C. Adequacy of Data: Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to subsurface conditions, other physical conditions, and Underground Facilities, and possible changes in the Bidding Documents due to differing or unanticipated subsurface or physical conditions appear in Paragraphs 5.03, 5.04, and 5.05 of the General Conditions. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to a Hazardous Environmental Condition at the Site, if any, and possible changes in the Contract Documents due to any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work, appear in Paragraph 5.06 of the General Conditions.

4.03 Site Visit and Testing by Bidders

A. Bidder may conduct a Site visit during normal working hours, and shall not disturb any ongoing operations at the Site.

B. Bidder is not required to conduct any subsurface testing, or exhaustive investigations of Site conditions.

C. On request, and to the extent Owner has control over the Site, and schedule permitting, the Owner will provide Bidder access to the Site to conduct such additional examinations, investigations, explorations, tests, and studies as Bidder deems necessary for preparing and submitting a successful Bid. Owner will not have any obligation to grant such access if doing so is not practical because of existing operations, security or safety concerns, or restraints on Owner's authority regarding the Site.

D. Bidder shall comply with all applicable Laws and Regulations regarding excavation and location of utilities, obtain all permits, and comply with all terms and conditions established by Owner or by property owners or other entities controlling the Site with respect to schedule, access, existing operations, security, liability insurance, and applicable safety programs.

4.04 Owner’s Safety Program

A. Site visits and work at the Site may be governed by an Owner safety program. As the General Conditions indicate, if an Owner safety program exists, it will be noted in the Supplementary Conditions.

4.05 Other Work at the Site

A. Reference is made to Article 8 of the Supplementary Conditions for the identification of the general nature of other work of which Owner is aware (if any) that is to be performed at the Site by Owner or others (such as utilities and other prime contractors) and relates to the Work contemplated by these Bidding Documents. If Owner is party to a written contract for such other work, then on request, Owner will provide to each Bidder access to examine such contracts (other than portions thereof related to price and other confidential matters), if any.

ARTICLE 5 – BIDDER’S REPRESENTATIONS

5.01 It is the responsibility of each Bidder before submitting a Bid to:

A. examine and carefully study the Bidding Documents, and any data and reference items identified in the Bidding Documents;
B. visit the Site, conduct a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and satisfy itself as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work;

C. become familiar with and satisfy itself as to all Laws and Regulations that may affect cost, progress, and performance of the Work;

D. carefully study all: (1) reports of explorations and tests of subsurface conditions at or adjacent to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings, and (2) reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings;

E. consider the information known to Bidder itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder; and (3) Bidder’s safety precautions and programs;

F. agree, based on the information and observations referred to in the preceding paragraph, that at the time of submitting its Bid no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for performance of the Work at the price bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents;

G. become aware of the general nature of the work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents;

H. promptly give Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder discovers in the Bidding Documents and confirm that the written resolution thereof by Engineer is acceptable to Bidder;

I. determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance and furnishing of the Work; and

J. agree that the submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article, that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

ARTICLE 6 – PRE-BID CONFERENCE

6.01 A non-mandatory pre-Bid conference will be held at the CIRA Maintenance Building, 2415 E. Empire St., Bloomington, IL 61704.

ARTICLE 7 – INTERPRETATIONS AND ADDENDA

7.01 All questions about the meaning or intent of the Bidding Documents are to be submitted to Engineer in writing. Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda delivered to all parties recorded as having received the Bidding Documents. Questions received less than seven days prior to the date for opening of Bids may not be answered. Only questions answered by Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

7.02 Addenda may be issued to clarify, correct, supplement, or change the Bidding Documents.
ARTICLE 8 – BID SECURITY

8.01 A Bid must be accompanied by Bid security made payable to Owner in an amount of 5 percent of Bidder’s maximum Bid price (determined by adding the base bid and all alternates) and in the form of a certified check, bank money order, or a Bid bond (on the form included in the Bidding Documents) issued by a surety meeting the requirements of Paragraphs 6.01 and 6.02 of the General Conditions.

8.02 The Bid security of the apparent Successful Bidder will be retained until Owner awards the contract to such Bidder, and such Bidder has executed the Contract Documents, furnished the required contract security, and met the other conditions of the Notice of Award, whereupon the Bid security will be released. If the Successful Bidder fails to execute and deliver the Contract Documents and furnish the required contract security within 15 days after the Notice of Award, Owner may consider Bidder to be in default, annul the Notice of Award, and exercise its rights under the Bid Bond. Such forfeiture shall be Owner’s exclusive remedy if Bidder defaults.

8.03 The Bid security of other Bidders that Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of seven days after the Effective Date of the Contract or 61 days after the Bid opening, whereupon Bid security furnished by such Bidders will be released.

8.04 Bid security of other Bidders that Owner believes do not have a reasonable chance of receiving the award will be released within seven days after the Bid opening.

ARTICLE 9 – CONTRACT TIMES

9.01 The number of days within which, or the dates by which, Milestones are to be achieved and the Work is to be substantially completed and ready for final payment are set forth in the Agreement.

ARTICLE 10 – SUBSTITUTE AND “OR-EQUAL” ITEMS

10.01 The Contract for the Work, as awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration during the bidding and Contract award process of possible substitute or “or-equal” items. In cases in which the Contract allows the Contractor to request that Engineer authorize the use of a substitute or “or-equal” item of material or equipment, application for such acceptance may not be made to and will not be considered by Engineer until after the Effective Date of the Contract.

10.02 All prices that Bidder sets forth in its Bid shall be based on the presumption that the Contractor will furnish the materials and equipment specified or described in the Bidding Documents, as supplemented by Addenda. Any assumptions regarding the possibility of post-Bid approvals of “or-equal” or substitution requests are made at Bidder’s sole risk.

ARTICLE 11 – SUBCONTRACTORS, SUPPLIERS, AND OTHERS

11.01 A Bidder shall be prepared to retain specific Subcontractors, Suppliers, or other individuals or entities for the performance of the Work if required by the Bidding Documents (most commonly in the Specifications) to do so. If a prospective Bidder objects to retaining any such Subcontractor, Supplier, or other individual or entity, and the concern is not relieved by an Addendum, then the prospective Bidder should refrain from submitting a Bid.

11.02 Subsequent to the submittal of the Bid, Owner may not require the Successful Bidder or Contractor to retain any Subcontractor, Supplier, or other individual or entity against which Contractor has reasonable objection.

11.03 If apparent Successful Bidder declines to make any such substitution, Owner may award the Contract to the next lowest Bidder that proposes to use acceptable Subcontractors, Suppliers, or other individuals or entities. Declining to make requested substitutions will constitute grounds for forfeiture of the Bid security of any Bidder. Any Subcontractor, Supplier, individual, or entity so listed and against which Owner or Engineer makes no written objection prior to the giving of the
Notice of Award will be deemed acceptable to Owner and Engineer subject to subsequent revocation of such acceptance as provided in Paragraph 7.06 of the General Conditions.

ARTICLE 12 – PREPARATION OF BID

12.01 The Bid Form is included with the Bidding Documents.
   A. All blanks on the Bid Form shall be completed in ink and the Bid Form signed in ink. Erasures or alterations shall be initialed in ink by the person signing the Bid Form. A Bid price shall be indicated for each section, Bid item, alternate, adjustment unit price item, and unit price item listed therein.

12.02 A Bid by a corporation shall be executed in the corporate name by a corporate officer (whose title must appear under the signature), accompanied by evidence of authority to sign. The corporate address and state of incorporation shall be shown.

12.03 A Bid by a limited liability company shall be executed in the name of the firm by a member or other authorized person and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm shall be shown.

12.04 A Bid by an individual shall show the Bidder’s name and official address.

12.05 A Bid by a joint venture shall be executed by an authorized representative of each joint venturer in the manner indicated on the Bid Form. The official address of the joint venture shall be shown.

12.06 All names shall be printed in ink below the signatures.

12.07 The Bid shall contain an acknowledgment of receipt of all Addenda, the numbers of which shall be filled in on the Bid Form.

12.08 Postal and e-mail addresses and telephone number for communications regarding the Bid shall be shown.

12.09 The Bid shall contain evidence of Bidder’s authority and qualification to do business in the state where the Project is located, or Bidder shall covenant in writing to obtain such authority and qualification prior to award of the Contract and attach such covenant to the Bid. Bidder’s state contractor license number, if any, shall also be shown on the Bid Form.

ARTICLE 13 – BASIS OF BID

13.01 Lump Sum/Unit Price
   A. Bidders shall submit a Bid on a lump sum basis as set forth in the Bid Form.
   B. Unit Price basis as set forth in the Bid Form.

ARTICLE 14 – SUBMITTAL OF BID

14.01 With each copy of the Bidding Documents, a Bidder is furnished one separate unbound copy of the Bid Form, and, if required, the Bid Bond Form. The unbound copy of the Bid Form is to be completed and submitted with the Bid security and the other documents required to be submitted under the terms of Article 7 of the Bid Form.

14.02 A Bid shall be received no later than the date and time prescribed and at the place indicated in the invitation to bid and shall be enclosed in a plainly marked package with the Project title (and, if applicable, the designated portion of the Project for which the Bid is submitted), the name and address of Bidder, and shall be accompanied by the Bid security and other required documents. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid shall be enclosed in a separate package plainly marked on the outside with the notation "BID ENCCLOSED."

A mailed Bid shall be addressed to: Carl Olson
                                           Central Illinois Regional Airport

0191346.00 CIRA Chilled Water System Upgrades 00 0200 - 6 INSTRUCTIONS TO BIDDERS FOR CONSTRUCTION DOCUMENTS
ARTICLE 15 – MODIFICATION AND WITHDRAWAL OF BID

15.01 A Bid may be withdrawn by an appropriate document duly executed in the same manner that a Bid must be executed and delivered to the place where Bids are to be submitted prior to the date and time for the opening of Bids. Upon receipt of such notice, the unopened Bid will be returned to the Bidder.

15.02 If within 24 hours after Bids are opened any Bidder files a duly signed written notice with Owner and promptly thereafter demonstrates to the reasonable satisfaction of Owner that there was a material and substantial mistake in the preparation of its Bid, that Bidder may withdraw its Bid, and the Bid security will be returned. Thereafter, if the Work is rebid, that Bidder will be disqualified from further bidding on the Work.

ARTICLE 16 – OPENING OF BIDS

16.01 Bids will be received at the time and place indicated in the advertisement or invitation to bid and Article 15.02 above, unless obviously non-responsive, and will not be opened nor publicly and read aloud.

ARTICLE 17 – BIDS TO REMAIN SUBJECT TO ACCEPTANCE

17.01 All Bids will remain subject to acceptance for the period of time stated in the Bid Form, but Owner may, in its sole discretion, release any Bid and return the Bid security prior to the end of this period.

ARTICLE 18 – EVALUATION OF BIDS AND AWARD OF CONTRACT

18.01 Owner reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Owner will reject the Bid of any Bidder that Owner finds, after reasonable inquiry and evaluation, to not be responsible. If Bidder purports to add terms or conditions to its Bid, takes exception to any provision of the Bidding Documents, or attempts to alter the contents of the Contract Documents for purposes of the Bid, then the Owner will reject the Bid as nonresponsive; provided that Owner also reserves the right to waive all minor informalities not involving price, time, or changes in the Work.

18.02 If Owner awards the contract for the Work, such award shall be to the responsible Bidder submitting the lowest responsive Bid, lowest responsive sum of bids in combination with the work of the adjacent Medical Center Drive Extension project, or any combination thereof that may benefit the Owner in any way.

18.03 Evaluation of Bids

A. In evaluating Bids, Owner will consider whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices, and other data, as may be requested in the Bid Form or prior to the Notice of Award.

18.04 In evaluating whether a Bidder is responsible, Owner will consider the qualifications of the Bidder and may consider the qualifications and experience of Subcontractors and Suppliers proposed for those portions of the Work for which the identity of Subcontractors and Suppliers must be submitted as provided in the Bidding Documents.

18.05 Owner may conduct such investigations as Owner deems necessary to establish the responsibility, qualifications, and financial ability of Bidders and any proposed Subcontractors or Suppliers.
ARTICLE 19 – BONDS AND INSURANCE

19.01 Article 6 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth Owner’s requirements as to performance and payment bonds and insurance. When the Successful Bidder delivers the Agreement (executed by Successful Bidder) to Owner, it shall be accompanied by required bonds and insurance documentation.

ARTICLE 20 – SIGNING OF AGREEMENT

20.01 When Owner issues a Notice of Award to the Successful Bidder, it shall be accompanied by the unexecuted counterparts of the Agreement along with the other Contract Documents as identified in the Agreement. Within 15 days thereafter, Successful Bidder shall execute and deliver the required number of counterparts of the Agreement (and any bonds and insurance documentation required to be delivered by the Contract Documents) to Owner. Within ten days thereafter, Owner shall deliver one fully executed counterpart of the Agreement to Successful Bidder, together with printed and electronic copies of the Contract Documents as stated in Paragraph 2.02 of the General Conditions.
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ARTICLE 1 – BID RECIPIENT

1.01 This Bid is submitted to:

Central Illinois Regional Airport
3201 CIRA Dr., Suite 200
Bloomington, IL 61704

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 – BIDDER’S ACKNOWLEDGEMENTS

2.01 Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

ARTICLE 3 – BIDDER’S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bidding Documents, and any data and reference items identified in the Bidding Documents, and hereby acknowledges receipt of the following Addenda:

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B. Bidder has visited the Site, conducted a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and satisfied itself as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Bidder is familiar with and has satisfied itself as to all Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Bidder has considered the information known to Bidder itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and any Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder; and (3) Bidder’s safety precautions and programs.

E. Bidder agrees, based on the information and observations referred to in the preceding paragraph, that no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents.

F. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.
G. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and confirms that the written resolution thereof by Engineer is acceptable to Bidder.

H. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance and furnishing of the Work.

I. The submission of this Bid constitutes an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article, and that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

ARTICLE 4 – BIDDER’S CERTIFICATION

4.01 Bidder certifies that:

A. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation;

B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;

C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and

D. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 4.01.D:

1. “corrupt practice” means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process;

2. “fraudulent practice” means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Owner, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;

3. “collusive practice” means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish bid prices at artificial, non-competitive levels; and

4. “coercive practice” means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

ARTICLE 5 – BASIS OF BID

5.01 The undersigned Bidder, having carefully examined the Procurement and Contracting Requirements, Conditions of the Contract, Drawings, Specifications, and all subsequent Addenda, as prepared by Farnsworth Group, Inc., and having visited the site, and being familiar with all conditions and requirements of the Work, hereby agrees to furnish all material, labor, equipment and services, including all scheduled allowances, necessary to complete the construction of the above-named project, according to the requirements of the Procurement and Contracting Documents, for the stipulated sum of:

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<th>Unit</th>
<th>Estimated Quantity</th>
<th>Bid Unit Price</th>
<th>Bid Price</th>
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0191346.00 CIRA Chilled Water System Upgrades

BID FORM FOR CONSTRUCTION DOCUMENTS
ARTICLE 6 – TIME OF COMPLETION

6.01 Bidder agrees that the Work will be substantially complete within 90 calendar days after the date when the Contract Times commence to run as provided in Paragraph 4.01 of the General Conditions, and will be completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions within 120 calendar days after the date when the Contract Times commence to run.

ARTICLE 7 – ATTACHMENTS TO THIS BID

7.01 The following documents are submitted with and made a condition of this Bid:
   A. Required Bid security;
   B. List of Proposed Subcontractors;
   C. List of Project References;
   D. Evidence of authority to do business in the state of the Project; or a written covenant to obtain such license within the time for acceptance of Bids;
   E. Certificate Regarding Debarment (00650)

ARTICLE 8 – DEFINED TERMS

8.01 The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

ARTICLE 9 – BID SUBMITTAL

BIDDER: [Indicate correct name of bidding entity]

0191346.00 CIRA Chilled Water System Upgrades 00 0410 - 5 BID FORM FOR CONSTRUCTION DOCUMENTS
By:
[Signature]

[Printed name]
(If Bidder is a corporation, a limited liability company, a partnership, or a joint venture, attach evidence of authority to sign.)

Attest:
[Signature]

[Printed name]

Title:

Submittal Date:

Address for giving notices:

____________________________________________________________________
____________________________________________________________________

Telephone Number:  ______________________________________________________

Email Address:  __________________________________________________________

Contact Name and e-mail address:  _________________________________________

Bidder’s License No.:  ____________________________________________________

(where applicable)
BID BOND

Any singular reference to Bidder, Surety, Owner or other party shall be considered plural where applicable.

BIDDER (Name and Address):

________________________
________________________
________________________

SURETY (Name, and Address of Principal Place of Business):


OWNER:
   Central Illinois Regional Airport
   3201 CIRA Dr., Suite 200
   Bloomington, IL 61704

BID
   Bid Due Date: January 3, 2020, 10 am.
   Description: CIRA Chilled Water System Upgrades, Bloomington, Illinois 61704

BOND
   Bond Number: __________________________
   Date: __________________________
   Penal sum (Words) __________________________ (Figures) $ __________________________

Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Bid Bond to be duly executed by an authorized officer, agent, or representative.

BIDDER (Seal) __________________________

Bidder’s Name and Corporate Seal __________________________
By: __________________________
   Signature __________________________
   Print Name __________________________
   Title __________________________
Attest: __________________________
   Signature __________________________
   Title __________________________

SURETY (Seal) __________________________

Surety’s Name and Corporate Seal __________________________
By: __________________________
   Signature (Attach Power of Attorney) __________________________
   Print Name __________________________
   Title __________________________
Attest: __________________________
   Signature __________________________
   Title __________________________

Note: Addresses are to be used for giving any required notice.
Provide execution by any additional parties, such as joint venturers, if necessary.

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Bidder’s and Surety’s liability. Recovery of such penal sum under the terms of this Bond shall be Owner’s sole and exclusive remedy upon default of Bidder.

2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the
Bidding Documents and any performance and payment bonds required by the Bidding Documents.

3. This obligation shall be null and void if:

3.1 Owner accepts Bidder’s Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or

3.2 All Bids are rejected by Owner, or

3.3 Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).

4. Payment under this Bond will be due and payable upon default of Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.

5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 120 days from the Bid due date without Surety’s written consent.

6. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety and in no case later than one year after the Bid due date.

7. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.

8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.

9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.

10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.

11. The term “Bid” as used herein includes a Bid, offer, or proposal as applicable.
PERFORMANCE BOND

CONTRACTOR (name and address): SURETY (name and address of principal place of business):

OWNER:
Central Illinois Regional Airport
3201 CIRA Dr.
Bloomington, IL 61704

CONSTRUCTION CONTRACT
Effective Date of the Agreement:
Amount: $
Description: CIRA Chilled Water System Upgrades

BOND
Bond Number:
Date (not earlier than the Effective Date of the Agreement of the Construction Contract):
Amount:
Modifications to this Bond Form: None See Paragraph 16

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL

Contractor’s Name and Corporate Seal
By: Signature
Print Name
Title
Attest: Signature
Title

SURETY

Surety’s Name and Corporate Seal
By: Signature (attach power of attorney)
Print Name
Title
Attest: Signature
Title

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

0191346.00 CIRA Chilled Water System Upgrades 00 0610 - 1 PERFORMANCE BOND
1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.

2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.

3. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond shall arise after:

   3.1 The Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice shall indicate whether the Owner is requesting a conference among the Owner, Contractor, and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Paragraph 3.1 shall be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor, and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement shall not waive the Owner's right, if any, subsequently to declare a Contractor Default;

   3.2 The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and

   3.3 The Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.

4. Failure on the part of the Owner to comply with the notice requirement in Paragraph 3.1 shall not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.

5. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:

   5.1 Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;

   5.2 Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;

   5.3 Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owners concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 7 in excess of the Balance of the Contract Price incurred by the Owner as a result of the Contractor Default; or

   5.4 Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:

      5.4.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or

      5.4.2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.

6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Paragraph 5.4, and the Owner refuses the payment or the Surety has denied liability, in whole or in part, without further notice the Owner shall be entitled to enforce any remedy available to the Owner.

7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Owner shall not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety shall not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication for:

   7.1 the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;

   7.2 additional legal, design professional, and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and

   7.3 liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.

8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.

9. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.
10. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.

11. Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and shall be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum periods of limitations available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to the Surety, the Owner, or the Contractor shall be mailed or delivered to the address shown on the page on which their signature appears.

13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

14. Definitions

14.1 Balance of the Contract Price: The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made including allowance for the Contractor for any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.

14.2 Construction Contract: The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.

14.3 Contractor Default: Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.

14.4 Owner Default: Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

14.5 Contract Documents: All the documents that comprise the agreement between the Owner and Contractor.

15. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

16. Modifications to this Bond are as follows:
PAYMENT BOND

CONTRACTOR (name and address):

SURETY (name and address of principal place of business):

OWNER:
Central Illinois Regional Airport
3201 CIRA Dr.
Bloomington, IL 61704

CONSTRUCTION CONTRACT

Effective Date of the Agreement:
Amount:
Description: CIRA Chilled Water System Upgrades

BOND

Bond Number:
Date (not earlier than the Effective Date of the Agreement of the Construction Contract):
Amount:
Modifications to this Bond Form: ☐ None ☐ See Paragraph 18

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL

Contractor’s Name and Corporate Seal

By: ____________________________
Signature

Print Name
Title

Attest: ____________________________
Signature
Title

SURETY

Surety’s Name and Corporate Seal

By: ____________________________
Signature (attach power of attorney)

Print Name
Title

Attest: ____________________________
Signature
Title

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner to pay for labor, materials, and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.

2. If the Contractor promptly makes payment of all sums due to Claimants, and defend, indemnifies, and holds

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7. When a Claimant has satisfied the conditions of
6. If a notice of non-payment required by Paragraph 5.1.1
5. The Surety’s obligations to a Claimant under this Bond
4. When the Owner has satisfied the conditions in
3. If there is no Owner Default under the Construction
2. No suit or action shall be commenced by a Claimant
1. The Surety hereby waives notice of any change,
0. PAYMENT BOND

harmless the Owner from claims, demands, liens, or
undisputed and the basis for challenging any
amounts that are disputed; and
7.2 Pay or arrange for payment of any undisputed
amounts.
7.3 The Surety’s failure to discharge its obligations
under Paragraph 7.1 or 7.2 shall not be deemed
to constitute a waiver of defenses the Surety or
Contractor may have or acquire as to a Claim,
except as to undisputed amounts for which the
Surety and Claimant have reached agreement.
If, however, the Surety fails to discharge its
obligations under Paragraph 7.1 or 7.2, the
Surety shall indemnify the Claimant for the
reasonable attorney’s fees the Claimant incurs
thereafter to recover any sums found to be due
and owing to the Claimant.
8. The Surety’s total obligation shall not exceed the
amount of this Bond, plus the amount of reasonable
attorney’s fees provided under Paragraph 7.3, and the
amount of this Bond shall be credited for any payments
made in good faith by the Surety.
9. Amounts owed by the Owner to the Contractor under
the Construction Contract shall be used for the
performance of the Construction Contract and to
satisfy claims, if any, under any construction
performance bond. By the Contractor furnishing and
the Owner accepting this Bond, they agree that all
funds earned by the Contractor in the performance of
the Construction Contract are dedicated to satisfy
obligations of the Contractor and Surety under this
Bond, subject to the Owner’s priority to use the funds
for the completion of the work.
10. The Surety shall not be liable to the Owner, Claimants,
or others for obligations of the Contractor that are
unrelated to the Construction Contract. The Owner
shall not be liable for the payment of any costs or
expenses of any Claimant under this Bond, and shall
have under this Bond no obligation to make payments
to or give notice on behalf of Claimants, or otherwise
have any obligations to Claimants under this Bond.
11. The Surety hereby waives notice of any change,
including changes of time, to the Construction Contract
or to related subcontracts, purchase orders, and other
obligations.
12. No suit or action shall be commenced by a Claimant
under this Bond other than in a court of competent
jurisdiction in the state in which the project that is the
subject of the Construction Contract is located or after
the expiration of one year from the date (1) on which
the Claimant sent a Claim to the Surety pursuant to
Paragraph 5.1.2 or 5.2, or (2) on which the last labor or
service was performed by anyone or the last materials
or equipment were furnished by anyone under the
Construction Contract, whichever of (1) or (2) first
occurs. If the provisions of this paragraph are void or
prohibited by law, the minimum period of limitation
available to sureties as a defense in the jurisdiction of
the suit shall be applicable.
13. Notice and Claims to the Surety, the Owner, or the Contractor shall be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, shall be sufficient compliance as of the date received.

14. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.

16. Definitions

16.1 Claim: A written statement by the Claimant including at a minimum:

1. The name of the Claimant;
2. The name of the person for whom the labor was done, or materials or equipment furnished;
3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Construction Contract;
4. A brief description of the labor, materials, or equipment furnished;
5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;
6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;
7. The total amount of previous payments received by the Claimant; and
8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.

16.2 Claimant: An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials, or equipment for use in the performance of the Construction Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic’s lien or similar statute against the real property upon which the Project is located. The intent of this Bond shall be to include without limitation in the terms of “labor, materials, or equipment” that part of the water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and the Contractor’s subcontractors, and all other items for which a mechanic’s lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

16.3 Construction Contract: The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and all changes made to the agreement and the Contract Documents.

16.4 Owner Default: Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

16.5 Contract Documents: All the documents that comprise the agreement between the Owner and Contractor.

17. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

18. Modifications to this Bond are as follows:
Bidder Certification
In Compliance with Article 33E to the "Criminal Code of 1961"

I __________________________________________________________, do hereby certify that:

Name

1. I am ___________________________________ of the __________________________ Firm
and have authority to execute this certification on behalf of the firm

2. This firm is not barred from bidding on this contract as a result of a violation of either
Section 33E-3, Bid-rigging, or Section 33E-4, Bid Rotating, as set forth in Article 33E to
the "Criminal Code of 1961."

Name of Firm ____________________________________________

Signature ________________________________________________

Title _____________________________________________________

Date _____________________________________________________

Corporate Seal (where appropriate)

On this ______ day of ___________________________ 20______, 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 free act and deed.

Notary Public ____________________________ Commission Expires __________

Notary Seal
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ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 Defined Terms

A. Wherever used in the Bidding Requirements or Contract Documents, a term printed with initial capital letters, including the term’s singular and plural forms, will have the meaning indicated in the definitions below. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. Addenda—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.

2. Agreement—The written instrument, executed by Owner and Contractor, that sets forth the Contract Price and Contract Times, identifies the parties and the Engineer, and designates the specific items that are Contract Documents.

3. Application for Payment—The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

4. Bid—The offer of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

5. Bidder—An individual or entity that submits a Bid to Owner.

6. Bidding Documents—The Bidding Requirements, the proposed Contract Documents, and all Addenda.

7. Bidding Requirements—The advertisement or invitation to bid, Instructions to Bidders, Bid Bond or other Bid security, if any, the Bid Form, and the Bid with any attachments.

8. Change Order—A document which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, or other revision to the Contract, issued on or after the Effective Date of the Contract.

9. Change Proposal—A written request by Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times, or both; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.

10. Claim—(a) A demand or assertion by Owner directly to Contractor, duly submitted in compliance with the procedural requirements set forth herein: seeking an adjustment of Contract Price or Contract Times, or both; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer’s decision regarding a Change Proposal; seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract; or (b) a demand or assertion by Contractor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer’s decision regarding a Change Proposal.
Proposal; or seeking resolution of a contractual issue that Engineer has declined to address. A demand for money or services by a third party is not a Claim.

11. **Constituent of Concern**—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to (a) the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. §§9601 et seq. ("CERCLA"); (b) the Hazardous Materials Transportation Act, 49 U.S.C. §§5501 et seq.; (c) the Resource Conservation and Recovery Act, 42 U.S.C. §§6901 et seq. ("RCRA"); (d) the Toxic Substances Control Act, 15 U.S.C. §§2601 et seq.; (e) the Clean Water Act, 33 U.S.C. §§1251 et seq.; (f) the Clean Air Act, 42 U.S.C. §§7401 et seq.; or (g) any other federal, state, or local statute, law, rule, regulation, ordinance, resolution, code, order, or decree regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.

12. **Contract**—The entire and integrated written contract between the Owner and Contractor concerning the Work.

13. **Contract Documents**—Those items so designated in the Agreement, and which together comprise the Contract.

14. **Contract Price**—The money that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents.

15. **Contract Times**—The number of days or the dates by which Contractor shall: (a) achieve Milestones, if any; (b) achieve Substantial Completion; and (c) complete the Work.

16. **Contractor**—The individual or entity with which Owner has contracted for performance of the Work.

17. **Cost of the Work**—See Paragraph 13.01 for definition.

18. **Drawings**—The part of the Contract that graphically shows the scope, extent, and character of the Work to be performed by Contractor.

19. **Effective Date of the Contract**—The date, indicated in the Agreement, on which the Contract becomes effective.

20. **Engineer**—The individual or entity named as such in the Agreement.

21. **Field Order**—A written order issued by Engineer which requires minor changes in the Work but does not change the Contract Price or the Contract Times.

22. **Hazardous Environmental Condition**—The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated in the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, does not establish a Hazardous Environmental Condition.

23. **Laws and Regulations; Laws or Regulations**—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

24. **Liens**—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.
25. **Milestone**—A principal event in the performance of the Work that the Contract requires Contractor to achieve by an intermediate completion date or by a time prior to Substantial Completion of all the Work.

26. **Notice of Award**—The written notice by Owner to a Bidder of Owner's acceptance of the Bid.

27. **Notice to Proceed**—A written notice by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work.

28. **Owner**—The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract.

29. **Progress Schedule**—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor’s plan to accomplish the Work within the Contract Times.

30. **Project**—The total undertaking to be accomplished for Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Work to be performed under the Contract Documents is a part.

31. **Project Manual**—The written documents prepared for, or made available for, procuring and constructing the Work, including but not limited to the Bidding Documents or other construction procurement documents, geotechnical and existing conditions information, the Agreement, bond forms, General Conditions, Supplementary Conditions, and Specifications. The contents of the Project Manual may be bound in one or more volumes.

32. **Resident Project Representative**—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative or “RPR” includes any assistants or field staff of Resident Project Representative.

33. **Samples**—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and that establish the standards by which such portion of the Work will be judged.

34. **Schedule of Submittals**—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer’s review of the submittals and the performance of related construction activities.

35. **Schedule of Values**—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor’s Applications for Payment.

36. **Shop Drawings**—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.

37. **Site**—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements, and such other lands furnished by Owner which are designated for the use of Contractor.
38. **Specifications**—The part of the Contract that consists of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.

39. **Subcontractor**—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work.

40. **Substantial Completion**—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms “substantially complete” and “substantially completed” as applied to all or part of the Work refer to Substantial Completion thereof.

41. **Successful Bidder**—The Bidder whose Bid the Owner accepts, and to which the Owner makes an award of contract, subject to stated conditions.

42. **Supplementary Conditions**—The part of the Contract that amends or supplements these General Conditions.

43. **Supplier**—A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or a Subcontractor.

44. **Technical Data**—Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (a) subsurface conditions at the Site, or physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities) or (b) Hazardous Environmental Conditions at the Site. If no such express identifications of Technical Data have been made with respect to conditions at the Site, then the data contained in boring logs, recorded measurements of subsurface water levels, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical or environmental report prepared for the Project and made available to Contractor are hereby defined as Technical Data with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06.

45. **Underground Facilities**—All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including but not limited to those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, fiber optic transmissions, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.

46. **Unit Price Work**—Work to be paid for on the basis of unit prices.

47. **Work**—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction; furnishing, installing, and incorporating all materials and equipment into such construction; and may include related services such as testing, start-up, and commissioning, all as required by the Contract Documents.
48. **Work Change Directive**—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner and recommended by Engineer, ordering an addition, deletion, or revision in the Work.

1.02 **Terminology**

A. The words and terms discussed in the following paragraphs are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. **Intent of Certain Terms or Adjectives:**

1. The Contract Documents include the terms “as allowed,” “as approved,” “as ordered,” “as directed” or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Article 10 or any other provision of the Contract Documents.

C. **Day:**

1. The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.

D. **Defective:**

1. The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:
   a. does not conform to the Contract Documents; or
   b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
   c. has been damaged prior to Engineer’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 15.03 or 15.04).

E. **Furnish, Install, Perform, Provide:**

1. The word “furnish,” when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.

2. The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.
4. If the Contract Documents establish an obligation of Contractor with respect to specific services, materials, or equipment, but do not expressly use any of the four words “furnish,” “install,” “perform,” or “provide,” then Contractor shall furnish and install said services, materials, or equipment complete and ready for intended use.

F. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 – PRELIMINARY MATTERS

2.01 Delivery of Bonds and Evidence of Insurance

A. Bonds: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.

B. Evidence of Contractor’s Insurance: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each named insured and additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract), the certificates and other evidence of insurance required to be provided by Contractor in accordance with Article 6.

C. Evidence of Owner’s Insurance: After receipt of the executed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each named insured and additional insured (as identified in the Supplementary Conditions or otherwise), the certificates and other evidence of insurance required to be provided by Owner under Article 6.

2.02 Copies of Documents

A. Owner shall furnish to Contractor four printed copies of the Contract (including one fully executed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.

B. Owner shall maintain and safeguard at least one original printed record version of the Contract, including Drawings and Specifications signed and sealed by Engineer and other design professionals. Owner shall make such original printed record version of the Contract available to Contractor for review. Owner may delegate the responsibilities under this provision to Engineer.

2.03 Before Starting Construction

A. Preliminary Schedules: Within 10 days after the Effective Date of the Contract (or as otherwise specifically required by the Contract Documents), Contractor shall submit to Engineer for timely review:

1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract;

2. a preliminary Schedule of Submittals; and

3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis
for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.04 Preconstruction Conference; Designation of Authorized Representatives

A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.03.A, procedures for handling Shop Drawings, Samples, and other submittals, processing Applications for Payment, electronic or digital transmittals, and maintaining required records.

B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.05 Initial Acceptance of Schedules

A. At least 10 days before submission of the first Application for Payment a conference, attended by Contractor, Engineer, and others as appropriate, will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.03.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer.

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor’s full responsibility therefor.

2. Contractor’s Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.

3. Contractor’s Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to the component parts of the Work.

2.06 Electronic Transmittals

A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may transmit, and shall accept, Project-related correspondence, text, data, documents, drawings, information, and graphics, including but not limited to Shop Drawings and other submittals, in electronic media or digital format, either directly, or through access to a secure Project website.

B. If the Contract does not establish protocols for electronic or digital transmittals, then Owner, Engineer, and Contractor shall jointly develop such protocols.

C. When transmitting items in electronic media or digital format, the transmitting party makes no representations as to long term compatibility, usability, or readability of the items resulting from the recipient’s use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the items, or from those established in applicable transmittal protocols.
ARTICLE 3 – DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 Intent
   A. The Contract Documents are complementary; what is required by one is as binding as if required by all.
   B. It is the intent of the Contract Documents to describe a functionally complete project (or part thereof) to be constructed in accordance with the Contract Documents.
   C. Unless otherwise stated in the Contract Documents, if there is a discrepancy between the electronic or digital versions of the Contract Documents (including any printed copies derived from such electronic or digital versions) and the printed record version, the printed record version shall govern.
   D. The Contract supersedes prior negotiations, representations, and agreements, whether written or oral.
   E. Engineer will issue clarifications and interpretations of the Contract Documents as provided herein.

3.02 Reference Standards
   A. Standards Specifications, Codes, Laws and Regulations
      1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard specification, manual, reference standard, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Contract if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.
      2. No provision of any such standard specification, manual, reference standard, or code, or any instruction of a Supplier, shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees, from those set forth in the part of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the part of the Contract Documents prepared by or for Engineer.

3.03 Reporting and Resolving Discrepancies
   A. Reporting Discrepancies:
      1. Contractor’s Verification of Figures and Field Measurements: Before undertaking each part of the Work, Contractor shall carefully study the Contract Documents, and check and verify pertinent figures and dimensions therein, particularly with respect to applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy that Contractor discovers, or has actual knowledge of, and shall not proceed with any Work affected thereby until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract Documents issued pursuant to Paragraph 11.01.
      2. Contractor’s Review of Contract Documents: If, before or during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy
within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 7.15) until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract Documents issued pursuant to Paragraph 11.01.

3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. Resolving Discrepancies:

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the part of the Contract Documents prepared by or for Engineer shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between such provisions of the Contract Documents and:

   a. the provisions of any standard specification, manual, reference standard, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference as a Contract Document); or

   b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 Requirements of the Contract Documents

A. During the performance of the Work and until final payment, Contractor and Owner shall submit to the Engineer all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Work under the Contract Documents, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work thereunder.

B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer’s written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.

C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly give written notice to Owner and Contractor that Engineer is unable to provide a decision or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

3.05 Reuse of Documents

A. Contractor and its Subcontractors and Suppliers shall not:

   1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or
bearing the seal of Engineer or its consultants, including electronic media editions, or reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer; or

2. have or acquire any title or ownership rights in any other Contract Documents, reuse any such Contract Documents for any purpose without Owner’s express written consent, or violate any copyrights pertaining to such Contract Documents.

B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

ARTICLE 4 – COMMENCEMENT AND PROGRESS OF THE WORK

4.01 Commencement of Contract Times; Notice to Proceed

A. The Contract Times will commence to run on the thirtieth day after the Effective Date of the Contract or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Contract. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Contract, whichever date is earlier.

4.02 Starting the Work

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work shall be done at the Site prior to such date.

4.03 Reference Points

A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer’s judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.04 Progress Schedule

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.05 as it may be adjusted from time to time as provided below.

1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.05) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times.

2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 11.

B. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, or during any appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree in writing.
4.05 Delays in Contractor’s Progress

A. If Owner, Engineer, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Times and Contract Price. Contractor’s entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor’s ability to complete the Work within the Contract Times.

B. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of Contractor. Delay, disruption, and interference attributable to and within the control of a Subcontractor or Supplier shall be deemed to be within the control of Contractor.

C. If Contractor’s performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner, Contractor, and those for which they are responsible, then Contractor shall be entitled to an equitable adjustment in Contract Times. Contractor’s entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor’s ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor’s sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Contract Times under this paragraph include but are not limited to the following:

1. severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;
2. abnormal weather conditions;
3. acts or failures to act of utility owners (other than those performing other work at or adjacent to the Site by arrangement with the Owner, as contemplated in Article 8); and
4. acts of war or terrorism.

D. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by Article 5.

E. Paragraph 8.03 governs delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.

F. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Contractor.

G. Contractor must submit any Change Proposal seeking an adjustment in Contract Price or Contract Times under this paragraph within 30 days of the commencement of the delaying, disrupting, or interfering event.
ARTICLE 5 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 Availability of Lands

A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work.

B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which permanent improvements are to be made and Owner’s interest therein as necessary for giving notice of or filing a mechanic’s or construction lien against such lands in accordance with applicable Laws and Regulations.

C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

5.02 Use of Site and Other Areas

A. Limitation on Use of Site and Other Areas:

1. Contractor shall confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and such other adjacent areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for (a) damage to the Site; (b) damage to any such other adjacent areas used for Contractor’s operations; (c) damage to any other adjacent land or areas; and (d) for injuries and losses sustained by the owners or occupants of any such land or areas; provided that such damage or injuries result from the performance of the Work or from other actions or conduct of the Contractor or those for which Contractor is responsible.

2. If a damage or injury claim is made by the owner or occupant of any such land or area because of the performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible, Contractor shall (a) take immediate corrective or remedial action as required by Paragraph 7.12, or otherwise; (b) promptly attempt to settle the claim as to all parties through negotiations with such owner or occupant, or otherwise resolve the claim by arbitration or other dispute resolution proceeding, or at law; and (c) to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claim, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused directly or indirectly, in whole or in part by, or based upon, Contractor’s performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible.

B. Removal of Debris During Performance of the Work: During the progress of the Work the Contractor shall keep the Site and other adjacent areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste
materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

C. **Cleaning:** Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site and adjacent areas all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. **Loading of Structures:** Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent structures or land to stresses or pressures that will endanger them.

### 5.03 Subsurface and Physical Conditions

A. **Reports and Drawings:** The Supplementary Conditions identify:

1. those reports known to Owner of explorations and tests of subsurface conditions at or adjacent to the Site;
2. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities); and
3. Technical Data contained in such reports and drawings.

B. **Reliance by Contractor on Technical Data Authorized:** Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely upon the accuracy of the Technical Data (as defined in Article 1) contained in any geotechnical or environmental report prepared for the Project and made available to Contractor. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor’s purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or
2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or
3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions, or information.

### 5.04 Differing Subsurface or Physical Conditions

A. **Notice by Contractor:** If Contractor believes that any subsurface or physical condition that is uncovered or revealed at the Site either:

1. is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate; or
2. is of such a nature as to require a change in the Drawings or Specifications; or
3. differs materially from that shown or indicated in the Contract Documents; or
4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except with respect to an emergency) until receipt of a written statement permitting Contractor to do so.

B. **Engineer’s Review:** After receipt of written notice as required by the preceding paragraph, Engineer will promptly review the subsurface or physical condition in question; determine the necessity of Owner’s obtaining additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in Paragraph 5.04.A above; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor’s resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise Owner in writing of Engineer’s findings, conclusions, and recommendations.

C. **Owner’s Statement to Contractor Regarding Site Condition:** After receipt of Engineer’s written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer’s written findings, conclusions, and recommendations, in whole or in part.

D. **Possible Price and Times Adjustments:**

1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, or both, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in Contractor’s cost of, or time required for, performance of the Work; subject, however, to the following:

   a. such condition must fall within any one or more of the categories described in Paragraph 5.04.A;

   b. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03; and,

   c. Contractor’s entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor’s ability to complete the Work within the Contract Times.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:

   a. Contractor knew of the existence of such condition at the time Contractor made a commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract, or otherwise; or

   b. the existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding
Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor’s making such commitment; or

c. Contractor failed to give the written notice as required by Paragraph 5.04.A.

3. If Owner and Contractor agree regarding Contractor’s entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, or both, then any such adjustment shall be set forth in a Change Order.

4. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, or both, no later than 30 days after Owner’s issuance of the Owner’s written statement to Contractor regarding the subsurface or physical condition in question.

5.05 Underground Facilities

A. Contractor’s Responsibilities: The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or adjacent to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. Owner and Engineer do not warrant or guarantee the accuracy or completeness of any such information or data provided by others; and

2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:
   a. reviewing and checking all information and data regarding existing Underground Facilities at the Site;
   b. locating all Underground Facilities shown or indicated in the Contract Documents as being at the Site;
   c. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and
   d. the safety and protection of all existing Underground Facilities at the Site, and repairing any damage thereto resulting from the Work.

B. Notice by Contractor: If Contractor believes that an Underground Facility that is uncovered or revealed at the Site was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy, then Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer.

C. Engineer’s Review: Engineer will promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor’s resumption of Work in connection with the Underground Facility in question; determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and advise Owner in writing of Engineer’s findings, conclusions, and recommendations. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.
D. **Owner’s Statement to Contractor Regarding Underground Facility:** After receipt of Engineer’s written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the Underground Facility in question, addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer’s written findings, conclusions, and recommendations in whole or in part.

E. **Possible Price and Times Adjustments:**

1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, or both, to the extent that any existing Underground Facility at the Site that was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in Contractor’s cost of, or time required for, performance of the Work; subject, however, to the following:
   a. Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated the existence or actual location of the Underground Facility in question;
   b. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03;
   c. Contractor’s entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor’s ability to complete the Work within the Contract Times; and
   d. Contractor gave the notice required in Paragraph 5.05.B.

2. If Owner and Contractor agree regarding Contractor’s entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, or both, then any such adjustment shall be set forth in a Change Order.

3. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, or both, no later than 30 days after Owner’s issuance of the Owner’s written statement to Contractor regarding the Underground Facility in question.

5.06 **Hazardous Environmental Conditions at Site**

A. **Reports and Drawings:** The Supplementary Conditions identify:

1. those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and

2. Technical Data contained in such reports and drawings.

B. **Reliance by Contractor on Technical Data Authorized:** Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely on the accuracy of the Technical Data (as defined in Article 1) contained in any geotechnical or environmental report prepared for the Project and made available to Contractor. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:
1. the completeness of such reports and drawings for Contractor’s purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions or information.

C. Contractor shall not be responsible for removing or remediating any Hazardous Environmental Condition encountered, uncovered, or revealed at the Site unless such removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.

D. Contractor shall be responsible for controlling, containing, and duly removing all Constituents of Concern brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible, and for any associated costs; and for the costs of removing and remediating any Hazardous Environmental Condition created by the presence of any such Constituents of Concern.

E. If Contractor encounters, uncovers, or reveals a Hazardous Environmental Condition whose removal or remediation is not expressly identified in the Contract Documents as being within the scope of the Work, or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, then Contractor shall immediately: (1) secure or otherwise isolate such condition; (2) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 7.15); and (3) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 5.06.F. If Contractor or anyone for whom Contractor is responsible created the Hazardous Environmental Condition in question, then Owner may remove and remediate the Hazardous Environmental Condition, and impose a set-off against payments to account for the associated costs.

F. Contractor shall not resume Work in connection with such Hazardous Environmental Condition or in any affected area until after Owner has obtained any required permits related thereto, and delivered written notice to Contractor either (1) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (2) specifying any special conditions under which such Work may be resumed safely.

G. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, then within 30 days of Owner’s written notice regarding the resumption of Work, Contractor may submit a Change Proposal, or Owner may impose a set-off.

H. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work, following the
contractual change procedures in Article 11. Owner may have such deleted portion
of the Work performed by Owner’s own forces or others in accordance with Article 8.

I. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and
hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors,
members, partners, employees, agents, consultants, and subcontractors of each and
any of them from and against all claims, costs, losses, and damages (including but
not limited to all fees and charges of engineers, architects, attorneys, and other
professionals and all court or arbitration or other dispute resolution costs) arising out
of or relating to a Hazardous Environmental Condition, provided that such Hazardous
Environmental Condition (1) was not shown or indicated in the Drawings,
Specifications, or other Contract Documents, identified as Technical Data entitled to
limited reliance pursuant to Paragraph 5.06.B, or identified in the Contract
Documents to be included within the scope of the Work, and (2) was not created by
Contractor or by anyone for whom Contractor is responsible. Nothing in this
Paragraph 5.06.H shall obligate Owner to indemnify any individual or entity from and
against the consequences of that individual’s or entity’s own negligence.

J. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify
and hold harmless Owner and Engineer, and the officers, directors, members,
partners, employees, agents, consultants, and subcontractors of each and any of
them from and against all claims, costs, losses, and damages (including but not
limited to all fees and charges of engineers, architects, attorneys, and other
professionals and all court or arbitration or other dispute resolution costs) arising out
of or relating to the failure to control, contain, or remove a Constituent of Concern
brought to the Site by Contractor or by anyone for whom Contractor is responsible, or
to a Hazardous Environmental Condition created by Contractor or by anyone for
whom Contractor is responsible. Nothing in this Paragraph 5.06.J shall obligate
Contractor to indemnify any individual or entity from and against the consequences
of that individual’s or entity’s own negligence.

K. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of
Constituents of Concern or to a Hazardous Environmental Condition uncovered or
revealed at the Site.

ARTICLE 6 – BONDS AND INSURANCE

6.01 Performance, Payment, and Other Bonds

A. Contractor shall furnish a performance bond and a payment bond, each in an amount
at least equal to the Contract Price, as security for the faithful performance and
payment of all of Contractor’s obligations under the Contract. These bonds shall
remain in effect until one year after the date when final payment becomes due or until
completion of the correction period specified in Paragraph 15.08, whichever is later,
except as provided otherwise by Laws or Regulations, the Supplementary Conditions,
or other specific provisions of the Contract. Contractor shall also furnish such other
bonds as are required by the Supplementary Conditions or other specific provisions
of the Contract.

B. All bonds shall be in the form prescribed by the Contract except as provided otherwise
by Laws or Regulations, and shall be executed by such sureties as are named in
“Companies Holding Certificates of Authority as Acceptable Sureties on Federal
Bonds and as Acceptable Reinsuring Companies” as published in Circular 570 (as
amended and supplemented) by the Financial Management Service, Surety Bond
Branch, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-
fact must be accompanied by a certified copy of that individual’s authority to bind the
surety. The evidence of authority shall show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

C. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds in the required amounts.

D. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or its right to do business is terminated in any state or jurisdiction where any part of the Project is located, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the bond and surety requirements above.

E. If Contractor has failed to obtain a required bond, Owner may exclude the Contractor from the Site and exercise Owner’s termination rights under Article 16.

F. Upon request, Owner shall provide a copy of the payment bond to any Subcontractor, Supplier, or other person or entity claiming to have furnished labor or materials used in the performance of the Work.

6.02 Insurance—General Provisions

A. Owner and Contractor shall obtain and maintain insurance as required in this Article and in the Supplementary Conditions.

B. All insurance required by the Contract to be purchased and maintained by Owner or Contractor shall be obtained from insurance companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue insurance policies for the required limits and coverages. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.

C. Contractor shall deliver to Owner, with copies to each named insured and additional insured (as identified in this Article, in the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Contractor has obtained and is maintaining the policies, coverages, and endorsements required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies and endorsements, and documentation of applicable self-insured retentions and deductibles. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

D. Owner shall deliver to Contractor, with copies to each named insured and additional insured (as identified in this Article, the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Owner has obtained and is maintaining the policies, coverages, and endorsements required of Owner by the Contract (if any). Upon request by Contractor or any other insured, Owner shall also provide other evidence of such required insurance (if any), including but not limited to copies of policies and endorsements, and documentation of applicable self-insured retentions and deductibles. Owner may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

E. Failure of Owner or Contractor to demand such certificates or other evidence of the other party’s full compliance with these insurance requirements, or failure of Owner or Contractor to identify a deficiency in compliance from the evidence provided, shall
not be construed as a waiver of the other party’s obligation to obtain and maintain such insurance.

F. If either party does not purchase or maintain all of the insurance required of such party by the Contract, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage.

G. If Contractor has failed to obtain and maintain required insurance, Owner may exclude the Contractor from the Site, impose an appropriate set-off against payment, and exercise Owner’s termination rights under Article 16.

H. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect to obtain equivalent insurance to protect such other party’s interests at the expense of the party who was required to provide such coverage, and the Contract Price shall be adjusted accordingly.

I. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor’s interests.

J. The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor’s liability under the indemnities granted to Owner and other individuals and entities in the Contract.

6.03 Contractor’s Insurance

A. **Workers’ Compensation:** Contractor shall purchase and maintain workers’ compensation and employer’s liability insurance for:
   1. claims under workers’ compensation, disability benefits, and other similar employee benefit acts.
   2. United States Longshoreman and Harbor Workers’ Compensation Act and Jones Act coverage (if applicable).
   3. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor’s employees (by stop-gap endorsement in monopolist worker’s compensation states).
   4. Foreign voluntary worker compensation (if applicable).

B. **Commercial General Liability—Claims Covered:** Contractor shall purchase and maintain commercial general liability insurance, covering all operations by or on behalf of Contractor, on an occurrence basis, against:
   1. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor’s employees.
   2. claims for damages insured by reasonably available personal injury liability coverage.
   3. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom.

C. **Commercial General Liability—Form and Content:** Contractor’s commercial liability policy shall be written on a 1996 (or later) ISO commercial general liability form (occurrence form) and include the following coverages and endorsements:
   1. Products and completed operations coverage:
      a. Such insurance shall be maintained for three years after final payment.
b. Contractor shall furnish Owner and each other additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract) evidence of continuation of such insurance at final payment and three years thereafter.

2. Blanket contractual liability coverage, to the extent permitted by law, including but not limited to coverage of Contractor’s contractual indemnity obligations in Paragraph 7.18.

3. Broad form property damage coverage.

4. Severability of interest.

5. Underground, explosion, and collapse coverage.

6. Personal injury coverage.

7. Additional insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together); or CG 20 10 07 04 and CG 20 37 07 04 (together); or their equivalent.

8. For design professional additional insureds, ISO Endorsement CG 20 32 07 04, “Additional Insured—Engineers, Architects or Surveyors Not Engaged by the Named Insured” or its equivalent.

D. Automobile liability: Contractor shall purchase and maintain automobile liability insurance against claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance, or use of any motor vehicle. The automobile liability policy shall be written on an occurrence basis.

E. Umbrella or excess liability: Contractor shall purchase and maintain umbrella or excess liability insurance written over the underlying employer’s liability, commercial general liability, and automobile liability insurance described in the paragraphs above. Subject to industry-standard exclusions, the coverage afforded shall follow form as to each and every one of the underlying policies.

F. Contractor’s pollution liability insurance: Contractor shall purchase and maintain a policy covering third-party injury and property damage claims, including clean-up costs, as a result of pollution conditions arising from Contractor’s operations and completed operations. This insurance shall be maintained for no less than three years after final completion.

G. Additional insureds: The Contractor’s commercial general liability, automobile liability, umbrella or excess, and pollution liability policies shall include and list as additional insureds Owner and Engineer, and any individuals or entities identified in the Supplementary Conditions; include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds; and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby (including as applicable those arising from both ongoing and completed operations) on a non-contributory basis. Contractor shall obtain all necessary endorsements to support these requirements.

H. Contractor’s professional liability insurance: If Contractor will provide or furnish professional services under this Contract, through a delegation of professional design services or otherwise, then Contractor shall be responsible for purchasing and maintaining applicable professional liability insurance. This insurance shall provide protection against claims arising out of performance of professional design or related services.
services, and caused by a negligent error, omission, or act for which the insured party is legally liable. It shall be maintained throughout the duration of the Contract and for a minimum of two years after Substantial Completion. If such professional design services are performed by a Subcontractor, and not by Contractor itself, then the requirements of this paragraph may be satisfied through the purchasing and maintenance of such insurance by such Subcontractor.

I. General provisions: The policies of insurance required by this Paragraph 6.03 shall:

1. include at least the specific coverages provided in this Article.
2. be written for not less than the limits of liability provided in this Article and in the Supplementary Conditions, or required by Laws or Regulations, whichever is greater.
3. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed, or renewal refused until at least 10 days prior written notice has been given to Contractor. Within three days of receipt of any such written notice, Contractor shall provide a copy of the notice to Owner, Engineer, and each other insured under the policy.
4. remain in effect at least until final payment (and longer if expressly required in this Article) and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work as a warranty or correction obligation, or otherwise, or returning to the Site to conduct other tasks arising from the Contract Documents.
5. be appropriate for the Work being performed and provide protection from claims that may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable.

J. The coverage requirements for specific policies of insurance must be met by such policies, and not by reference to excess or umbrella insurance provided in other policies.

6.04 Owner's Liability Insurance

A. In addition to the insurance required to be provided by Contractor under Paragraph 6.03, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.

B. Owner's liability policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's liability policies for any of Contractor's obligations to the Owner, Engineer, or third parties.

6.05 Property Insurance

A. Builder's Risk: Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the full insurable replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

1. include the Owner and Contractor as named insureds, and all Subcontractors, and any individuals or entities required by the Supplementary Conditions to be
insured under such builder’s risk policy, as insureds or named insureds. For
purposes of the remainder of this Paragraph 6.05, Paragraphs 6.06 and 6.07,
and any corresponding Supplementary Conditions, the parties required to be
insured shall collectively be referred to as “insureds.”

2. be written on a builder’s risk “all risk” policy form that shall at least include
insurance for physical loss or damage to the Work, temporary buildings,
falsework, and materials and equipment in transit, and shall insure against at
least the following perils or causes of loss: fire; lightning; windstorm; riot; civil
commotion; terrorism; vehicle impact; aircraft; smoke; theft; vandalism and
malicious mischief; mechanical breakdown, boiler explosion, and artificially
generated electric current; earthquake; volcanic activity, and other earth
movement; flood; collapse; explosion; debris removal; demolition occasioned by
enforcement of Laws and Regulations; water damage (other than that caused by
flood); and such other perils or causes of loss as may be specifically required by
the Supplementary Conditions. If insurance against mechanical breakdown,
boiler explosion, and artificially generated electric current; earthquake; volcanic
activity, and other earth movement; or flood, are not commercially available under
builder’s risk policies, by endorsement or otherwise, such insurance may be
provided through other insurance policies acceptable to Owner and Contractor.

3. cover, as insured property, at least the following: (a) the Work and all materials,
supplies, machinery, apparatus, equipment, fixtures, and other property of a
similar nature that are to be incorporated into or used in the preparation,
fabrication, construction, erection, or completion of the Work, including Owner-
furnished or assigned property; (b) spare parts inventory required within the
scope of the Contract; and (c) temporary works which are not intended to form
part of the permanent constructed Work but which are intended to provide
working access to the Site, or to the Work under construction, or which are
intended to provide temporary support for the Work under construction, including
scaffolding, form work, fences, shoring, falsework, and temporary structures.

4. cover expenses incurred in the repair or replacement of any insured property
(including but not limited to fees and charges of engineers and architects).

5. extend to cover damage or loss to insured property while in temporary storage at
the Site or in a storage location outside the Site (but not including property stored
at the premises of a manufacturer or Supplier).

6. extend to cover damage or loss to insured property while in transit.

7. allow for partial occupation or use of the Work by Owner, such that those portions
of the Work that are not yet occupied or used by Owner shall remain covered by
the builder’s risk insurance.

8. allow for the waiver of the insurer’s subrogation rights, as set forth below.

9. provide primary coverage for all losses and damages caused by the perils or
causes of loss covered.

10. not include a co-insurance clause.

11. include an exception for ensuing losses from physical damage or loss with
respect to any defective workmanship, design, or materials exclusions.

12. include performance/hot testing and start-up.
13. be maintained in effect, subject to the provisions herein regarding Substantial Completion and partial occupancy or use of the Work by Owner, until the Work is complete.

B. Notice of Cancellation or Change: All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 6.05 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured.

C. Deductibles: The purchaser of any required builder’s risk or property insurance shall pay for costs not covered because of the application of a policy deductible.

D. Partial Occupancy or Use by Owner: If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 15.04, then Owner (directly, if it is the purchaser of the builder’s risk policy, or through Contractor) will provide notice of such occupancy or use to the builder’s risk insurer. The builder’s risk insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy; rather, those portions of the Work that are occupied or used by Owner may come off the builder’s risk policy, while those portions of the Work not yet occupied or used by Owner shall remain covered by the builder’s risk insurance.

E. Additional Insurance: If Contractor elects to obtain other special insurance to be included in or supplement the builder’s risk or property insurance policies provided under this Paragraph 6.05, it may do so at Contractor’s expense.

F. Insurance of Other Property: If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, such as tools, construction equipment, or other personal property owned by Contractor, a Subcontractor, or an employee of Contractor or a Subcontractor, then the entity or individual owning such property item will be responsible for deciding whether to insure it, and if so in what amount.

6.06 Waiver of Rights

A. All policies purchased in accordance with Paragraph 6.05, expressly including the builder’s risk policy, shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any insureds thereunder, or against Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors. Owner and Contractor waive all rights against each other and the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Engineer, its consultants, all Subcontractors, all individuals or entities identified in the Supplementary Conditions as insureds, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.
B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, for:

1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner’s property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and

2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial occupancy or use pursuant to Paragraph 15.04, after Substantial Completion pursuant to Paragraph 15.03, or after final payment pursuant to Paragraph 15.06.

C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 6.06.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them.

D. Contractor shall be responsible for assuring that the agreement under which a Subcontractor performs a portion of the Work contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in the Supplementary Conditions as insureds, the Engineer and its consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by builder’s risk insurance and any other property insurance applicable to the Work.

6.07 Receipt and Application of Property Insurance Proceeds

A. Any insured loss under the builder’s risk and other policies of insurance required by Paragraph 6.05 will be adjusted and settled with the named insured that purchased the policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state its position regarding a claim for insured loss in writing within 15 days after notice of such claim.

B. Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder’s risk and other policies of insurance required by Paragraph 6.05 shall distribute such proceeds in accordance with such agreement as the parties in interest may reach, or as otherwise required under the dispute resolution provisions of this Contract or applicable Laws and Regulations.

C. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the money so received applied on account thereof, and the Work and the cost thereof covered by Change Order, if needed.
ARTICLE 7 – CONTRACTOR’S RESPONSIBILITIES

7.01 Supervision and Superintendence
   A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.
   B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.02 Labor; Working Hours
   A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.
   B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours, Monday through Friday. Contractor will not perform Work on a Saturday, Sunday, or any legal holiday. Contractor may perform Work outside regular working hours or on Saturdays, Sundays, or legal holidays only with Owner's written consent, which will not be unreasonably withheld.

7.03 Services, Materials, and Equipment
   A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start up, and completion of the Work, whether or not such items are specifically called for in the Contract Documents.
   B. All materials and equipment incorporated into the Work shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.
   C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

7.04 “Or Equals”
   A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the Contract Price has been based upon Contractor furnishing such item as specified. The specification or description of such an item is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or “or equal” item is permitted, Contractor may request that Engineer authorize the use of other items of material or equipment, or items from other proposed suppliers under the circumstances described below.
1. If Engineer in its sole discretion determines that an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer shall deem it an “or equal” item. For the purposes of this paragraph, a proposed item of material or equipment will be considered functionally equal to an item so named if:
   a. in the exercise of reasonable judgment Engineer determines that:
      1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;
      2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole;
      3) it has a proven record of performance and availability of responsive service; and
      4) it is not objectionable to Owner.
   b. Contractor certifies that, if approved and incorporated into the Work:
      1) there will be no increase in cost to the Owner or increase in Contract Times; and
      2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

B. Contractor’s Expense: Contractor shall provide all data in support of any proposed “or equal” item at Contractor’s expense.

C. Engineer’s Evaluation and Determination: Engineer will be allowed a reasonable time to evaluate each “or-equal” request. Engineer may require Contractor to furnish additional data about the proposed “or-equal” item. Engineer will be the sole judge of acceptability. No “or-equal” item will be ordered, furnished, installed, or utilized until Engineer’s review is complete and Engineer determines that the proposed item is an “or-equal”, which will be evidenced by an approved Shop Drawing or other written communication. Engineer will advise Contractor in writing of any negative determination.

D. Effect of Engineer’s Determination: Neither approval nor denial of an “or-equal” request shall result in any change in Contract Price. The Engineer’s denial of an “or-equal” request shall be final and binding, and may not be reversed through an appeal under any provision of the Contract Documents.

E. Treatment as a Substitution Request: If Engineer determines that an item of material or equipment proposed by Contractor does not qualify as an “or-equal” item, Contractor may request that Engineer consider the proposed item as a substitute pursuant to Paragraph 7.05.

7.05 Substitutes

A. Unless the specification or description of an item of material or equipment required to be furnished under the Contract Documents contains or is followed by words reading that no substitution is permitted, Contractor may request that Engineer authorize the use of other items of material or equipment under the circumstances described below. To the extent possible such requests shall be made before commencement of related construction at the Site.

1. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is functionally
equivalent to that named and an acceptable substitute therefor. Engineer will not accept requests for review of proposed substitute items of material or equipment from anyone other than Contractor.

2. The requirements for review by Engineer will be as set forth in Paragraph 7.05.B, as supplemented by the Specifications, and as Engineer may decide is appropriate under the circumstances.

3. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:

   a. shall certify that the proposed substitute item will:
      1) perform adequately the functions and achieve the results called for by the general design,
      2) be similar in substance to that specified, and
      3) be suited to the same use as that specified.

   b. will state:
      1) the extent, if any, to which the use of the proposed substitute item will necessitate a change in Contract Times,
      2) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item, and
      3) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty.

   c. will identify:
      1) all variations of the proposed substitute item from that specified, and
      2) available engineering, sales, maintenance, repair, and replacement services.

   d. shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including but not limited to changes in Contract Price, shared savings, costs of redesign, and claims of other contractors affected by any resulting change.

B. Engineer’s Evaluation and Determination: Engineer will be allowed a reasonable time to evaluate each substitute request, and to obtain comments and direction from Owner. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No substitute will be ordered, furnished, installed, or utilized until Engineer’s review is complete and Engineer determines that the proposed item is an acceptable substitute. Engineer’s determination will be evidenced by a Field Order or a proposed Change Order accounting for the substitution itself and all related impacts, including changes in Contract Price or Contract Times. Engineer will advise Contractor in writing of any negative determination.

C. Special Guarantee: Owner may require Contractor to furnish at Contractor’s expense a special performance guarantee or other surety with respect to any substitute.
D. *Reimbursement of Engineer’s Cost*: Engineer will record Engineer’s costs in evaluating a substitute proposed or submitted by Contractor. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

E. *Contractor’s Expense*: Contractor shall provide all data in support of any proposed substitute at Contractor’s expense.

F. *Effect of Engineer’s Determination*: If Engineer approves the substitution request, Contractor shall execute the proposed Change Order and proceed with the substitution. The Engineer’s denial of a substitution request shall be final and binding, and may not be reversed through an appeal under any provision of the Contract Documents. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.05.D, by timely submittal of a Change Proposal.

7.06 **Concerning Subcontractors, Suppliers, and Others**

A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner.

B. Contractor shall retain specific Subcontractors, Suppliers, or other individuals or entities for the performance of designated parts of the Work if required by the Contract to do so.

C. Subsequent to the submittal of Contractor’s Bid or final negotiation of the terms of the Contract, Owner may not require Contractor to retain any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against which Contractor has reasonable objection.

D. Prior to entry into any binding subcontract or purchase order, Contractor shall submit to Owner the identity of the proposed Subcontractor or Supplier (unless Owner has already deemed such proposed Subcontractor or Supplier acceptable, during the bidding process or otherwise). Such proposed Subcontractor or Supplier shall be deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within five days.

E. Owner may require the replacement of any Subcontractor, Supplier, or other individual or entity retained by Contractor to perform any part of the Work. Owner also may require Contractor to retain specific replacements; provided, however, that Owner may not require a replacement to which Contractor has a reasonable objection. If Contractor has submitted the identity of certain Subcontractors, Suppliers, or other individuals or entities for acceptance by Owner, and Owner has accepted it (either in writing or by failing to make written objection thereto), then Owner may subsequently revoke the acceptance of any such Subcontractor, Supplier, or other individual or entity so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity.

F. If Owner requires the replacement of any Subcontractor, Supplier, or other individual or entity retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, or both, with respect to the replacement; and Contractor shall initiate a Change Proposal for such adjustment within 30 days of Owner’s requirement of replacement.
G. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of the right of Owner to the completion of the Work in accordance with the Contract Documents.

H. On a monthly basis Contractor shall submit to Engineer a complete list of all Subcontractors and Suppliers having a direct contract with Contractor, and of all other Subcontractors and Suppliers known to Contractor at the time of submittal.

I. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions.

J. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors, Suppliers, and all other individuals or entities performing or furnishing any of the Work.

K. Contractor shall restrict all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed herein.

L. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

M. All Work performed for Contractor by a Subcontractor or Supplier shall be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer.

N. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor on account of Work performed for Contractor by the particular Subcontractor or Supplier.

O. Nothing in the Contract Documents:
   1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier, or other individual or entity; nor
   2. shall create any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

7.07 Patent Fees and Royalties

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors from and against all claims, costs, losses,
and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.

C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

7.08 Permits

A. Unless otherwise provided in the Contract Documents, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of the submission of Contractor’s Bid (or when Contractor became bound under a negotiated contract). Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

7.09 Taxes

A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

7.10 Laws and Regulations

A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor’s compliance with any Laws or Regulations.

B. If Contractor performs any Work or takes any other action knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all resulting costs and losses, and shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work or other action. It shall not be Contractor’s responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor’s obligations under Paragraph 3.03.

C. Owner or Contractor may give notice to the other party of any changes after the submission of Contractor’s Bid (or after the date when Contractor became bound under a negotiated contract) in Laws or Regulations having an effect on the cost or
time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such changes, then within 30 days of such notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.11 Record Documents
A. Contractor shall maintain in a safe place at the Site one printed record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, written interpretations and clarifications, and approved Shop Drawings. Contractor shall keep such record documents in good order and annotate them to show changes made during construction. These record documents, together with all approved Samples, will be available to Engineer for reference. Upon completion of the Work, Contractor shall deliver these record documents to Engineer.

7.12 Safety and Protection
A. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:
   1. all persons on the Site or who may be affected by the Work;
   2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
   3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.
B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify Owner; the owners of adjacent property, Underground Facilities, and other utilities; and other contractors and utility owners performing work at or adjacent to the Site, when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.
C. Contractor shall comply with the applicable requirements of Owner’s safety programs, if any. The Supplementary Conditions identify any Owner’s safety programs that are applicable to the Work.
D. Contractor shall inform Owner and Engineer of the specific requirements of Contractor’s safety program with which Owner’s and Engineer’s employees and representatives must comply while at the Site.
E. All damage, injury, or loss to any property referred to in Paragraph 7.12.A.2 or 7.12.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor at its expense (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions
of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

F. Contractor's duties and responsibilities for safety and protection shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 15.06.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

G. Contractor's duties and responsibilities for safety and protection shall resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

7.13 Safety Representative

A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

7.14 Hazard Communication Programs

A. Contractor shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

7.15 Emergencies

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent threatened damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If Engineer determines that a change in the Contract Documents is required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

7.16 Shop Drawings, Samples, and Other Submittals

A. Shop Drawing and Sample Submittal Requirements:
   1. Before submitting a Shop Drawing or Sample, Contractor shall have:
      a. reviewed and coordinated the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
      b. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;
      c. determined and verified the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
      d. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and
procedures of construction, and safety precautions and programs incident thereto.

2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor’s obligations under the Contract Documents with respect to Contractor’s review of that submittal, and that Contractor approves the submittal.

3. With each submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be set forth in a written communication separate from the Shop Drawings or Sample submittal; and, in addition, in the case of Shop Drawings by a specific notation made on each Shop Drawing submitted to Engineer for review and approval of each such variation.

B. Submittal Procedures for Shop Drawings and Samples: Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals. Each submittal will be identified as Engineer may require.

1. Shop Drawings:
   a. Contractor shall submit the number of copies required in the Specifications.
   b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 7.16.D.

2. Samples:
   a. Contractor shall submit the number of Samples required in the Specifications.
   b. Contractor shall clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 7.16.D.

3. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer’s review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. Other Submittals: Contractor shall submit other submittals to Engineer in accordance with the accepted Schedule of Submittals, and pursuant to the applicable terms of the Specifications.

D. Engineer’s Review:

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer’s review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
2. Engineer’s review and approval will not extend to means, methods, techniques, sequences, or procedures of construction or to safety precautions or programs incident thereto.

3. Engineer’s review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

4. Engineer’s review and approval of a Shop Drawing or Sample shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 7.16.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will document any such approved variation from the requirements of the Contract Documents in a Field Order.

5. Engineer’s review and approval of a Shop Drawing or Sample shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 7.16.A and B.

6. Engineer’s review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, shall not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.

7. Neither Engineer’s receipt, review, acceptance or approval of a Shop Drawing, Sample, or other submittal shall result in such item becoming a Contract Document.

8. Contractor shall perform the Work in compliance with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.16.D.4.

E. Resubmittal Procedures:

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous submittals.

2. Contractor shall furnish required submittals with sufficient information and accuracy to obtain required approval of an item with no more than three submittals. Engineer will record Engineer’s time for reviewing a fourth or subsequent submittal of a Shop Drawings, sample, or other item requiring approval, and Contractor shall be responsible for Engineer’s charges to Owner for such time. Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges.

3. If Contractor requests a change of a previously approved submittal item, Contractor shall be responsible for Engineer’s charges to Owner for its review time, and Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

7.17 Contractor’s General Warranty and Guarantee

A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its officers, directors,
members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on Contractor’s warranty and guarantee.

B. Contractor’s warranty and guarantee hereunder excludes defects or damage caused by:
   1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or
   2. normal wear and tear under normal usage.

C. Contractor’s obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor’s obligation to perform the Work in accordance with the Contract Documents:
   1. observations by Engineer;
   2. recommendation by Engineer or payment by Owner of any progress or final payment;
   3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;
   4. use or occupancy of the Work or any part thereof by Owner;
   5. any review and approval of a Shop Drawing or Sample submittal;
   6. the issuance of a notice of acceptability by Engineer;
   7. any inspection, test, or approval by others; or
   8. any correction of defective Work by Owner.

D. If the Contract requires the Contractor to accept the assignment of a contract entered into by Owner, then the specific warranties, guarantees, and correction obligations contained in the assigned contract shall govern with respect to Contractor’s performance obligations to Owner for the Work described in the assigned contract.

7.18 Indemnification

A. To the fullest extent permitted by Laws and Regulations, and in addition to any other obligations of Contractor under the Contract or otherwise, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable.

B. In any and all claims against Owner or Engineer or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors by any employee (or the survivor or personal representative of such employee) of Contractor,
any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.18.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers’ compensation acts, disability benefit acts, or other employee benefit acts.

C. The indemnification obligations of Contractor under Paragraph 7.18.A shall not extend to the liability of Engineer and Engineer’s officers, directors, members, partners, employees, agents, consultants and subcontractors arising out of:

1. the preparation or approval of, or the failure to prepare or approve maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or

2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

### 7.19 Delegation of Professional Design Services

A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor’s responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable Laws and Regulations.

B. If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional’s written approval when submitted to Engineer.

C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.

D. Pursuant to this paragraph, Engineer’s review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer’s review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 7.16.D.1.

E. Contractor shall not be responsible for the adequacy of the performance or design criteria specified by Owner or Engineer.
ARTICLE 8 – OTHER WORK AT THE SITE

8.01 Other Work

A. In addition to and apart from the Work under the Contract Documents, the Owner may perform other work at or adjacent to the Site. Such other work may be performed by Owner’s employees, or through contracts between the Owner and third parties. Owner may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.

B. If Owner performs other work at or adjacent to the Site with Owner’s employees, or through contracts for such other work, then Owner shall give Contractor written notice thereof prior to starting any such other work. If Owner has advance information regarding the start of any utility work at or adjacent to the Site, Owner shall provide such information to Contractor.

C. Contractor shall afford each other contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other work with Owner’s employees, proper and safe access to the Site, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others’ work with the written consent of Engineer and the others whose work will be affected.

D. If the proper execution or results of any part of Contractor’s Work depends upon work performed by others under this Article 8, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor’s Work. Contractor’s failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor’s Work except for latent defects and deficiencies in such other work.

8.02 Coordination

A. If Owner intends to contract with others for the performance of other work at or adjacent to the Site, to perform other work at or adjacent to the Site with Owner’s employees, or to arrange to have utility owners perform work at or adjacent to the Site, the following will be set forth in the Supplementary Conditions or provided to Contractor prior to the start of any such other work:

1. the identity of the individual or entity that will have authority and responsibility for coordination of the activities among the various contractors;

2. an itemization of the specific matters to be covered by such authority and responsibility; and

3. the extent of such authority and responsibilities.

B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

8.03 Legal Relationships

A. If, in the course of performing other work at or adjacent to the Site for Owner, the Owner’s employees, any other contractor working for Owner, or any utility owner causes damage to the Work or to the property of Contractor or its Subcontractors, or
delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor must submit any Change Proposal seeking an equitable adjustment in the Contract Price or the Contract Times under this paragraph within 30 days of the damaging, delaying, disrupting, or interfering event. The entitlement to, and extent of, any such equitable adjustment shall take into account information (if any) regarding such other work that was provided to Contractor in the Contract Documents prior to the submittal of the Bid or the final negotiation of the terms of the Contract. When applicable, any such equitable adjustment in Contract Price shall be conditioned on Contractor assigning to Owner all Contractor’s rights against such other contractor or utility owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Contractor’s entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor’s ability to complete the Work within the Contract Times.

B. Contractor shall take reasonable and customary measures to avoid damaging, delaying, disrupting, or interfering with the work of Owner, any other contractor, or any utility owner performing other work at or adjacent to the Site. If Contractor fails to take such measures and as a result damages, delays, disrupts, or interferes with the work of any such other contractor or utility owner, then Owner may impose a set-off against payments due to Contractor, and assign to such other contractor or utility owner the Owner’s contractual rights against Contractor with respect to the breach of the obligations set forth in this paragraph.

C. When Owner is performing other work at or adjacent to the Site with Owner’s employees, Contractor shall be liable to Owner for damage to such other work, and for the reasonable direct delay, disruption, and interference costs incurred by Owner as a result of Contractor’s failure to take reasonable and customary measures with respect to Owner’s other work. In response to such damage, delay, disruption, or interference, Owner may impose a set-off against payments due to Contractor.

D. If Contractor damages, delays, disrupts, or interferes with the work of any other contractor, or any utility owner performing other work at or adjacent to the Site, through Contractor’s failure to take reasonable and customary measures to avoid such impacts, or if any claim arising out of Contractor’s actions, inactions, or negligence in performance of the Work at or adjacent to the Site is made by any such other contractor or utility owner against Contractor, Owner, or Engineer, then Contractor shall (1) promptly attempt to settle the claim as to all parties through negotiations with such other contractor or utility owner, or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law, and (2) indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claims, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such damage, delay, disruption, or interference.

ARTICLE 9 – OWNER’S RESPONSIBILITIES

9.01 Communications to Contractor

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.
9.02 Replacement of Engineer
A. Owner may at its discretion appoint an engineer to replace Engineer, provided Contractor makes no reasonable objection to the replacement engineer. The replacement engineer’s status under the Contract Documents shall be that of the former Engineer.

9.03 Furnish Data
A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

9.04 Pay When Due
A. Owner shall make payments to Contractor when they are due as provided in the Agreement.

9.05 Lands and Easements; Reports, Tests, and Drawings
A. Owner’s duties with respect to providing lands and easements are set forth in Paragraph 5.01.
B. Owner’s duties with respect to providing engineering surveys to establish reference points are set forth in Paragraph 4.03.
C. Article 5 refers to Owner’s identifying and making available to Contractor copies of reports of explorations and tests of conditions at the Site, and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

9.06 Insurance
A. Owner’s responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 6.

9.07 Change Orders
A. Owner’s responsibilities with respect to Change Orders are set forth in Article 11.

9.08 Inspections, Tests, and Approvals
A. Owner’s responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 14.02.B.

9.09 Limitations on Owner’s Responsibilities
A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor’s means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor’s failure to perform the Work in accordance with the Contract Documents.

9.10 Undisclosed Hazardous Environmental Condition
A. Owner’s responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 5.06.

9.11 Evidence of Financial Arrangements
A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner’s obligations under the Contract Documents (including obligations under proposed changes in the Work).
9.12 **Safety Programs**

A. While at the Site, Owner’s employees and representatives shall comply with the specific applicable requirements of Contractor’s safety programs of which Owner has been informed.

B. Owner shall furnish copies of any applicable Owner safety programs to Contractor.

**ARTICLE 10 – ENGINEER’S STATUS DURING CONSTRUCTION**

10.01 **Owner's Representative**

A. Engineer will be Owner’s representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner’s representative during construction are set forth in the Contract.

10.02 **Visits to Site**

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor’s executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer’s efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer’s visits and observations are subject to all the limitations on Engineer’s authority and responsibility set forth in Paragraph 10.08. Particularly, but without limitation, during or as a result of Engineer’s visits or observations of Contractor’s Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor’s means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

10.03 **Project Representative**

A. If Owner and Engineer have agreed that Engineer will furnish a Resident Project Representative to represent Engineer at the Site and assist Engineer in observing the progress and quality of the Work, then the authority and responsibilities of any such Resident Project Representative will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 10.08. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent, or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

10.04 **Rejecting Defective Work**

A. Engineer has the authority to reject Work in accordance with Article 14.
10.05 *Shop Drawings, Change Orders and Payments*

A. Engineer’s authority, and limitations thereof, as to Shop Drawings and Samples, are set forth in Paragraph 7.16.

B. Engineer’s authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, are set forth in Paragraph 7.19.

C. Engineer’s authority as to Change Orders is set forth in Article 11.

D. Engineer’s authority as to Applications for Payment is set forth in Article 15.

10.06 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor as set forth in Paragraph 13.03.

10.07 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will render decisions regarding the requirements of the Contract Documents, and judge the acceptability of the Work, pursuant to the specific procedures set forth herein for initial interpretations, Change Proposals, and acceptance of the Work. In rendering such decisions and judgments, Engineer will not show partiality to Owner or Contractor, and will not be liable to Owner, Contractor, or others in connection with any proceedings, interpretations, decisions, or judgments conducted or rendered in good faith.

10.08 *Limitations on Engineer’s Authority and Responsibilities*

A. Neither Engineer’s authority or responsibility under this Article 10 or under any other provision of the Contract, nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer, shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor’s means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor’s failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer’s review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 15.06.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals, that the results certified indicate compliance with the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 10.08 shall also apply to the Resident Project Representative, if any.
10.09 Compliance with Safety Program

A. While at the Site, Engineer’s employees and representatives will comply with the specific applicable requirements of Owner’s and Contractor’s safety programs (if any) of which Engineer has been informed.

ARTICLE 11 – AMENDING THE CONTRACT DOCUMENTS; CHANGES IN THE WORK

11.01 Amending and Supplementing Contract Documents

A. The Contract Documents may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.

1. Change Orders:
   a. If an amendment or supplement to the Contract Documents includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order. A Change Order also may be used to establish amendments and supplements of the Contract Documents that do not affect the Contract Price or Contract Times.
   b. Owner and Contractor may amend those terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, without the recommendation of the Engineer. Such an amendment shall be set forth in a Change Order.

2. Work Change Directives: A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive’s effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Contract Documents governing adjustments, expressly including Paragraph 11.04 regarding change of Contract Price. Contractor must submit any Change Proposal seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 30 days after the completion of the Work set out in the Work Change Directive. Owner must submit any Claim seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 60 days after issuance of the Work Change Directive.

3. Field Orders: Engineer may authorize minor changes in the Work if the changes do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Owner and also on Contractor, which shall perform the Work involved promptly. If Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.02 Owner-Authorized Changes in the Work

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work. Such changes shall be supported by Engineer’s recommendation, to the extent the change involves the design (as set forth in the Drawings, Specifications, or otherwise), or
other engineering or technical matters. Such changes may be accomplished by a Change Order, if Owner and Contractor have agreed as to the effect, if any, of the changes on Contract Times or Contract Price; or by a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved; or, in the case of a deletion in the Work, promptly cease construction activities with respect to such deleted Work. Added or revised Work shall be performed under the applicable conditions of the Contract Documents. Nothing in this paragraph shall obligate Contractor to undertake work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor’s safety obligations under the Contract Documents or Laws and Regulations.

11.03 **Unauthorized Changes in the Work**

A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents, as amended, modified, or supplemented, except in the case of an emergency as provided in Paragraph 7.15 or in the case of uncovering Work as provided in Paragraph 14.05.

11.04 **Change of Contract Price**

A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price shall comply with the provisions of Paragraph 11.06. Any Claim for an adjustment of Contract Price shall comply with the provisions of Article 12.

B. An adjustment in the Contract Price will be determined as follows:

1. where the Work involved is covered by unit prices contained in the Contract Documents, then by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 13.03); or

2. where the Work involved is not covered by unit prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.04.C.2); or

3. where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor’s fee for overhead and profit (determined as provided in Paragraph 11.04.C).

C. **Contractor’s Fee:** When applicable, the Contractor’s fee for overhead and profit shall be determined as follows:

1. a mutually acceptable fixed fee; or

2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:
   a. for costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2, the Contractor’s fee shall be 15 percent;
   b. for costs incurred under Paragraph 13.01.B.3, the Contractor’s fee shall be five percent;
   c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 11.01.C.2.a and 11.01.C.2.b is that the Contractor’s fee shall be based on:
(1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.A.1 and 13.01.A.2 by the Subcontractor that actually performs the Work, at whatever tier, and (2) with respect to Contractor itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of five percent of the amount (fee plus underlying costs incurred) attributable to the next lower tier Subcontractor; provided, however, that for any such subcontracted work the maximum total fee to be paid by Owner shall be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the work;

d. no fee shall be payable on the basis of costs itemized under Paragraphs 13.01.B.4, 13.01.B.5, and 13.01.C;

e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor’s fee by an amount equal to five percent of such net decrease; and

f. when both additions and credits are involved in any one change, the adjustment in Contractor’s fee shall be computed on the basis of the net change in accordance with Paragraphs 11.04.C.2.a through 11.04.C.2.e, inclusive.

11.05 Change of Contract Times

A. The Contract Times may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Times shall comply with the provisions of Paragraph 11.06. Any Claim for an adjustment in the Contract Times shall comply with the provisions of Article 12.

B. An adjustment of the Contract Times shall be subject to the limitations set forth in Paragraph 4.05, concerning delays in Contractor’s progress.

11.06 Change Proposals

A. Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; appeal an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; contest a set-off against payment due; or seek other relief under the Contract. The Change Proposal shall specify any proposed change in Contract Times or Contract Price, or both, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents.

1. Procedures: Contractor shall submit each Change Proposal to Engineer promptly (but in no event later than 30 days) after the start of the event giving rise thereto, or after such initial decision. The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal. The supporting data shall be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event. Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal.

2. Engineer’s Action: Engineer will review each Change Proposal and, within 30 days after receipt of the Contractor’s supporting data, either deny the Change
Proposal in whole, approve it in whole, or deny it in part and approve it in part. Such actions shall be in writing, with a copy provided to Owner and Contractor. If Engineer does not take action on the Change Proposal within 30 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of Engineer’s inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under Article 12.

3. **Binding Decision:** Engineer’s decision will be final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.

B. **Resolution of Certain Change Proposals:** If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then Engineer will notify the parties that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice shall be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.

11.07 **Execution of Change Orders**

A. Owner and Contractor shall execute appropriate Change Orders covering:

1. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive;

2. changes in Contract Price resulting from an Owner set-off, unless Contractor has duly contested such set-off;

3. changes in the Work which are: (a) ordered by Owner pursuant to Paragraph 11.02, (b) required because of Owner’s acceptance of defective Work under Paragraph 14.04 or Owner’s correction of defective Work under Paragraph 14.07, or (c) agreed to by the parties, subject to the need for Engineer’s recommendation if the change in the Work involves the design (as set forth in the Drawings, Specifications, or otherwise), or other engineering or technical matters; and

4. changes in the Contract Price or Contract Times, or other changes, which embody the substance of any final and binding results under Paragraph 11.06, or Article 12.

B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of this Paragraph 11.07, it shall be deemed to be of full force and effect, as if fully executed.

11.08 **Notification to Surety**

A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor’s responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.
ARTICLE 12 – CLAIMS

12.01 Claims

A. Claims Process: The following disputes between Owner and Contractor shall be submitted to the Claims process set forth in this Article:

1. Appeals by Owner or Contractor of Engineer’s decisions regarding Change Proposals;

2. Owner demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents; and

3. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters.

B. Submittal of Claim: The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. The responsibility to substantiate a Claim shall rest with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, or both, Contractor shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and that to the best of Contractor's knowledge and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.

C. Review and Resolution: The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim shall be stated in writing and submitted to the other party, with a copy to Engineer.

D. Mediation:

1. At any time after initiation of a Claim, Owner and Contractor may mutually agree to mediation of the underlying dispute. The agreement to mediate shall stay the Claim submittal and response process.

2. If Owner and Contractor agree to mediation, then after 60 days from such agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process shall resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal and decision process shall resume as of the date of the conclusion of the mediation, as determined by the mediator.

3. Owner and Contractor shall each pay one-half of the mediator’s fees and costs.

E. Partial Approval: If the party receiving a Claim approves the Claim in part and denies it in part, such action shall be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 17 for final resolution of disputes.

F. Denial of Claim: If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not take action on the Claim within 90 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating
that as a result of the inaction, the Claim is deemed denied, thereby commencing the
time for appeal of the denial. A denial of the Claim shall be final and binding unless
within 30 days of the denial the other party invokes the procedure set forth in Article
17 for the final resolution of disputes.

G. Final and Binding Results: If the parties reach a mutual agreement regarding a Claim,
whether through approval of the Claim, direct negotiations, mediation, or otherwise;
or if a Claim is approved in part and denied in part, or denied in full, and such actions
become final and binding; then the results of the agreement or action on the Claim
shall be incorporated in a Change Order to the extent they affect the Contract,
including the Work, the Contract Times, or the Contract Price.

ARTICLE 13 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

13.01 Cost of the Work

A. Purposes for Determination of Cost of the Work: The term Cost of the Work means
the sum of all costs necessary for the proper performance of the Work at issue, as
further defined below. The provisions of this Paragraph 13.01 are used for two distinct
purposes:

1. To determine Cost of the Work when Cost of the Work is a component of the
Contract Price, under cost-plus-fee, time-and-materials, or other cost-based
terms; or

2. To determine the value of a Change Order, Change Proposal, Claim, set-off, or
other adjustment in Contract Price. When the value of any such adjustment is
determined on the basis of Cost of the Work, Contractor is entitled only to those
additional or incremental costs required because of the change in the Work or
because of the event giving rise to the adjustment.

B. Costs Included: Except as otherwise may be agreed to in writing by Owner, costs
included in the Cost of the Work shall be in amounts no higher than those prevailing
in the locality of the Project, shall not include any of the costs itemized in Paragraph
13.01.C, and shall include only the following items:

1. Payroll costs for employees in the direct employ of Contractor in the performance
of the Work under schedules of job classifications agreed upon by Owner and
Contractor. Such employees shall include, without limitation, superintendents,
foremen, and other personnel employed full time on the Work. Payroll costs for
employees not employed full time on the Work shall be apportioned on the basis
of their time spent on the Work. Payroll costs shall include, but not be limited to,
salaries and wages plus the cost of fringe benefits, which shall include social
security contributions, unemployment, excise, and payroll taxes, workers'
compensation, health and retirement benefits, bonuses, sick leave, and vacation
and holiday pay applicable thereto. The expenses of performing Work outside of
regular working hours, on Saturday, Sunday, or legal holidays, shall be included
in the above to the extent authorized by Owner.

2. Cost of all materials and equipment furnished and incorporated in the Work,
including costs of transportation and storage thereof, and Suppliers’ field services
required in connection therewith. All cash discounts shall accrue to Contractor
unless Owner deposits funds with Contractor with which to make payments, in
which case the cash discounts shall accrue to Owner. All trade discounts,
rebates, and refunds and returns from sale of surplus materials and equipment
shall accrue to Owner, and Contractor shall make provisions so that they may be
obtained.
3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor’s Cost of the Work and fee shall be determined in the same manner as Contractor’s Cost of the Work and fee as provided in this Paragraph 13.01.

4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.

5. Supplemental costs including the following:
   a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor’s employees incurred in discharge of duties connected with the Work.
   b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.
   c. Rentals of all construction equipment and machinery, and the parts thereof, whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.
   d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.
   e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.
   f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 6.05), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor’s fee.
   g. The cost of utilities, fuel, and sanitary facilities at the Site.
   h. Minor expenses such as communication service at the Site, express and courier services, and similar petty cash items in connection with the Work.
i. The costs of premiums for all bonds and insurance that Contractor is required by the Contract Documents to purchase and maintain.

C. Costs Excluded: The term Cost of the Work shall not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 13.01.B.1 or specifically covered by Paragraph 13.01.B.4. The payroll costs and other compensation excluded here are to be considered administrative costs covered by the Contractor's fee.

2. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.

4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 13.01.B.

D. Contractor's Fee: When the Work as a whole is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 11.04.C.

E. Documentation: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 13, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

13.02 Allowances

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

B. Cash Allowances: Contractor agrees that:

1. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and

2. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have
been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.

C. Contingency Allowance: Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

13.03 Unit Price Work

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Payments to Contractor for Unit Price Work will be based on actual quantities.

C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor’s overhead and profit for each separately identified item.

D. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer’s preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer’s written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of the following paragraph.

E. Within 30 days of Engineer’s written decision under the preceding paragraph, Contractor may submit a Change Proposal, or Owner may file a Claim, seeking an adjustment in the Contract Price if:

1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement;
2. there is no corresponding adjustment with respect to any other item of Work; and
3. Contractor believes that it is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price, and the parties are unable to agree as to the amount of any such increase or decrease.

ARTICLE 14 – TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

14.01 Access to Work

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and authorities having jurisdiction will have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor’s safety procedures and programs so that they may comply therewith as applicable.
14.02 Tests, Inspections, and Approvals

A. Contractor shall give Engineer timely notice of readiness of the Work (or specific parts thereof) for all required inspections and tests, and shall cooperate with inspection and testing personnel to facilitate required inspections and tests.

B. Owner shall retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform all inspections and tests expressly required by the Contract Documents to be furnished and paid for by Owner, except that costs incurred in connection with tests or inspections of covered Work shall be governed by the provisions of Paragraph 14.05.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

D. Contractor shall be responsible for arranging, obtaining, and paying for all inspections and tests required:

1. by the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to Owner;

2. to attain Owner’s and Engineer’s acceptance of materials or equipment to be incorporated in the Work;

3. by manufacturers of equipment furnished under the Contract Documents;

4. for testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work; and

5. for acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor’s purchase thereof for incorporation in the Work.

Such inspections and tests shall be performed by independent inspectors, testing laboratories, or other qualified individuals or entities acceptable to Owner and Engineer.

E. If the Contract Documents require the Work (or part thereof) to be approved by Owner, Engineer, or another designated individual or entity, then Contractor shall assume full responsibility for arranging and obtaining such approvals.

F. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation. Such uncovering shall be at Contractor’s expense unless Contractor had given Engineer timely notice of Contractor’s intention to cover the same and Engineer had not acted with reasonable promptness in response to such notice.

14.03 Defective Work

A. Contractor’s Obligation: It is Contractor’s obligation to assure that the Work is not defective.

B. Engineer’s Authority: Engineer has the authority to determine whether Work is defective, and to reject defective Work.

C. Notice of Defects: Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor.
D. **Correction, or Removal and Replacement**: Promptly after receipt of written notice of defective Work, Contractor shall correct all such defective Work, whether or not fabricated, installed, or completed, or, if Engineer has rejected the defective Work, remove it from the Project and replace it with Work that is not defective.

E. **Preservation of Warranties**: When correcting defective Work, Contractor shall take no action that would void or otherwise impair Owner’s special warranty and guarantee, if any, on said Work.

F. **Costs and Damages**: In addition to its correction, removal, and replacement obligations with respect to defective Work, Contractor shall pay all claims, costs, losses, and damages arising out of or relating to defective Work, including but not limited to the cost of the inspection, testing, correction, removal, replacement, or reconstruction of such defective Work, fines levied against Owner by governmental authorities because the Work is defective, and the costs of repair or replacement of work of others resulting from defective Work. Prior to final payment, if Owner and Contractor are unable to agree as to the measure of such claims, costs, losses, and damages resulting from defective Work, then Owner may impose a reasonable set-off against payments due under Article 15.

14.04 **Acceptance of Defective Work**

A. If, instead of requiring correction or removal and replacement of defective Work, Owner prefers to accept it, Owner may do so (subject, if such acceptance occurs prior to final payment, to Engineer’s confirmation that such acceptance is in general accord with the design intent and applicable engineering principles, and will not endanger public safety). Contractor shall pay all claims, costs, losses, and damages attributable to Owner’s evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness), and for the diminished value of the Work to the extent not otherwise paid by Contractor. If any such acceptance occurs prior to final payment, the necessary revisions in the Contract Documents with respect to the Work shall be incorporated in a Change Order. If the parties are unable to agree as to the decrease in the Contract Price, reflecting the diminished value of Work so accepted, then Owner may impose a reasonable set-off against payments due under Article 15. If the acceptance of defective Work occurs after final payment, Contractor shall pay an appropriate amount to Owner.

14.05 **Uncovering Work**

A. Engineer has the authority to require special inspection or testing of the Work, whether or not the Work is fabricated, installed, or completed.

B. If any Work is covered contrary to the written request of Engineer, then Contractor shall, if requested by Engineer, uncover such Work for Engineer’s observation, and then replace the covering, all at Contractor’s expense.

C. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, then Contractor, at Engineer’s request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, and provide all necessary labor, material, and equipment.

1. If it is found that the uncovered Work is defective, Contractor shall be responsible for all claims, costs, losses, and damages arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and pending Contractor’s full discharge of this
responsibility the Owner shall be entitled to impose a reasonable set-off against payments due under Article 15.

2. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, then Contractor may submit a Change Proposal within 30 days of the determination that the Work is not defective.

14.06 Owner May Stop the Work

A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, then Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work shall not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

14.07 Owner May Correct Defective Work

A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace rejected Work as required by Engineer, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, then Owner may, after seven days written notice to Contractor, correct or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 14.07, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor’s services related thereto, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner’s representatives, agents and employees, Owner’s other contractors, and Engineer and Engineer’s consultants access to the Site to enable Owner to exercise the rights and remedies under this paragraph.

C. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 will be charged against Contractor as set-offs against payments due under Article 15. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor’s defective Work.

D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner’s rights and remedies under this Paragraph 14.07.

ARTICLE 15 – PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

15.01 Progress Payments

A. Basis for Progress Payments: The Schedule of Values established as provided in Article 2 will serve as the basis for progress payments and will be incorporated into a
form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed during the pay period, as determined under the provisions of Paragraph 13.03. Progress payments for cost-based Work will be based on Cost of the Work completed by Contractor during the pay period.

B. Applications for Payments:

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens, and evidence that the materials and equipment are covered by appropriate property insurance, a warehouse bond, or other arrangements to protect Owner’s interest therein, all of which must be satisfactory to Owner.

2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor’s legitimate obligations associated with prior Applications for Payment.

3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

C. Review of Applications:

1. Engineer will, within 10 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Owner, or return the Application to Contractor indicating in writing Engineer’s reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.

2. Engineer’s recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer’s observations of the executed Work as an experienced and qualified design professional, and on Engineer’s review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer’s knowledge, information and belief:

   a. the Work has progressed to the point indicated;
   b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 13.03, and any other qualifications stated in the recommendation); and
c. the conditions precedent to Contractor’s being entitled to such payment appear to have been fulfilled in so far as it is Engineer’s responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:
   a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract; or
   b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer’s review of Contractor’s Work for the purposes of recommending payments nor Engineer’s recommendation of any payment, including final payment, will impose responsibility on Engineer:
   a. to supervise, direct, or control the Work, or
   b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or
   c. for Contractor’s failure to comply with Laws and Regulations applicable to Contractor’s performance of the Work, or
   d. to make any examination to ascertain how or for what purposes Contractor has used the money paid on account of the Contract Price, or
   e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer’s opinion, it would be incorrect to make the representations to Owner stated in Paragraph 15.01.C.2.

6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer’s opinion to protect Owner from loss because:
   a. the Work is defective, requiring correction or replacement;
   b. the Contract Price has been reduced by Change Orders;
   c. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
   d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible; or
   e. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents.

D. Payment Becomes Due:

1. Ten days after presentation of the Application for Payment to Owner with Engineer’s recommendation, the amount recommended (subject to any Owner set-offs) will become due, and when due will be paid by Owner to Contractor.
E. **Reductions in Payment by Owner.**

1. In addition to any reductions in payment (set-offs) recommended by Engineer, Owner is entitled to impose a set-off against payment based on any of the following:
   
   a. claims have been made against Owner on account of Contractor’s conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages on account of Contractor’s conduct in the performance or furnishing of the Work, including but not limited to claims, costs, losses, or damages from workplace injuries, adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;
   
   b. Contractor has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site;
   
   c. Contractor has failed to provide and maintain required bonds or insurance;
   
   d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;
   
   e. Owner has incurred extra charges or engineering costs related to submittal reviews, evaluations of proposed substitutes, tests and inspections, or return visits to manufacturing or assembly facilities;
   
   f. the Work is defective, requiring correction or replacement;
   
   g. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
   
   h. the Contract Price has been reduced by Change Orders;
   
   i. an event that would constitute a default by Contractor and therefore justify a termination for cause has occurred;
   
   j. liquidated damages have accrued as a result of Contractor’s failure to achieve Milestones, Substantial Completion, or final completion of the Work;
   
   k. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;
   
   l. there are other items entitling Owner to a set off against the amount recommended.

2. If Owner imposes any set-off against payment, whether based on its own knowledge or on the written recommendations of Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and the specific amount of the reduction, and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, if Contractor remedies the reasons for such action. The reduction imposed shall be binding on Contractor unless it duly submits a Change Proposal contesting the reduction.

3. Upon a subsequent determination that Owner’s refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 15.01.C.1 and subject to interest as provided in the Agreement.
15.02 **Contractor’s Warranty of Title**

A. Contractor warrants and guarantees that title to all Work, materials, and equipment furnished under the Contract will pass to Owner free and clear of (1) all Liens and other title defects, and (2) all patent, licensing, copyright, or royalty obligations, no later than seven days after the time of payment by Owner.

15.03 **Substantial Completion**

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete and request that Engineer issue a certificate of Substantial Completion. Contractor shall at the same time submit to Owner and Engineer an initial draft of punch list items to be completed or corrected before final payment.

B. Promptly after Contractor’s notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a preliminary certificate of Substantial Completion which shall fix the date of Substantial Completion. Engineer shall attach to the certificate a punch list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the preliminary certificate during which to make written objection to Engineer as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the preliminary certificate, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the preliminary certificate to Owner, notify Contractor in writing that the Work is not substantially complete, stating the reasons therefor. If Owner does not object to the provisions of the certificate, or if despite consideration of Owner’s objections Engineer concludes that the Work is substantially complete, then Engineer will, within said 14 days, execute and deliver to Owner and Contractor a final certificate of Substantial Completion (with a revised punch list of items to be completed or corrected) reflecting such changes from the preliminary certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of receipt of the preliminary certificate of Substantial Completion, Owner and Contractor will confer regarding Owner’s use or occupancy of the Work following Substantial Completion, review the builder’s risk insurance policy with respect to the end of the builder’s risk coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by Owner. Unless Owner and Contractor agree otherwise in writing, Owner shall bear responsibility for security, operation, protection of the Work, property insurance, maintenance, heat, and utilities upon Owner’s use or occupancy of the Work.

E. After Substantial Completion the Contractor shall promptly begin work on the punch list of items to be completed or corrected prior to final payment. In appropriate cases Contractor may submit monthly Applications for Payment for completed punch list items, following the progress payment procedures set forth above.

F. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the punch list.
15.04 **Partial Use or Occupancy**

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:

1. At any time Owner may request in writing that Contractor permit Owner to use or occupy any such part of the Work that Owner believes to be substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 15.03.A through E for that part of the Work.

2. At any time Contractor may notify Owner and Engineer in writing that Contractor considers any such part of the Work substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 15.03 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 6.05 regarding builder's risk or other property insurance.

15.05 **Final Inspection**

A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work, or agreed portion thereof, is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

15.06 **Final Payment**

A. **Application for Payment:**

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, annotated record documents (as provided in Paragraph 7.11), and other documents, Contractor may make application for final payment.

2. The final Application for Payment shall be accompanied (except as previously delivered) by:
   a. all documentation called for in the Contract Documents;
   b. consent of the surety, if any, to final payment;
c. satisfactory evidence that all title issues have been resolved such that title to all Work, materials, and equipment has passed to Owner free and clear of any Liens or other title defects, or will so pass upon final payment.

d. a list of all disputes that Contractor believes are unsettled; and

e. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of the Work, and of Liens filed in connection with the Work.

3. In lieu of the releases or waivers of Liens specified in Paragraph 15.06.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (a) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (b) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien, or Owner at its option may issue joint checks payable to Contractor and specified Subcontractors and Suppliers.

B. Engineer’s Review of Application and Acceptance:

1. If, on the basis of Engineer’s observation of the Work during construction and final inspection, and Engineer’s review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor’s other obligations under the Contract have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer’s recommendation of final payment and present the Application for Payment to Owner for payment. Such recommendation shall account for any set-offs against payment that are necessary in Engineer’s opinion to protect Owner from loss for the reasons stated above with respect to progress payments. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable, subject to the provisions of Paragraph 15.07. Otherwise, Engineer will return the 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 for Payment.

C. Completion of Work: The Work is complete (subject to surviving obligations) when it is ready for final payment as established by the Engineer’s written recommendation of final payment.

D. Payment Becomes Due: Thirty days after the presentation to Owner of the final Application for Payment and accompanying documentation, the amount recommended by Engineer (less any further sum Owner is entitled to set off against Engineer’s recommendation, including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions above with respect to progress payments) will become due and shall be paid by Owner to Contractor.

15.07 Waiver of Claims

A. The making of final payment will not constitute a waiver by Owner of claims or rights against Contractor. Owner expressly reserves claims and rights arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 15.05, from Contractor’s failure to comply with the Contract Documents or the terms
of any special guarantees specified therein, from outstanding Claims by Owner, or from Contractor’s continuing obligations under the Contract Documents.

B. The acceptance of final payment by Contractor will constitute a waiver by Contractor of all claims and rights against Owner other than those pending matters that have been duly submitted or appealed under the provisions of Article 17.

15.08 Correction Period

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents, or by any specific provision of the Contract Documents), any Work is found to be defective, or if the repair of any damages to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas used by Contractor as permitted by Laws and Regulations, is found to be defective, then Contractor shall promptly, without cost to Owner and in accordance with Owner’s written instructions:

1. correct the defective repairs to the Site or such other adjacent areas;
2. correct such defective Work;
3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and
4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others, or to other land or areas resulting therefrom.

B. If Contractor does not promptly comply with the terms of Owner’s written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others).

C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.

D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this paragraph, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

E. Contractor’s obligations under this paragraph are in addition to all other obligations and warranties. The provisions of this paragraph shall not be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

ARTICLE 16 – SUSPENSION OF WORK AND TERMINATION

16.01 Owner May Suspend Work

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by written notice to Contractor and Engineer. Such notice will fix the date on which Work will be resumed. Contractor
shall resume the Work on the date so fixed. Contractor shall be entitled to an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension. Any Change Proposal seeking such adjustments shall be submitted no later than 30 days after the date fixed for resumption of Work.

16.02 Owner May Terminate for Cause

A. The occurrence of any one or more of the following events will constitute a default by Contractor and justify termination for cause:
   1. Contractor’s persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule);
   2. Failure of Contractor to perform or otherwise to comply with a material term of the Contract Documents;
   3. Contractor’s disregard of Laws or Regulations of any public body having jurisdiction; or
   4. Contractor’s repeated disregard of the authority of Owner or Engineer.

B. If one or more of the events identified in Paragraph 16.02.A occurs, then after giving Contractor (and any surety) ten days written notice that Owner is considering a declaration that Contractor is in default and termination of the contract, Owner may proceed to:
   1. declare Contractor to be in default, and give Contractor (and any surety) notice that the Contract is terminated; and
   2. enforce the rights available to Owner under any applicable performance bond.

C. Subject to the terms and operation of any applicable performance bond, if Owner has terminated the Contract for cause, Owner may exclude Contractor from the Site, take possession of the Work, incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and complete the Work as Owner may deem expedient.

D. Owner may not proceed with termination of the Contract under Paragraph 16.02.B if Contractor within seven days of receipt of notice of intent to terminate begins to correct its failure to perform and proceeds diligently to cure such failure.

E. If Owner proceeds as provided in Paragraph 16.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds the cost to complete the Work, including all related claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals) sustained by Owner, such excess will be paid to Contractor. If the cost to complete the Work including such related claims, costs, losses, and damages exceeds such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

F. Where Contractor’s services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue, or any rights or remedies of Owner against Contractor or any
surety under any payment bond or performance bond. Any retention or payment of money due Contractor by Owner will not release Contractor from liability.

G. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 6.01.A, the provisions of that bond shall govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

16.03 Owner MayTerminate For Convenience

A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses; and

3. other reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.

B. Contractor shall not be paid on account of loss of anticipated overhead, profits, or revenue, or other economic loss arising out of or resulting from such termination.

16.04 Contractor May Stop Work or Terminate

A. If, through no act or fault of Contractor, (1) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (2) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (3) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the contract and recover from Owner payment on the same terms as provided in Paragraph 16.03.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this paragraph are not intended to preclude Contractor from submitting a Change Proposal for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor’s stopping the Work as permitted by this paragraph.

ARTICLE 17 – FINAL RESOLUTION OF DISPUTES

17.01 Methods and Procedures

A. Disputes Subject to Final Resolution: The following disputed matters are subject to final resolution under the provisions of this Article:

1. A timely appeal of an approval in part and denial in part of a Claim, or of a denial in full; and
2. Disputes between Owner and Contractor concerning the Work or obligations under the Contract Documents, and arising after final payment has been made.

B. **Final Resolution of Disputes:** For any dispute subject to resolution under this Article, Owner or Contractor may:
   1. elect in writing to invoke the dispute resolution process provided for in the Supplementary Conditions; or
   2. agree with the other party to submit the dispute to another dispute resolution process; or
   3. if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to, give written notice to the other party of the intent to submit the dispute to a court of competent jurisdiction.

**ARTICLE 18 – MISCELLANEOUS**

18.01 **Giving Notice**

   A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:
      1. delivered in person, by a commercial courier service or otherwise, to the individual or to a member of the firm or to an officer of the corporation for which it is intended; or
      2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the sender of the notice.

18.02 **Computation of Times**

   A. When any period of time is referred to in the Contract by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

18.03 **Cumulative Remedies**

   A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract. The provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

18.04 **Limitation of Damages**

   A. With respect to any and all Change Proposals, Claims, disputes subject to final resolution, and other matters at issue, neither Owner nor Engineer, nor any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, shall be liable to Contractor for any claims, costs, losses, or damages sustained by Contractor on or in connection with any other project or anticipated project.
18.05 *No Waiver*
   A. A party’s non-enforcement of any provision shall not constitute a waiver of that provision, nor shall it affect the enforceability of that provision or of the remainder of this Contract.

18.06 *Survival of Obligations*
   A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract, as well as all continuing obligations indicated in the Contract, will survive final payment, completion, and acceptance of the Work or termination or completion of the Contract or termination of the services of Contractor.

18.07 *Controlling Law*
   A. This Contract is to be governed by the law of the state in which the Project is located.

18.08 *Headings*
   A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.
SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract, (00 0700 Standard General Conditions of the Construction Contract). All provisions that are not so amended or supplemented remain in full force and effect.

The terms used in these Supplementary Conditions have the meanings stated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof.

The address system used in these Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix "SC" added thereto.

**SC-2.02 Copies of Documents**

Delete Paragraph 2.02.A in its entirety and insert the following new paragraph in its place:

A. Owner shall furnish to Contractor 5 copies of conformed Contract Documents incorporating and integrating all Addenda and any amendments negotiated prior to the Effective Date of the Contract (including one fully executed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies of the conformed Contract Documents will be furnished upon request at the cost of reproduction.

**SC-5.03 Subsurface and Physical Conditions**

None

**SC-5.06 Hazardous Environmental Conditions**

Potential Petroleum Impacted Soils

**SC-6.02 Insurance—General Provisions**

Add the following paragraph immediately after Paragraph 6.02.B:

1. Contractor may obtain worker’s compensation insurance from an insurance company that has not been rated by A.M. Best, provided that such company (a) is domiciled in the state in which the project is located, (b) is certified or authorized as a worker’s compensation insurance provider by the appropriate state agency, and (c) has been accepted to provide worker’s compensation insurance for similar projects by the state within the last 12 months.

**SC-6.03 Contractor’s Liability Insurance**

Add the following new paragraph immediately after Paragraph 6.03.J:

K. The limits of liability for the insurance required by Paragraph 6.03 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:
1. Workers’ Compensation, and related coverages under Paragraphs 6.03.A.1 and A.2 of the General Conditions:

State: ____________________________
Federal, if applicable (e.g., Longshoreman’s): ____________________________

Employer’s Liability:
- Bodily injury, each accident $2,000,000
- Bodily injury by disease, each employee $2,000,000
- Bodily injury/disease aggregate $2,000,000

Foreign voluntary worker compensation ____________________________

2. Contractor’s Commercial General Liability under Paragraphs 6.03.B and 6.03.C of the General Conditions:

- General Aggregate $2,000,000
- Products - Completed Operations Aggregate $2,000,000
- Personal and Advertising Injury $1,000,000
- Each Occurrence (Bodily Injury and Property Damage) $1,000,000

3. Automobile Liability under Paragraph 6.03.D. of the General Conditions:

- Bodily Injury:
  - Each person $1,000,000
  - Each accident $1,000,000

- Property Damage:
  - Each accident $2,000,000
SC-7.09 Taxes

SC 7.09 Add a new paragraph immediately after Paragraph 7.09.A:

B. Owner is exempt from payment of sales and compensating use taxes of the State of Illinois and of cities and counties thereof on all materials to be incorporated into the Work.
   1. Owner will provide evidence of tax-exempt status to Contractor after award of Contract.
   2. Owner’s exemption does not apply to construction tools, machinery, equipment, or other property purchased by or leased by Contractor, or to supplies or materials not incorporated into the Work.

SC-8.02 Coordination

SC-8.02 Delete Paragraph 8.02.A in its entirety and replace with the following:

A.
   2. The following specific matters are to be covered by such authority and responsibility:
      • Coordination with awarded Contractor regarding ongoing construction operations
      • Traffic Control
      • Protection of installed components for adjacent projects upon substantial completion
   3. The extent of such authority and responsibilities is: as required by Owner.

SC-10.03 Project Representative

SC-10.03 Add the following new paragraphs immediately after Paragraph 10.03.A:

B. The Resident Project Representative (RPR) will be Engineer's representative at the Site, will act as directed by and under the supervision of Engineer, and will confer with Engineer regarding RPR's actions.
   1. General: RPR's dealings in matters pertaining to the Work in general shall be with Engineer and Contractor. RPR's dealings with Subcontractors shall only be through or with the full knowledge and approval of Contractor. RPR shall generally communicate with Owner only with the knowledge of and under the direction of Engineer.
   2. Schedules: Review the progress schedule, schedule of Shop Drawing and Sample submittals, and Schedule of Values prepared by Contractor and consult with Engineer concerning acceptability.
   3. Conferences and Meetings: Attend meetings with Contractor, such as preconstruction conferences, progress meetings, job conferences, and other Project-related meetings, and prepare and circulate copies of minutes thereof.
4. Liaison:
   a. Serve as Engineer’s liaison with Contractor. Working principally through Contractor’s authorized representative or designee, assist in providing information regarding the provisions and intent of the Contract Documents.
   b. Assist Engineer in serving as Owner’s liaison with Contractor when Contractor’s operations affect Owner’s on-Site operations.
   c. Assist in obtaining from Owner additional details or information, when required for proper execution of the Work.

5. Interpretation of Contract Documents: Report to Engineer when clarifications and interpretations of the Contract Documents are needed and transmit to Contractor clarifications and interpretations as issued by Engineer.

6. Shop Drawings and Samples:
   a. Record date of receipt of Samples and Contractor-approved Shop Drawings.
   b. Receive Samples which are furnished at the Site by Contractor, and notify Engineer of availability of Samples for examination.
   c. Advise Engineer and Contractor of the commencement of any portion of the Work requiring a Shop Drawing or Sample submittal for which RPR believes that the submittal has not been approved by Engineer.

7. Modifications: Consider and evaluate Contractor’s suggestions for modifications in Drawings or Specifications and report such suggestions, together with RPR’s recommendations, if any, to Engineer. Transmit to Contractor in writing decisions as issued by Engineer.

8. Review of Work and Rejection of Defective Work:
   a. Conduct on-Site observations of Contractor’s work in progress to assist Engineer in determining if the Work is in general proceeding in accordance with the Contract Documents.
   b. Report to Engineer whenever RPR believes that any part of Contractor’s work in progress is defective, will not produce a completed Project that conforms generally to the Contract Documents, or will imperil the integrity of the design concept of the completed Project as a functioning whole as indicated in the Contract Documents, or has been damaged, or does not meet the requirements of any inspection, test or approval required to be made; and advise Engineer of that part of work in progress that RPR believes should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection or approval.

9. Inspections, Tests, and System Start-ups:
   a. Verify that tests, equipment, and systems start-ups and operating and maintenance training are conducted in the presence of appropriate Owner’s personnel, and that Contractor maintains adequate records thereof.
b. Observe, record, and report to Engineer appropriate details relative to the test procedures and systems start-ups.

10. Records:
   a. Prepare a daily report or keep a diary or log book, recording Contractor’s hours on the Site, Subcontractors present at the Site, weather conditions, data relative to questions of Change Orders, Field Orders, Work Change Directives, or changed conditions, Site visitors, deliveries of equipment or materials, daily activities, decisions, observations in general, and specific observations in more detail as in the case of observing test procedures; and send copies to Engineer.

   b. Record names, addresses, fax numbers, e-mail addresses, web site locations, and telephone numbers of all Contractors, Subcontractors, and major Suppliers of materials and equipment.

   c. Maintain records for use in preparing Project documentation.

11. Reports:
   a. Furnish to Engineer periodic reports as required of progress of the Work and of Contractor’s compliance with the Progress Schedule and schedule of Shop Drawing and Sample submittals.

   b. Draft and recommend to Engineer proposed Change Orders, Work Change Directives, and Field Orders. Obtain backup material from Contractor.

   c. Immediately notify Engineer of the occurrence of any Site accidents, emergencies, acts of God endangering the Work, force majeure or delay events, damage to property by fire or other causes, or the discovery of any Constituent of Concern or Hazardous Environmental Condition.

12. Payment Requests: Review applications for payment with Contractor for compliance with the established procedure for their submission and forward with recommendations to Engineer, noting particularly the relationship of the payment requested to the Schedule of Values, Work completed, and materials and equipment delivered at the Site but not incorporated in the Work.

13. Certificates, Operation and Maintenance Manuals: During the course of the Work, verify that materials and equipment certificates, operation and maintenance manuals and other data required by the Contract Documents to be assembled and furnished by Contractor are applicable to the items actually installed and in accordance with the Contract Documents, and have these documents delivered to Engineer for review and forwarding to Owner prior to payment for that part of the Work.

14. Completion:
   a. Participate in Engineer’s visits to the Site to determine Substantial Completion, assist in the determination of Substantial Completion and the preparation of a punch list of items to be completed or corrected.

   b. Participate in Engineer’s final visit to the Site to determine completion of the Work, in the company of Owner and Contractor,
and prepare a final punch list of items to be completed and deficiencies to be remedied.

c. Observe whether all items on the final list have been completed or corrected and make recommendations to Engineer concerning acceptance and issuance of the notice of acceptability of the work.

C. The RPR shall not:

1. Authorize any deviation from the Contract Documents or substitution of materials or equipment (including “or-equal” items).

2. Exceed limitations of Engineer’s authority as set forth in the Contract Documents.

3. Undertake any of the responsibilities of Contractor, Subcontractors, or Suppliers.

4. Advise on, issue directions relative to, or assume control over any aspect of the means, methods, techniques, sequences or procedures of Contractor’s work.

5. Advise on, issue directions regarding, or assume control over security or safety practices, precautions, and programs in connection with the activities or operations of Owner or Contractor.

6. Participate in specialized field or laboratory tests or inspections conducted off-site by others except as specifically authorized by Engineer.

7. Accept Shop Drawing or Sample submittals from anyone other than Contractor.

8. Authorize Owner to occupy the Project in whole or in part.

\textit{SC-13.01 } Cost of the Work

SC 13.01.B.5.c Delete Paragraph 13.01.B.5.c in its entirety and insert the following in its place:

\begin{itemize}
  \item \textbf{c. Construction Equipment and Machinery:}
  \begin{itemize}
    \item \textbf{1) } Rentals of all construction equipment and machinery, and the parts thereof, in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.
    \item \textbf{2) } Costs for equipment and machinery owned by Contractor will be paid at a rate shown for such equipment. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs. Costs will include the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, shall cease to accrue when the use thereof is no longer necessary for the changed Work. Equipment or machinery with a value of less than $1,000 will be considered small tools.
  \end{itemize}
\end{itemize}
SC-18.09 **Miscellaneous Requirements**

Add the following new paragraphs immediately after Paragraph 18.08.

**SC-18.09 Certified Payrolls Requirements (Public Act 94-0515)**

A. Contractor and subcontractors on public works projects must submit certified payroll records on a monthly basis to the public body in charge of the construction project, along with a statement affirming that such records are true and accurate, that the wages paid to each worker are not less than the required rate and that the contractor is aware that filing records he or she knows to be false is a Class B misdemeanor.

B. The certified payroll records must include for every worker employed on the public works project the name, address, telephone number, social security number, job classification, hourly wages paid in each pay period, number of hours worked each day, and starting and ending time of work each day. These certified payroll records are considered public records and public bodies must make these records available to the public under the Freedom of Information Act, with the exception of the employee’s address, telephone number and social security number.

**SC-18.10 Prevailing Wage Determinations - Not less than the prevailing rates of wages, as established by the Illinois Department of Labor for prevailing wages, effective as of the date of bid opening, or such prevailing wage rate of wages as may thereafter be established by the Illinois Department of labor for the county where the Work is performed shall be paid to all laborers, workers and mechanics performing Work under this contract, including any subcontract, and all bonds required hereunder shall include a provision to guarantee the faithful performance of such prevailing wage obligations.**

The Contractor will be required to comply with the wage and labor requirements stated herein and to pay not less than the minimum wages in accordance with the Wage Decisions established by the United States Department of Labor or the State of Illinois for the county where the work is performed. The highest rate, whether federal or state, will be the minimum rate paid for each work classification.

Contractor shall prominently post the current Schedule of Prevailing Wages at the project site.

PART 1 - GENERAL

A. FAA AIRWAY FACILITIES. The Contractor shall permit FAA Airway Facilities (FAA AF) personnel the right to enter the work site during the term of the contract for maintenance of existing navigation and communication facilities.

In the event that the proposed work will impact existing FAA navigation and communication facilities, the Contractor shall notify the Owner/FAA one week in advance of construction activity in order to allow the FAA sufficient time to locate and mark existing field cables and to avoid all unscheduled facility outage. The Contractor shall coordinate with FAA concerning all operation and shutdown of all FAA navigational facilities during this construction project.

Any FAA equipment/cable that is damaged by the Contractor shall be repaired as approved by FAA. If FAA cables are anticipated to facilitate construction, the Contractor shall provide advance notice to FAA in order to mobilize a FAA technician to the site for observation of the splicing. Splicing and cable repair shall meet the FAA Airway Facilities specifications and shall be accomplished to the satisfaction of FAA. All such work shall be performed by qualified workmen regularly engaged in cable repair and splicing. In the event the existing cable cannot be repaired to the satisfaction of FAA AF personnel, new cable of like kind shall be procured and installed by the Contractor.

B. OPERATIONAL SAFETY ON AIRPORT DURING CONSTRUCTION. All work within the Airport Operations Area shall be accomplished in conformance to Advisory Circular 150/5370-2 (Latest Edition). The contract drawings include information regarding minimum requirements operational safety on the airport during construction. The Contractor shall prepare a detailed safety plan based on the minimum requirements set forth on the safety plan provided in the contract drawings. The Contractor’s safety plan shall identify specific methods, sequencing, phasing that he/she intends to use in order to accomplish the project work. The final safety plan shall be the result of a coordinated effort between the Owner, the Engineer and the Contractor.

The Contractor shall adhere to the approved safety plan as agreed upon by the Owner, Engineer and Contractor. Modifications or deviations from the approved safety plan shall be submitted to the Engineer for review and approval prior to implementation.

END OF SECTION 00843
SECTION 23 0010 - MECHANICAL GENERAL REQUIREMENTS

PART 1 GENERAL

1.1. GENERAL

A. All work under this section shall comply with the contract requirements noted on the architectural drawings and/or specifications and shall include all mechanical sections specified herein. All work under this section shall comply with the contract requirements noted on architectural drawings and specifications general requirements.

B. Mechanical contractor shall schedule start-up session to start HVAC equipment. Schedule one full day of start-up at least two weeks prior to substantial completion.

1.2. WORK INCLUDED

A. Provide all labor, materials, equipment and tools required for completely finished and operational HVAC and mechanical systems to fulfill the design intent shown on the documents.

B. Work shall be of the finest quality of construction, materials and workmanship.

C. Install equipment in accordance with manufacturer recommendations.

D. The plans are diagrammatic and generally show the locations of fixtures, equipment, ductwork and piping and shall not be scaled. Provide all offsets, fittings and components required for a complete system even if not explicitly called out on the drawings.

1.4. COORDINATION AND VERIFICATION

A. Refer to the architectural interior details, floor plans, elevations and other contract drawings as well as existing structural, mechanical, fire protection, electrical systems and other existing conditions. Coordinate work with that of the other trades to avoid interference.

B. All dimensions and existing conditions shall be field verified prior to the commencement of the work.

C. Contract Documents:

1. General: The Contract Documents are diagrammatic, showing certain physical relationships which must be established within the mechanical work and its interface with other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing material quantities.

2. When electronic CAD files or building information modeling (BIM) files have been provided to the contractor, the contractor shall only consider the files as design to only show the intent of the design. The contractor shall be responsible for the Coordination drawings based on the design.

3. Work out all “tight” conditions in advance of installation. If necessary, and before work proceeds in those areas, prepare coordination drawings showing all work in congested areas. Provide additional work necessary to overcome congested conditions at no increase in contract sum or schedule.

4. Clearly indicate solutions to space problems. Identification of space problems without solutions is not acceptable. Only areas clearly identified will be reviewed.

5. Acceptance by the Architect/Engineer does not imply acceptance of any deviations from contract documents requirements or acceptance of uncoordinated work. Review is for general conformance to the design concept and general compliance with the information given in the contract documents.

6. Locate equipment requiring periodic servicing so that it is readily accessible. Provide means of service access, following appropriate manufacturer’s recommended service clearance space or, as applicable, means of access using duct, wall, or ceiling access doors.

7. Install ductwork and piping to leave sufficient space for AHJ inspection of wall construction.
8. Supplemental Instructions: The exact location for some items in this Specification may not be shown on the Drawings. The location of such items may be established by the Engineer during the progress of the work.

9. If prevented by project conditions, prepare drawings showing proposed rearrangement of Work, including changes to Work specified in other sections. Obtain permission of Architect before proceeding.

10. Discrepancies:
   a. Examine Drawings and Specifications.
   b. Report any discrepancies to the Architect and obtain written instructions before proceeding.
   c. Should there be a conflict within or between the Specifications or Drawings, the more stringent or higher quality requirements shall apply.
   d. Items called for in either specifications or drawings shall be required as if called for in both.
   e. Be responsible for providing proper documentation of equipment product data and shop drawings to all entities providing service.

1.5. CODES, REGULATIONS, FEES, PERMITS
   A. Conform to the codes in force at the time of construction in the jurisdiction of the project.
   B. Call for inspections from the authority having jurisdiction. If discrepancies exist between the contract documents and the local requirements, the more stringent shall apply.
   C. Contractor shall obtain all required permits prior to the start of the project.
   D. Post permits as required.
   E. Contractor shall pay all permit fees, tap fees and inspection fees. Owner shall pay any required development fees.

1.6. PROTECTION
   A. People
      1. Comply with all applicable health and safety regulations. Set barricades and signs as necessary to minimize hazards for building occupants and trades.
      2. Equipment, materials or other potential hazards to the public and working occupants of the building shall not be left overnight outside of the designated working or construction areas.
   B. Work
      1. Take all necessary measure to protect the work during and after installation to ensure that it will be unblemished, undamaged and clean when turned over to the owner.
      2. Follow indoor air quality management requirements of section 01 3546.
   C. Equipment and Materials
      1. Deliver equipment in its original unbroken package to prevent damage or entrance of foreign matter. Perform all handling and shipping in accordance with manufacturer's recommendations. Provide protective coverings during construction. Identifying labels intact and legible.
      2. Immediately upon delivery, identify and inspect materials and equipment delivered to Site to assure compliance with Contract Documents, approved submittals and reviewed Shop Drawings.
      3. Protect from loss, damage, dust, water, etc., until notice of completion has been filed. Promptly replace lost, damaged or defective materials and equipment with new at no increase in Contract Sum. Remove damaged or defective materials from site.
4. Do not store equipment or materials outdoors unprotected. Remove improperly stored equipment and materials from site. Contractor shall provide storage in appropriate enclosed warehouse as required at contractors expense.
5. Piping shall be delivered to site with ends sealed. Seal shall remain in place until installed. Provide seal on end of all open ductwork and piping at end of day.

1.7. OWNER-FURNISHED EQUIPMENT
A. All equipment called out in the Specifications or shown on the Drawings as "Owner-Furnished Equipment" or equipment furnished by other Divisions shall be installed and connected under this Contract. Provide all connection components as required, including but not limited to, reducers, pressure regulators, back-flow preventers, flexible connectors, unions, gauges, thermometers, and isolation valves as required by manufacturer's installation requirements or contract document details. Provide rough-ins for all future connections indicated.

1.8. CUTTING AND PATCHING
A. Cut and patch as necessary for the installation of the materials and equipment. Coordinate patching with the architectural contractor.
B. Do not cut any structural members without prior approval from the architect or structural engineer.

1.9. OPERATION AND MAINTENANCE MANUAL
A. Refer to Division 01 for O&M Manual requirements. Provide most stringent between items noted below and in Division 1. If there are no requirements in Division 1, the requirements below shall apply.
B. Upon substantial completion of the work, submit one O&M Manual to the engineer for review and comment. Respond to comments and submit a total of 3 copies of the O&M Manual to the architect upon project completion.
C. Manual shall be in a 3-ring binder with edge and front labels. Include a table of contents and include:
   1. Final approved submittals indicating all model numbers, serial numbers, cut sheets, and all performance criteria on furnished equipment
   2. Installation, Operation and Maintenance Instructions
   3. Parts Lists
   4. Test and Balance Report
   5. Certificates of Inspection
   6. Executed Warranties
D. Provide PDF format copy of O&M manual as noted above. PDF shall be bookmarked with titles per specification section and per piece of equipment within each section.

1.10. WARRANTIES
A. Provide a one year warranty on all mechanical work installed under contract. Provide an additional 4 year warranty for all refrigerant compressors installed.
B. Include executed warranties in O&M Manual.
C. Warranty shall include parts, labor, and shipping and shall cover any damage caused by failures in the covered mechanical systems.

1.11. RECORD DRAWINGS
A. Refer to Division 01 for requirements. At a minimum comply with the following requirements.
B. Maintain a set of redlined drawings at the jobsite with all changes to the Contract Documents, whether generated by addenda, change orders, or field conditions, and dimensioned locations of underground utilities. Maintain a daily record of these changes and keep current set of drawings showing these changes. Submit set of redlined drawings to the owner at project
close-out.. Record changes and locations of installed systems drawn to scale and fully dimensioned, and as specified in Division 1, but a minimum of:

1. Work concealed behind or within other work, in an inaccessible arrangement.
2. Mains and branches of piping systems:
   a. With valves and control devices located and numbered.
   b. With concealed unions located.
   c. With items requiring maintenance located (traps, strainers, expansion compensators, tanks, etc.) and clearly labeled..
3. Underground piping and ducts, both exterior and interior.
4. Ductwork layouts, including locations of coils, dampers, filters, boxes and similar units.
5. Concealed control system devices and sensors.

1.12. DEMONSTRATION
A. Provide factory trained personnel to instruct operating staff in maintenance and adjustment and operation of mechanical equipment. Provide instruction during regular work hours prior to acceptance and turn over to operating staff. Scheduling of training shall be at owner’s direction. Use operating and maintenance manual and updated as-constructed drawings for instruction purposes.
B. Demonstrate normal start-up and shut-down, emergency shut-down and seasonal change over. Review operation of safety devices and control systems.
C. Inspections and Tests:
   1. Arrange for all required inspections and tests.
   2. Pay all charges.
   3. Notify Architect / Engineer two (2) business days before tests.
   4. Submit one copy for Owner’s records of permits, licenses, inspection reports and test reports.

PART 2 PRODUCTS
2.1. SUBMITTALS
A. Bidders shall quote on brands and manufacturers of equipment as requested in these Specifications and Drawings. See appropriate section of the Contract Documents for requirements governing the prior approval process.
B. Coordinate submittals 3 weeks (min.) prior to expected order date so that work will not be delayed by submittals.
C. No extension of time will be allowed because of failure to properly coordinate and sequence submittals.
D. Submittals from subcontractors and equipment suppliers are to be carefully checked by the Contractor for space requirements and conformance to the Drawings and Specifications. These submittals shall be so noted by the Contractor prior to forwarding to the Architect/Engineer for checking. No deviations from the Drawings and Specifications will be allowed, recognized or considered unless brought to the attention of the Architect/Engineer at the time the submittals are submitted by the Contractor. Submittals not processed by the Contractor before forwarding to the Architect/Engineer for approval will be returned to the Contractor for his prior processing.
E. Submittal is for information and record, unless otherwise indicated, and is not a change order request.
F. Submitting Contractor is responsible for routing reviewed submittals to all parties affected including but not limited to electrical, structural, temperature control, and test and balance subcontractors.

G. Submittals shall include catalog cut-sheets with submitted products and options clearly identified, written descriptions, and specification sheets detailing the associated product, item and assembly.

H. No substitution for brands named in the Contract Documents will be considered unless written request has been submitted to the Engineer. Each such request shall include a complete description of the proposed substitute, drawings, cut sheets, performance and test data, and any other data or information necessary for complete evaluation. The burden of proving acceptability of a proposed product rests on the party submitting the request for approval. Request for product approval substitutions shall be submitted in writing to the Engineer a minimum of ten (10) working days in advance of the bid date.

I. Shop drawings shall include details, installation drawings, assembly drawings, fabrication drawings, diagrams, and other information which show adaptation or installation of Contractor-furnished products or materials for overall project.

J. The purpose of submittals and shop drawings is to ensure Contractor understands design requirements and demonstrates understanding by indicating and detailing intended materials, methods, and installation practices. Submittals and shop drawings are not a method of requesting substitutions or deviation from Specifications. If discrepancies between submittals, shop drawings, and Contract Documents are discovered either prior to or after submittals and shop drawings are reviewed, requirements of Contract Documents shall take precedence.

K. Catalog numbers referenced throughout the Division 23 Drawings and Specifications are intended to convey a general understanding of the type and quality of the product required. Where written descriptions differ from information conveyed by a catalog number, the written description shall govern. No extra shall be allowed because a catalog number is found to be incomplete or obsolete.

L. Group complete information of related systems, products, and accessories in a single submittal. If submitted as a hard copy, submittals shall be submitted in a three-ring binder, with separate sections for each type or category of equipment, with labeled tabs indicating the contents of the section. If submitted electronically, the submittal shall be in a PDF file with each section bookmarked with labels. Within each section, each sub item or equipment tag shall be bookmarked with a corresponding tag.

M. In the front of each submittal binder, the Mechanical Contractor shall include a signed letter from the project Electrical Contractor indicating that the Electrical Contractor has reviewed the mechanical submittals and has verified that the equipment being submitted will conform to the design of the project electrical systems.

N. After Architect/Engineer review, submittals and shop drawings will be returned together with Submittal Review Sheet which indicates comments on submittals and shop drawings and with specific actions such as "No Exception Taken", "Make Corrections Noted", "Rejected", and "Resubmit". Continue to resubmit submittals and shop drawings until "No Exception Taken" or "Make Corrections Noted-Resubmittal Not Required" action is indicated.

O. Resubmittals will be reviewed for compliance with comment made on the original submittal only. Clearly identify replied-to comments with a resubmittal number and date. If any other changes are made that are not in reply to comments, clearly identify the changes. Indicate dates of previous submissions and submittal numbers. Direct specific attention to any changes made in addition to those made in reply to previous review comments.

P. If more than two submittals (either for products, materials, shop drawings, record drawings, or test and balance reports) are made by the Contractor of basis of design, listed general equivalents or substitutions, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants at their consultants current published hourly rate. Such extra fees may be deducted from payments by the Owner to the Contractor.
Q. Refer to individual specification sections for submittal requirements. However, a minimum, shop drawings shall be submitted for each of the following items as applicable to the project:

1. Automatic Flow Control Valves
2. Condensing Units
3. Controls & Control Diagrams including Wiring Plans
4. Pipe & Duct Insulation & Accessories
5. Pipe Accessories
6. Pipe and Pipe Fittings
7. Pipe Hangers, Supports & Accessories
8. Pipe Identification Systems
9. Pressure Gauges
10. Pumps
11. Relief Valves
12. Thermometers
13. Vibration Isolation Equipment

2.2. HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
D. Trapeze and Riser Supports:
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.
E. Fasteners for all galvanized, stainless steel or aluminum supports shall be stainless steel.
F. All galvanized supports with coating damaged by drilling, cutting, welding or other means shall be coated with two coats of cold-galvanizing.

2.3. EQUIPMENT SUPPORTS

A. Structural steel for supports: ASTM A36.
B. Use galvanized members installed in fan plenums or areas of high humidity or condensation, and outside. All fasteners shall be stainless steel. Any damage caused by cutting, drilling, or welding or any other means to galvanized surface must be repaired by apply two coats of cold-galvanizing.
C. Furnish other members with shop coat of red primer.
D. Retouch primer after field welding.
E. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to properly support and anchor HVAC materials and equipment.
F. Comply with AWS D1.1 for field welding.

2.4. SLEEVES

A. Sleeve Material
   1. Concrete floors, concrete and masonry walls: ASTM A 53, Type E, Grade B, schedule 40 black steel pipe.
2. Drywall partitions: 18 gauge galvanized steel sheet metal.

B. Sleeves shall be sized such that the annular space between outside surface of pipe or pipe insulation and the inside surface of the sleeve is not less than 1/2". Increase space as required to allow for uninterrupted insulation and free longitudinal movement. Provide larger annular space if required by firestopping product installation instructions.

C. Sleeves through floor assemblies shall extend 4" above the slab and provide a watertight seal.

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

2.5. GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

B. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

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

D. Packaging: Premixed and factory packaged.

2.6. ESCUTCHEONS

A. Split-casting, cast-brass type with chrome finish, with concealed hinge and set screw with an ID to closely fit around pipe, tube and insulation of insulated piping and an OD that completely covers opening.

PART 3 EXECUTION
3.1. INSTALLATION

A. Execute work such that all components function together as a complete, workable system. Make slight alterations necessary to make adjustable parts fit with fixed parts. Execute work to contribute to efficiency of operation, accessibility, sightliness, and minimum maintenance clearances. Leave equipment properly adjusted and in working order.

B. Verify dimensions indicated and report any error or inconsistency before commencing work.

C. Coordinate work with other trades through the General Contractor so that equipment, especially in the ceiling, will fit to patterns of finished materials, and locate all elements to carry harmony of architectural design throughout the building. Coordinate work with other trades to avoid conflicts, especially in places where close, careful fitting is required. Coordination problems and field solutions must be approved through the General Contractor and the Architect/Engineer before proceeding with work.

D. Conform and accommodate systems to the building structure, equipment and usage so that they do not interfere with the operation of any other system or operational part of the building.

E. Preparation: Final installation of materials and equipment shall be based on actual dimensions and conditions at the job site. Field measure for materials or equipment requiring exact fit.

F. Workmanship: Perform work in accordance with good commercial practice and all applicable trade standards, including current SMACNA standards. The finished appearance of the work shall be of equal importance with its mechanical efficiency.

G. Clearances: The Subcontractors working under this Division shall be responsible for the sufficiency of the size of shafts and chases, and clearances in double partitions and hung ceilings for proper equipment installation. Cooperate with Contractors of other Divisions whose work is in the same space and advise the General Contractor of requirements. Such spaces and clearances shall be kept to the minimum size required.

1. Install equipment, ductwork, piping and accessories:
   a. Straight and true.
b. Aligned with other work and with general lines of the building.
c. Concealed in occupied spaces, unless noted otherwise.
d. Out-of-the-way with maximum passageway and headroom remaining in each space.

2. Except as otherwise indicated, arrange mechanical services and overhead equipment to not obstruct windows, doors or other openings. Clearance shall be a minimum of:
   a. 7'-6" headroom in mechanical spaces.
   b. 9'-6" headroom in unfinished or shell spaces.

3. Give the right-of-way to piping systems required to slope for drainage (over other service lines and ductwork).

H. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Equipment shall include, but not be limited to, valves, shock absorbers, traps, cleanouts, motors, controllers, switchgear, drain points, manual dampers, and smoke and fire dampers. If required for accessibility, the Contractor shall furnish access doors for this purpose, subject to the following:
   1. Access door shall be sized to permit removal of equipment, or 24"x24" if used for service only.
   2. Furnish doors to trades performing work in which they are to be installed. Group valves, devices and other equipment to permit use of minimum number of access doors.
   3. Doors shall be lockable and suitable for painting to match adjacent finishes.

I. Minor deviations from the Drawings may be allowed to provide for better equipment accessibility. The General Contractor shall approve of any change prior to this Contractor making the change.

J. Properly locate anchors, chases, recesses and openings required for the proper installation of the work. Arrange with the proper contractors for the building of anchors, etc., and for the leaving of the required chases, recesses and openings in sufficient time to be installed in the normal course of work. Install equipment and materials in accordance with manufacturer recommendations unless specifically indicated otherwise, or where local codes or regulations take precedence. This includes the performance of tests the manufacturer recommends. It is intended that anything, whether labor or materials, which is usually furnished as a part of any equipment specified and which is necessary for the best operation shall be furnished as a part of the contract without additional cost, whether or not shown or described.

K. Anchor and secure all equipment to the building substrate and structure. Provide all supplemental steel, anchors and attachments as required to properly support and anchor materials in this division.

L. Erect, install, and secure components in a structurally sound and appropriate manner.

M. Where necessary, temporarily brace, shore, or otherwise support members until final connections are installed.

N. Leave all temporary bracing, shoring, or other structural supports in place as long as practical for safety and to maintain proper alignment.

O. Handle materials in a manner to prevent scratching, abrading, distortion, chipping, breaking, or other disfigurement.

P. Conduct work in a manner to avoid injury or damage to previously placed work. Any work so impaired or damaged shall be replaced at no expense to Owner.

Q. Fabricate and install materials true to line, plumb, and level.

R. Leave finished surfaces smooth and flat, free from wrinkles, warps, scratches, dents, and other imperfections.

S. Testing: See individual Specification sections in Division 23 for testing of mechanical work.
T. Protection: Cover and seal ends of pipe and ductwork during construction to prevent entry of foreign material and moisture. Protect insulation against dirt, water, chemical or mechanical damage before, during and after installation. Protect fixtures and equipment against damage during mechanical work. All air handling equipment shall be fitted with all specified filters prior to any startup or operation. Provide additional sets of filters during construction as required to maintain cleanliness of system. Filter to be as scheduled or at a minimum high-quality, 30% min. efficient pleated filters. The use of "construction filters" is NOT authorized. Failure to provide required filters will cause the contractor to provide, at their own cost, the services of an independent third party provider to clean and sterilize all contaminated duct systems.

U. Freeze Protection: Do not run piping in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection. Water piping exposed to freezing conditions shall be insulated as specified, with aluminum weather jacket and electric heating cable, thermostatically controlled, as specified under 23 0533. Heat tracing shall be coordinated with Electrical Contractor and installed on all exterior water piping, per applicable Division 23 and 26 Specifications.

V. Scaffolding, Rigging and Hoisting: Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required.

W. Wherever possible, arrange for the movement and positioning of equipment so that enclosing partitions, walls and roofs will not be delayed or need to be removed. Otherwise, advise General Contractor of opening requirements to be maintained for the subsequent entry of equipment.

X. Coordinate the movement of heavy items with shoring and bracing so that the building structure will not be overloaded during the movement and installation.

Y. Materials and apparatus required for the work to be new, of first-class quality, and to be furnished, delivered, installed, connected and finished in every detail. Equipment shall be selected and arranged such that it fits properly into the building space provided. Where no specific kind or quality of material is given, a first-class standard article shall be furnished.

Z. Equipment start-up and adjustment of all HVAC equipment and water heaters shall be performed by certified factory representatives of the respective equipment manufacturer.

AA. Furnish the services of an experienced superintendent, who will be constantly in charge of installation of the work, together with all skilled tradesmen, fitters, helpers and labor required to unload, transfer, erect, connect, adjust, start, operate and test each system.

3.2. HANGER AND SUPPORT INSTALLATION
A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Hangers Exposed to View: Threaded rod and angle or channel supports. Coordinate with Architect for required painting of exposed supports.

3.3. THROUGH PENETRATIONS
A. References:
   2. UL 1479 Standard for Fire Tests of Through-Penetration Firestops, including optional air leakage test.

B. Non-Rated Walls
   1. All penetrations through concrete or masonry walls shall be sleeved with a steel standard weight pipe sleeve which shall be grouted in place. Closures shall be provided between the pipe and sleeve wherever an exterior wall or is penetrated. Use Link-Seal modular rubber seals as manufactured by Thunderline Corp., Wayne, Michigan.
3.4. GROUTING
   A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
   B. Clean surfaces that will come into contact with grout.
   C. Provide forms as required for placement of grout.
   D. Avoid air entrapment during placement of grout.
   E. Place grout, completely filling equipment bases.
   F. Place grout on concrete bases and provide smooth bearing surface for equipment.
   G. Place grout around anchors.
   H. Cure placed grout.

3.5. CLEANING
   A. Cleaning During Construction and Final Cleaning: Comply with General Requirements.
   B. Clean exposed surfaces of piping, hangers, ducts and other exposed items of grease, dirt or other foreign material. Clean and polish plumbing fixtures, fittings, and exposed plated piping. Leave clean and free from paint, grease, dirt, etc. Remove labels from exposed equipment. Carefully and thoroughly clean all items of equipment. If finishes have been damaged, refinish to original condition using factory-provided matching paint, and leave all equipment in proper working order and intended appearance. At the completion of the work, remove all rubbish, cleaning supplies and debris resulting from the operation and leave spaces clean and ready to use.
   C. Replace air filters in all equipment immediately prior to Owner's Date of Acceptance. Clean ducts, blowers and coils if units were operated without filters at any time during construction. Provide one (1) complete set of clean filters to Owner at project turnover.
   D. Flush all piping systems free of foreign substances before installing valves or making final connections. Notify the Owner/Architect seven (7) days in advance of final flushing so that Owner/Architect may attend and verify the cleanliness of the pipe.

3.6. MECHANICAL SERVICE AND MAINTENANCE
   A. Include four (4) complete service and maintenance calls plus emergency calls spaced at reasonable intervals throughout one (1) year warranty period. During each maintenance call, technicians shall:
      1. Verify proper working order of safety devices on each piece of equipment.
      2. Check lubrication of all moving parts and lubricate as necessary.
      3. Verify proper operating temperatures, pressures, flows, etc. for each major piece of equipment.

3.7. CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
   A. Contractor shall conform to the waste management plan requirements of Section 017419, Construction Waste Management and Disposal. Document all waste, disposal and recycling in accordance with the waste management plan in support of LEED requirements.

END OF SECTION
SECTION 23 0519
METERS AND GAGES FOR HVAC PIPING

PART 1  GENERAL

1.01  RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 1 Specification Sections, apply to this Section.

1.02  SUMMARY
   A. Section Includes:
      1. Bimetallic-actuated thermometers.
      2. Liquid-in-glass thermometers.
      3. Thermowells.
      4. Dial-type pressure gages.
      5. Gage attachments.
      6. Test plugs.
      7. Sight flow indicators.
   B. Related Sections:
      1. Division 22 Section "Facility Natural-Gas Piping" for gas meters.

1.03  SUBMITTALS
   A. Product Data:
      1. For each type of product indicated. Include scale range, ratings, and accuracies.
      2. Water meter characteristics including flow range and pressure drop.
   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.

PART 2  PRODUCTS

2.01  BIMETALLIC-ACTUATED THERMOMETERS
   A. Manufacturers:  Subject to compliance with requirements, provide products by one of the
      following:
      1. Ashcroft Inc.
      2. Marsh Bellofram.
      5. REOTEMP Instrument Corporation.
      6. Tel-Tru Manufacturing Company.
      7. Trerice, H. O. Co.
      8. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
      9. Weiss Instruments, Inc.
      10. Weksler Glass Thermometer Corp.
      11. WIKA Instrument Corporation - USA.
      12. Winters Instruments - U.S.
   C. Case:  Sealed types; stainless steel with 5-inch nominal diameter.
   D. Dial:  Non-reflective aluminum with permanently etched scale markings and scales in deg. F.
   E. Connector Type(s):  Union joint, adjustable angle with unified-inch screw threads.
   F. Connector Size:  1/2 inch, with ASME B1.1 screw threads.
   G. Stem:  0.25 or 0.375 inch in diameter; stainless steel.
   H. Window:  Plain glass.
I. Ring: Stainless steel.
J. Element: Bimetal coil.
K. Pointer: Dark-colored metal.
L. Accuracy: Plus, or minus 1 percent of scale range.

2.02 LIQUID-IN-GLASS THERMOMETERS
A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ashcroft.
      b. Flo Fab Inc.
      c. Miljoco Corporation.
      e. Tel-Tru Manufacturing Company.
      f. Trerice, H. O. Co.
      g. Weiss Instruments, Inc.
      h. Weksler Glass Thermometer Corp.
      i. Winters Instruments - U.S.
   3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
   5. Tube: Glass with magnifying lens and blue or green organic liquid. Do not provide mercury.
   6. Tube background: Non-reflective aluminum with permanently etched scale markings graduated in deg. F.
   8. Stem: Aluminum and of length to suit installation.
      a. Design for air duct installation: With ventilated shroud.
      b. Design for thermowell installation: Bare stem.
   10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.03 THERMOWELLS
A. Thermowells:
   2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
   3. Material for use with copper tubing: CNR or CUNI, copper nickel.
   5. Type: Stepped shank unless straight or tapered shank is indicated.
   6. External threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
   7. Internal threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
   8. Bore: Diameter required to match thermometer bulb or stem.
   9. Insertion length: Length required to match thermometer bulb or stem.
   10. Lagging extension: Include on all thermowells. Provide appropriate extension length for insulated piping and tubing.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.04 PRESSURE GAGES
A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AMETEK, Inc.; U.S. Gauge.
      b. Ashcroft Inc.
c. Marsh Bellofram.
d. Miljoco Corporation.
e. Palmer Wahl Instrumentation Group.
f. REOTEMP Instrument Corporation.
g. Tel-Tru Manufacturing Company.
h. Trerice, H. O. Co.
i. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
j. Weiss Instruments, Inc.
k. Weksler Glass Thermometer Corp.
l. WIKA Instrument Corporation - USA.
m. Winters Instruments - U.S.

3. Case: Liquid-filled and sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-element assembly: Bourdon tube unless otherwise indicated.
5. Pressure connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
10. Ring: Metal.
11. Accuracy: Grade 1A, plus or minus 1 percent of full-scale range.
12. Temperature: Minimum 150 deg. F operating ambient temperature and suitable for the maximum fluid temperature.

2.05 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of steel pipe with NPS 1/4 pipe threads.

C. Valves: Brass ball, with NPS 1/4, ASME B1.20.1 pipe threads, 400 psig WOG.

2.06 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flow Design, Inc.
   4. Peterson Equipment Co., Inc.
   5. Sisco Manufacturing Company, Inc.
   6. Trerice, H. O. Co.
   7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   8. Weiss Instruments, Inc.
   9. Weksler Glass Thermometer Corp.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg. F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.
2.07 SIGHT FLOW INDICATORS

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
   1. Archon Industries, Inc.
   2. Dwyer Instruments, Inc.
   4. Ernst Co., John C., Inc.
   5. Ernst Flow Industries.
   6. KOBOld Instruments, Inc. - USA; KOBOld Messring GmbH.
   7. OPW Engineered Systems; a Dover company.
   8. Penberthy; A Brand of Tyco Valves & Controls - Prophetstown.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 150 psig.

E. Minimum Temperature Rating: 200 deg. F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches into fluid or one-third pipe diameter (whichever is larger) and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Do not install bushings.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids (except steam).

H. Install test plugs in piping tees.

I. Install flow indicators in piping systems in accessible positions for easy viewing.

J. Install permanent indicators on walls or brackets in accessible and readable positions.

K. Install connection fittings in accessible locations for attachment to portable indicators.

L. Install thermometers in the most readable position in the following locations:
   1. Inlet and outlet of each hydronic boiler.
   2. Two inlets and two outlets of each chiller.
   3. Inlet and outlet of each hydronic coil in air-handling units.
   4. Two inlets and two outlets of each hydronic heat exchanger.
   5. Inlet and outlet of each thermal-storage tank.
   6. Outside-, return-, supply-, and mixed-air ducts at each air handling unit and where indicated on the drawings.
   7. Inlets and outlets of heating water, perimeter heating water and chilled water system three-way control valves.
   8. Where indicated on the drawings and in other specification sections.

M. Install pressure gages in the following locations:
   1. Discharge of each pressure-reducing valve.
   2. Suction and discharge of each pump.
3. Where indicated on the drawings and in other specification sections.

3.02 CONNECTIONS
A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
B. Connect flowmeter-system elements to meters.

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

3.04 THERMOMETER SCALE-RANGE SCHEDULE
A. Scale Range for Chilled-Water Piping: 0 to 100 deg. F.
B. Scale Range for Condenser-Water Piping: 0 to 150 deg. F.
C. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg. F.
D. Scale Range for Low Pressure Steam and Steam-Condensate Piping: 0 to 250 deg. F.
E. Scale Range for Medium Pressure Steam and Steam-Condensate Piping: 50 to 400 deg. F.
F. Scale Range for Air Ducts: Minus 40 to plus 110 deg. F.

3.05 PRESSURE-GAGE SCHEDULE
A. Pressure gages at suction and discharge of each pump shall be liquid-filled.
B. Pressure gages at other installations shall be sealed.

3.06 PRESSURE-GAGE SCALE-RANGE SCHEDULE
A. Scale Range for Chilled-Water Piping: 0 to 100 psi.
B. Scale Range for Condenser-Water Piping: 0 to 100 psi.
C. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.
D. Scale Range for Low Pressure Steam Piping: 0 to 30 psi.
E. Scale Range for Medium Pressure Steam Piping: 0 to 100 psi.

3.07 ROUGHING-IN FOR WATER METERS
A. Install roughing-in piping and specialties for water meter installation according to instructions and requirements.
B. Install remote reading register and all wiring for water meters located more than 10'-0” above finished floor. Install remote reading register 5'-0” above finished floor in location selected by Engineer.

END OF SECTION
SECTION 23 0523
GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary
   Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY
A. Section includes:
   1. Ball valves.
   2. Butterfly valves.
   3. Check valves.
   4. Gate valves.
   5. Globe valves.
   6. Chain wheel actuators.
B. Related Sections include the following:
   1. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and
      charts.

1.03 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. Submit pressure drop curves for non-slam silent check valves.
   Include list indicating valve type and its piping system application. Include rated capacities;
   shipping, installed and operating weights; furnished specialties; and accessories.

1.04 QUALITY ASSURANCE
A. ASME Compliant:
   1. ASME B31.9 for building services piping valves.
   2. ASME B31.1 for power piping valves.
B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and
   design criteria.
C. Source Limitations: Obtain each type of valve from a single source from a single manufacturer.

1.05 DELIVERY, STORAGE AND HANDLING
A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves and weld ends.
   3. Set gate and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.
B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew-point temperature. If
      outdoor storage is necessary, store valves at least 4 inches off the ground in watertight
      enclosures.
C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand
   wheels or stems as lifting or rigging points.
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufactures: Subject to compliance with requirements, provide products by the manufacturers specified.

B. Acceptable Manufacturers:

2.02 GENERAL REQUIREMENTS FOR VALVES

A. Refer to Valve Schedule Articles for application of valves.
B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.
C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures. Valves shall be rated for pressure and temperatures no less than that of the piping system in which they are installed. Account for piping system pressure tests when selecting component ratings.
E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
F. Valve Actuators:
   1. Chain wheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
   2. Gear drive: For quarter-turn valves NPS 8 and larger.
   3. Hand-wheel: For valves other than quarter-turn types.
   4. Lever handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
   5. Wrench: For plug valves with square heads furnish Owner with one (1) wrench for every ten (10) plug valves for each size square plug head.
G. Extended Valve Stems: 2-inch extensions on all valves.
I. Valve Threads: According to ASME B1.20.1.
J. Valve Bypass and Drain Connections: MSS SP-45.

2.03 VALVE SCHEDULE

A. Gate Valves – 2" and Smaller:
   1. 125 psig steam, 200 psig CWP rating, MSS SP-80, threaded end, bronze body, union bonnet, rising stem, solid wedge.

B. Gate Valves – 2" and Smaller:
   1. Class 300, 600 psig steam rating, carbon steel body, socket welded end, hard faced seat rings, rising stem, solid wedge. Provide socket welded valves where indicated on the drawings.

C. Gate Valves – 2-1/2" and Larger:
   1. Class 125, 125 psig steam rating, flanged end, outside screw and yoke, cast iron body, bolted bonnet, solid wedge, bronze mounted.

D. Gate Valves – 2-1/2" and Larger:
1. Class 300, 600 psig steam rating, flanged end, carbon steel ASTM A216 grade WCB body, 13 percent chromium hard faced, bolted bonnet, flexible wedge disc. Provide socket welded valves where indicated on the drawings.

E. Globe Valve – 2" and Smaller:
   1. 125 psig steam, 200 psig CWP rating, MSS SP-80, threaded end, bronze body, union bonnet, integral seat, renewable TFE disc.

F. Globe Valve – 2" and Smaller:
   1. Class 300, 300 psig steam rating, socket welded end, bronze body, union bonnet, renewable stainless-steel disk and seat.

G. Globe Valve – 2-1/2" and Larger:
   1. Class 125, 200 psig CWP rating, 125 psig steam rating, MSS SP-85, flanged end, cast iron body, bolted bonnet, renewable cast bronze seat and disc, bronze mounted.

H. Globe Valve – 2-1/2" and Larger:
   1. Class 300, 500 psig steam rating, flanged end, cast steel body, hard faced seat and disc. Provide socket welded valves where indicated on the drawings.

I. Check Valves – 2" and Smaller:
   1. Class 125, 200 psig CWP rating, MSS SP-80, threaded end, bronze body, horizontal swing, bronze regrinding type disc, bronze renewable disc seat.

J. Check Valves – 2" and Smaller:
   1. Class 300, 300 psig steam rating, 600 psig CWP rating, MSS SP-80, threaded end, bronze body, horizontal swing, renewable bronze disc and seat, Y-pattern.

K. Check Valves – 2-1/2" and Larger:
   1. Class 125, 200 psig CWP rating, MSS SP-71, flanged end, cast iron body, bolted bonnet, horizontal swing, renewable cast bronze seat and disc.

L. Check Valves – 2-1/2" and Larger:
   1. ANSI Class 250, 250 psig CWP rating, 500 psig steam rating, MSS SP-71, flanged end, iron body, bronze mounted, renewable cast bronze disc and seat ring, bolted cover.

M. Non-Slam Silent Check Valve – 1" and Larger:
   1. ANSI Class 125, 200 psig CWP rating, cast iron body, stainless plug/disc, bronze/stainless steel stem, bronze seats, stainless steel spring. Wafer end dual-plate style or flanged globe style types are acceptable unless denoted otherwise.

N. Ball Valves – 2" and Smaller:
   1. 600 psig CWP rating, MSS SP-110, blowout proof stem, 2-piece bronze body, standard port, chrome plated brass ball, Teflon seats with bronze trim, threaded end, zinc plated steel handle with plastic coating. Provide extended handle that allows operation of valve without breaking the vapor barrier or otherwise disturbing insulation.

O. Butterfly Valve – 12" and Smaller:
   1. ANSI Class 125 flanged, 200 psig CWP rating, 125 psig bi-directional dead-end service with downstream flange removed, MSS SP-67, epoxy or polyester coated ductile iron body, lug style, extended neck, stainless steel or aluminum bronze or Nylon 11 encapsulated ductile iron disc, 416 stainless steel shaft, reinforced resilient EPDM seat and EPDM o-rings, shaft seal, worm gear operator with hand wheel size 8" and larger, locking handle size 6" and smaller. Factory test each valve to a minimum of 100 percent of the submitted pressure rating.

P. Butterfly Valve – 12" and Smaller:
   1. Class 250, 250 psig CWP rating at 100 deg F, 125 psig bi-directional dead-end service with downstream flange removed, MSS SP-67, epoxy or polyester coated ductile iron body, lug style, extended neck, stainless steel or aluminum bronze disc, 416 stainless steel shaft, reinforced resilient EPDM seat and EPDM o-rings, shaft seal, worm gear operator with hand wheel size 8" and larger, locking handle size 6" and smaller. Factory test each valve to a minimum of 100 percent of the submitted pressure rating.
R. Drain Valves:  
   1. Class 125, bronze body, screw-in bonnet, rising stem, composition disc, 3/4" hose outlet.

2.04 CHAINWHEEL ACTUATORS
A. Manufacturers:  
   1. Babbitt Steam Specialty Company.  
   2. Roto Hammer Industries, Inc.  
   3. Trumball Industries.
B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.  
   1. Sprocket rim with chain guides: Ductile iron, of type and size required for valve.  
   2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.  
   3. Chain: Hot-dip, galvanized steel or brass of size required to fit sprocket rim.

PART 3 EXECUTION
3.01 EXAMINATION
A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.  
   1. 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.

3.02 VALVE APPLICATIONS
A. Globe valves shall be installed for throttling service.
B. Ball valves shall be installed in 2" and smaller pipes for shutoff duty in all piping except steam supply and condensate return.
C. Butterfly valves shall be installed in 2-1/2" and larger pipes for shutoff duty in all piping systems except steam supply and condensate return.
D. Valves shall be installed on the inlet and outlet of each coil, at each piece of equipment, on each piping line coming out of a shaft to serve a floor, on each side of control valves and elsewhere as shown on the Contract Documents.
E. Safety valves shall have a relieving capacity of not less than the MBH output of the equipment. Relief shall be piped full size, without shutoff devices in line, to the nearest floor drain unless shown piped to the exterior on the Contract Documents.

3.03 VALVE INSTALLATION
A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance and equipment removal without system shutdown. Allow for actuator removal.
C. Locate valves for easy access and provide separate support where necessary.
D. Install valves in horizontal piping with stem at or above 45 degrees from vertical.
E. Install valves in position to allow full stem movement.
F. Install chain wheel operators in mechanical and equipment rooms on valves NPS 4 (DN 100) and larger which are more than 96 inches above floor. Extend chains to 60 inches above finished floor elevation. Confirm chain locations with the Engineer prior to installation.

G. Install check valves for proper direction of flow and as follows:
   1. Swing check valves: In horizontal position with hinge pin level.
   2. Dual-plate check valves: In horizontal or vertical position, between flanges.
   3. Lift check valves: With stem upright and plumb.

3.04 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before insulating or final adjusting and balancing. Replace valves if any leaking occurs.

END OF SECTION
PART 1 GENERAL

1.01 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY
   A. This Section includes the following hangers and supports for HVAC system piping and equipment:
      1. Steel pipe hangers and supports.
      2. Trapeze pipe hangers.
      3. Metal framing systems.
      4. Thermal-hanger shield inserts.
      5. Fastener systems.
      6. Pipe stands.
      7. Equipment supports.

1.03 DEFINITIONS
   A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.
   B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.04 PERFORMANCE REQUIREMENTS
   A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   C. Design seismic-restraint hangers and supports for piping and equipment.

1.05 SUBMITTALS
   A. Product Data: For the following:
      1. Steel pipe hangers and supports. Include piping system schedule delineating which piping systems receive roller hangers.
      2. Thermal-hanger shield inserts.
      3. Mechanical expansion anchor fastener systems.
      4. Spring hangers utilized at pumps and other locations.
   B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
      1. Trapeze pipe hangers: Include product data for components.
      4. Equipment supports.

1.06 QUALITY ASSURANCE
   A. Welding: Qualify procedures and personnel according to the following as applicable:
      1. AWS D1.1, "Structural Welding Code--Steel."
      4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
      5. ASME Boiler and Pressure Vessel Code: Section IX.
PART 2 PRODUCTS

2.01 STEEL PIPE HANGERS AND SUPPORTS
A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
B. Manufacturers:
   2. Carpenter & Paterson, Inc.
   3. ERICO/Michigan Hanger Co.
   6. PHD Manufacturing, Inc.
   7. PHS Industries, Inc.
   8. Piping Technology & Products, Inc.
   9. Tolco Inc.
C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.
D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

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

2.03 METAL FRAMING SYSTEMS
A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
B. Manufacturers:
   2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
   4. Thomas & Betts Corporation.
   5. Tolco Inc.
   6. Unistrut Corp.; Tyco International, Ltd.
C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.04 THERMAL HANGER SHIELDS
A. Description: Carbon steel, galvanized finish, shield. For use with Clevis hangers with ribs to keep shield centered in hanger. MSS-SP-69 Type 40.

2.05 THERMAL-HANGER SHIELD INSERTS
A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
B. Manufacturers:
   1. Carpenter & Paterson, Inc.
   2. ERICO/Michigan Hanger Co.
   3. PHS Industries, Inc.
   4. Pipe Shields, Inc.
   5. Rilco Manufacturing Company, Inc.
   6. Value Engineered Products, Inc.
C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 552, Type II cellular glass with vapor barrier.
D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
E. For Trapeze and Clamped Systems: Insert and shield shall cover entire circumference of pipe.
F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
G. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.06 FASTENER SYSTEMS
A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated or stainless steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      b. Empire Industries, Inc.
      c. Hilti, Inc.
      d. ITW Ramset/Red Head.
      e. MKT Fastening, LLC.
      f. Powers Fasteners.

2.07 PIPE STAND FABRICATION
A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support piping.
B. Compact Pipe Stand: One-piece UV-inhibited plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration, complete with seismic restraints. All metal components shall be hot dipped galvanized in accordance with ASTM A123 after fabrication.
   1. Manufacturers:
      a. ERICO/Michigan Hanger Co.
      b. MIRO Industries.
      c. Portable Pipe Hangers.
C. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

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

2.09 MISCELLANEOUS MATERIALS
A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Non-staining, non-corrosive and non-gaseous.
   2. Design mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION
3.01 HANGER AND SUPPORT APPLICATIONS
A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will come into direct contact with galvanized piping.
D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
E. Use pre-galvanized (hot dipped galvanized not required) or plain finish for indoor steel pipe hangers unless otherwise indicated.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, steel clevis hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30. Install second upper locknut on hanger rod and tighten.
2. Adjustable, swivel-ring band hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
3. U-bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
4. Pipe stanchion saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
5. Adjustable, pipe saddle supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
6. Single pipe rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
7. Adjustable roller hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
8. Complete pipe rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
9. Adjustable pipe roll and base units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
10. Hinged extension split pipe clamp (MSS Type 12): For support of pipes, NPS 3/4 to NPS 1-1/2, where the pipe is supported from a wall and routed vertically down the wall to discharge into a sink or a floor drain.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension pipe or riser clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 12.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel weld-less eye nuts (MSS Type 17): For 120 to 450 deg. F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or malleable concrete inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-beam c-clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Center-beam clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. C-clamps (MSS Type 23): For structural shapes.
5. Top-beam clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
6. Side-beam clamps (MSS Type 27): For bottom of steel I-beams.
7. Steel-beam clamps with eye nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
8. Linked-steel clamps with eye nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
9. Malleable beam clamps with extension pieces (MSS Type 30): For attaching to structural steel.
10. 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.
11. Horizontal travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
12. For building attachments other than those indicated (such as Z purlins), install appropriate attachments directly to building or install unistrut to structure and hang from the unistrut. Clarify with the Structural Engineer as required.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel pipe covering protection saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation, ribbed to center the shield with the pipe hanger.
3. Thermal-hanger shield inserts: For supporting insulated pipe.

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

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

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections. Utilize powder coated channel for all channel exposed to view in occupied spaces and mechanical spaces.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction. Do not utilize powder-actuated fasteners.
3.02 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of various sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   2. Field fabricated from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation:
   1. Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
   2. Provide vinyl frame caps on the ends of framing members which are located less than 8'-0" above finished floor.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:
   1. Curb-mounting type pipe stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 7 Section "Roof Accessories" for curbs.
   2. Insulate pipe stands which come in direct contact with piping or piping system components which operate below 50 deg. F.

G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.


I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 4 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.

L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

N. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping operating above ambient air temperature: Clamp may project through insulation.
      b. Piping operating below ambient air temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
5. Insert material: Length at least as long as protective shield.
6. Thermal-hanger shields: Install with insulation same thickness as piping insulation.
7. Pipe spacing: Arrange piping so that a minimum of 2-1/2” of clear space exists between the outer surfaces of the pipe insulation on parallel piping.
8. Spaces with no ceiling: Attach protective insulation shield to hanger utilizing tack weld such that shield cannot be dislodged from the hanger.

3.03 EQUIPMENT SUPPORTS
A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
C. Provide lateral bracing, to prevent swaying, for equipment supports.
D. Paint interior supports with corrosion resistant paint.
E. Insulate supports which come in direct contact with equipment or piping which operates below 50 deg. F.
F. Fabricate exterior supports from galvanized or stainless materials which are compatible with the equipment, piping and ductwork being supported.

3.04 METAL FABRICATIONS
A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.
D. Provide brush-on galvanizing touch-up for all bare metal exposed during installation or assembly. Galvanizing touch-up shall be compatible with original galvanized material.

3.05 ADJUSTING
A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.06 PAINTING
A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
SECTION 23 0548
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

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

1.02 SUMMARY
A. This Section includes vibration and isolation and seismic controls for HVAC components. This section includes seismic restraints for equipment, piping and ductwork.
B. This Section include the following:
   1. Elastomeric isolation pads.
   2. Restrained elastomeric isolation mounts.
   3. Freestanding and restrained spring isolators.
   4. Housed spring mounts.
   5. Elastomeric hangers.
   7. Pipe riser resilient supports.
   8. Resilient pipe guides.
  10. Seismic snubbers.
  11. Restraining cables.
  12. Steel and inertia, vibration isolation equipment bases.
  13. Anchor bolts.

1.03 DEFINITIONS
A. OSHPD: Office of Statewide Health Planning and Development for the State of California.
B. SMACNA: Sheet Metal and Air Conditioning Contractors National Association, Inc.

1.04 PERFORMANCE REQUIREMENTS
A. Seismic Restraint:
   1. Risk Category: III
   2. Seismic design category: C
   3. Component importance factor: 1
B. Seismic Hazard Level Designations, Piping and Ductwork Seismic Restraints and Equipment Pad Construction:
   1. SMACNA Seismic Hazard Level C for attachments made to slab on grade through the 2nd floor structure.
   2. SMACNA Seismic Hazard Level B for attachments made to the 2nd floor structure up to the roof structure.
C. Seismic restraint shall be provided in accordance with requirements of the applicable Building Code and other locally enforced codes.
D. Wind Restraint Loading:
   1. Basic wind speed and building classification: See structural drawings.
   2. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction and 45 degrees either side of normal.
1.05 SUBMITTALS

A. Product Data: Include load deflection curves rated load and overload capacity for each vibration isolation device.

B. Equipment Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:
   1. Vibration isolation base details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads. Include equipment and motor location template on concrete inertia base submittals to confirm overall size of inertia base and arrangement of items on top of inertia base.
   2. Seismic-restraint details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate material, strength, finish, quantity, diameter, depth of penetration of anchors and required anchor edge distances.

C. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment with withstand seismic and wind restraint forces identified in "Performance Requirements" Article above. Include the following:
   1. Basis for certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified" for all components with a performance criteria factor of 1.0.
      b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event" for all components with a performance criteria factor of 1.5.
   2. Dimensioned outline drawings of equipment unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Piping and Ductwork Seismic Restraint Shop Drawings signed and sealed by a qualified professional engineer. Include the following:
   1. Location of all piping and ductwork seismic restraints shown in plain view. Utilize contractor’s in-progress as-built drawings for the plans. Identify which type of restraint is used in which location (provide schedule as necessary).
   2. Submit seismic restraint shop drawing of piping and ductwork seismic restraints prior to the area undergoing its above ceiling inspection.
   3. Submit written verification that seismic restraint installation is complete and meets project requirements.

E. Wind Restraint Details: Detail fabrication and attachment of restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors. Submit calculations showing wind forces and compliance with all state and local codes.

1.06 QUALITY ASSURANCE

A. Seismic-restraint devices shall have horizontal and vertical load testing and analysis performed according to OSHPD and shall bear anchorage preapproval "OPA" number, from OSHPD or another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel."
C. HVAC equipment mounted outside the building shall be anchored to building structure in compliance with lateral load requirements of the locally enforced building code.

1.07 COORDINATION
A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3.
B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."
C. Coordinate with all trades the locations of seismic restraints for HVAC piping and equipment with all other systems and equipment in the vicinity.

PART 2 PRODUCTS
2.01 VIBRATION ISOLATORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   3. Mason Industries.
   4. Vibration Eliminator Co., Inc.
   5. Vibration Isolation.
   6. Vibration Mountings & Controls, Inc.

2.02 VIBRATION ISOLATORS
A. Elastomeric Isolator Pads: Oil and water resistant neoprene arranged in single or multiple layers, molded with non-slip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area and factory cut to sizes that match requirements of supported equipment.
B. Spring Isolators: Freestanding, laterally stable, open spring isolators.
   1. Outside spring diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   2. Minimum additional travel: 50 percent of the required deflection at rated load.
   3. Lateral stiffness: More than 80 percent of 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 1/4-inch-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.
C. Restrained Spring Isolators: Freestanding, steel, open spring isolators with seismic restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   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. Restraint: Seismic stop as required for equipment and authorities having jurisdiction.
   7. Base plate size shall limit flow load to 50 psig.
D. Elastomeric Hangers: Double deflection type, with molded, oil resistant rubber or neoprene isolator elements, steel housings with threaded connections for hanger rods. Color coded or otherwise identified to indicate capacity range.

E. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
   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 or other method which puts the neoprene in series with the spring.
   7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

F. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
   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.
   8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

G. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.

H. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-inch- thick, neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and re-insertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.03 SEISMIC-RESTRAINT DEVICES

A. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

B. Resilient Isolation Washers and Bushings: 1-piece, molded, neoprene having a durometer of 40 - 60, plus or minus 5, with a flat washer face.

C. Seismic Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
   1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient isolation washers and bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 40 - 60, plus or minus 5.
3. Maximum 1/4-inch air gap and minimum 1/4-inch thick resilient cushion.

D. Restraining Cables: ASTM A603 galvanized steel or ASTM A492 stainless steel aircraft cables with end connections made of steel assemblies that adjust to final installation angle and utilize clamping bolts or other method for cable engagement. Include brackets, swivel, and bolts designed for retraining cable service and with automatic locking and clamping devices.

E. Hanger Rod Stiffener: Steel tube or steel slotted support system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

F. Anchor Bolts: Seismic-rated, drill-in, and stud-wedge or female-wedge type suitable for seismic use in accordance with ACI 355. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488/E 488M. Provide adhesive anchor bolts for non-isolated equipment in excess of 10 HP.

G. Channel Support System: MFMA-3 shop or field fabricated support assembly made of slotted steel channels rated in tension, compressor, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end.

2.04 VIBRATION ISOLATION EQUIPMENT BASES

A. Steel Base Type B: Factory-fabricated, welded, structural-steel bases and rails.
   1. Design requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   2. Structural steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
   3. Support brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

B. Inertia Base Factory-fabricated, welded, structural-steel bases and rails ready for field-applied, cast-in-place concrete.
   1. Design requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
   2. Concrete thickness:
      a. Provide a thickness of 6” of concrete for all inertia bases unless noted otherwise.
   3. Structural steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment. Prime and paint all steel.
   4. Support brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
   5. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.
   6. Bottom pan with stiffener supports welded to the steel frame.
   7. Cast-in-place anchor templates for supported equipment.
   8. Rebar for concrete, sized and located as required.

2.05 FACTORY FINISHES

A. Finish: Manufacturer’s standard paint applied to factory-assembled and -tested equipment before shipping.
   1. Powder coating on springs and housings.
   2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
   3. Baked enamel or powder coat for metal components on isolators for interior use.
   4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.
PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

B. Install seismic snubbers or restrained springs on isolated equipment. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

C. Install restraining cables steel angles or channel at each trapeze and individual pipe hanger as specified herein. Install cables so they do not bend across sharp edges of adjacent equipment or building structure. Requirements apply equally to hanging equipment. Do not weld angles to threaded rods.

D. Install resilient bolt isolation washers on equipment anchor bolts.

E. Install hanger rod stiffeners where required to prevent buckling of hanger rods due to seismic forces.

F. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by ICC-ES, OSHPD or another agency acceptable to authorities having jurisdiction.

G. Attachment to Structure: Anchor bracing to structure at flange of beams, at upper chord of truss or at concrete members.

H. Drilled in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage reinforced steel and embedded items. Locate and avoid all items.
   2. Do not drill holes until concrete has achieved full design strength.
   3. Set anchors to manufacturer’s recommended torque, using a torque wrench.
   4. Install zinc coated anchors for interior and stainless steel anchors for exterior applications.

I. Field installed identification means on each actual seismic restraint which is cross-referenced to the submittal drawing.

J. Fill concrete inertia bases, after installing base frame, with 3000-psi concrete; trowel to a smooth finish.
   1. Cast-in-place concrete materials and placement requirements as specified in Division 3.

3.03 EQUIPMENT BASES

A. Concrete Equipment Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions for seismic codes at Project site.

B. Positively anchor concrete base to concrete floor. Unless otherwise indicated, install #3 with 6" hook dowel rods, 6" from edge of base, minimum four per base, on 18-inch centers around the full perimeter of the base.
   1. Place and secure anchorage devices a minimum of 6" from edge of base. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   4. Cast-in-place concrete materials and placement requirements are specified in Division 3.
3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section “Hydronic Piping” for piping flexible connections.

3.05 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. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.
D. Adjust active height of spring isolators.
E. Adjust snubbers according to manufacturer’s written recommendations.
F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
G. Torque anchor bolts according to equipment manufacturer’s written recommendations to resist seismic forces.

3.06 CLEANING

A. After completing equipment installation, inspect vibration isolation and seismic control devices. Remove paint splatters and other spots, dirt and debris, leaving equipment free to move on isolation supports.

3.07 PIPING RESTRAINTS

A. All piping shall be provided with seismic restraints in accordance with SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, Second Edition with September 2000 Amendment No. 1 as published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (ANSI/SMACNA 001-2000). Seismic Hazard Levels required are noted in Part 1 “Performance Requirements”.
   1. “12 inch” exceptions for piping are not applicable. Utilize the methods of the Seismic Restraint Manual without utilizing these exceptions.
B. Piping restraints shall comply with requirements at MSS SP-127.
   1. Brace a change in direction longer than 12 feet.
C. Seismically restrain (braces) all piping as follows:
   1. Brace all HVAC Piping 1-1/4” nominal diameter and larger.
D. Generate a coordination drawing showing pipe and ductwork restraint locations in a timely manner to facilitate coordination with other trades.

3.08 EQUIPMENT VIBRATION ISOLATION AND SEISMIC RESTRAINT

A. Manufacturer shall design and provide vibration isolation and seismic restraints to meet the requirements of this specification and as indicated on the Drawings.
B. Seismic restraints shall be designed and provided for all equipment.
C. All floor mounted equipment including boilers, pumps and expansion tanks, whether vibration isolated or not shall be anchored, bolted or welded to the structure to comply with the required design forces.
D. All roof mounted equipment whether vibration isolated or not shall be anchored, bolted or welded to its equipment support. All equipment supports shall be anchored, bolted or welded to the building structure to comply with the required design forces.
E. Suspended equipment shall be two rigid restraint or four point cables independently braced.
F. Wall mounted BAS panel shall be seismically restrained.

END OF SECTION
SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY
A. This Section includes the following mechanical identification materials and their installation:
1. Equipment labels.
2. Pipe labels.
3. Stencils.
4. Valve tags.
5. Valve schedules.
6. Ceiling and thermostat labels.

1.03 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Valve Tag Schedules: For each piping system. Include a listing of all valves to be labeled with proposed content for each label. Include valve numbering scheme. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.
C. Equipment Label Schedule: Include a listing of all equipment to be labeled with proposed content for each label.

1.04 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.01 EQUIPMENT IDENTIFICATION DEVICES
A. Equipment Labels: Engraved, color-coded, multi-layer, multi-color laminated plastic for mechanical engraving. Include contact-type, permanent adhesive suitable for surface temperature of equipment.
   1. Terminology: Match Owner's numbering scheme or drawing schedules with unique equipment number.
   2. Size: Length and width vary for required label content, but not less than 4-1/2 by 6 inches for equipment, 1/8 inch thick.
   3. Letters: 1/2 inch minimum.

2.02 PIPING IDENTIFICATION DEVICES
A. Manufactured Pipe Labels, General: Preprinted, color-coded, with lettering indicating service, and an arrow showing direction of flow.
   1. Colors: ASME A13.1 or Owner's current color scheme.
   2. Lettering:
3. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of material flow in piping.

B. Pre-Tensioned Pipe Labels: Pre-coiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations used on drawings and an arrow indicating flow direction. Provide lettering size at least 1-1/2 inches high.

2.03 VALVE TAGS

A. Valve Tags: Stamped with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Owner. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch- thick brass.
3. Lettering: Black filled.
4. Size: Minimum 1-1/2", larger as required for labeling scheme.

2.04 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-schedule frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: Extruded aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.05 TEMPERATURE SENSOR LABELS

A. Description: 1/4-inch wide clear extra strength tape with 1/8-inch high black letters. Extra strength adhesive for use on rough textured or uneven surfaces, as well as painted or powder coated surfaces.

PART 3 EXECUTION

3.01 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.02 EQUIPMENT IDENTIFICATION

A. Install equipment labels with permanent adhesive on or near each item of mechanical equipment.

1. Letter size: Minimum 3/4-inch for name of units and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
3. Locate labels where accessible and visible. Include labels for each piece of mechanical equipment and for the following general categories of equipment:
a. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
b. Pumps, compressors, chillers, condensers, and similar motor-driven units.
c. Fans, blowers, primary balancing dampers, and mixing boxes.
d. Packaged HVAC central-station and zone-type units.
e. Tanks and pressure vessels.
f. Filters.
g. Fire dampers and fire/smoke dampers.
h. Pressure reducing valves.
i. Terminal units (supply air terminal boxes, exhaust air valves): For terminal units located above ceiling, locate equipment label on the bottom or side of the terminal unit where it will be visible from the designated ceiling access panel/tile. If utilizing manufacturer’s labels, lettering shall be at least 1” tall. Permanent marker handwritten labels with 2” tall letters are also acceptable. Do not paint over manufacturer provided labels.

B. Install access panel and door labels on equipment and shaft access panels.

3.03 PIPING IDENTIFICATION

A. Install manufactured pipe label indicating service on each piping system. Install with flow indication arrows showing direction of material flow in piping.
   1. Pre-coiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

B. Locate pipe labels as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs less than ten feet long for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Each side of penetrations through walls, floors, ceilings, and 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 intervals of 15 feet along each run.
   7. At a minimum of once over each room for each piping system present over that room. Center the label in the pipe run over the room. If pipe length over the room is less than 15 feet than install labels at each wall penetration.

3.04 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; faucets; convenience hose connections; at HVAC terminal devices and at similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.05 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedules on a wall in an accessible location in each major equipment room.

3.06 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.07 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION
SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY
A. This Section includes testing, adjusting and balancing HVAC systems to produce design objectives, including the following:
   1. Balancing airflow and water flow within distribution systems, including sub-mains, branches and terminals, to indicated quantities according to specified tolerances.
   2. Adjusting total HVAC systems to provide indicated quantities.
   4. Setting quantitative performance of HVAC equipment.
   5. Verifying that automatic control devices are functioning properly.
   6. Reporting results of the activities and procedures specified in this Section.

1.03 DEFINITIONS
C. TAB: Testing, adjusting, and balancing.
D. TAB Specialist: An entity engaged to perform TAB Work.

1.04 SUBMITTALS
A. Qualification Data: Within 30 days of Contractor’s Notice To Proceed, submit documentation that the TAB Contractor and this Project’s TAB team members meet the qualifications specified in “Quality Assurance” Article. This documentation shall include the following:
   1. A list of the names of all individual on-site Field Supervisors and TAB Technicians who may be assigned to the project.
   2. A statement that each of the individual listed on-site Field Supervisors and TAB Technicians has met the experience and certification requirements of the specification.
   3. A statement that each of the individual listed on-site Field Supervisors and TAB Technicians has received the required training from the selected Controls Supplier.
   4. A statement noting that apprentice labor may be utilized for lesser skilled tasks if under the direct supervision of one of the listed individual on-site Field Supervisors and TAB Technicians who is on-site at all times the apprentice is working.


D. Pencil-copy initial TAB reports sent directly to the Engineer, as system TAB progresses.

E. Certified TAB reports.

F. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration. Calibration dates shall be within a period of six months prior to the first recorded measurements on the project site.
G. Additional testing reports with verified conditions noted, description of adjustments made, and outstanding corrective action items required by other trades.

1.05 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Shall meet the following minimum requirements:

1. TAB Contractor shall be either:
   a. A current certified member of AABC, registered in the state of the project site.
   b. A current certified member of NEBB registered in the state of the project site.
   c. A registered Professional Engineer licensed in the state of the project site that specialized in the testing, adjusting and balancing of systems with a minimum of ten years of documented experience.

2. Testing, adjusting and balancing shall be completed under the direct field supervision of the TAB Field Supervisor. The TAB Field Supervisor shall be either:
   a. A direct employee of the TAB Contractor who is currently certified as an AABC Test and Balance Engineer with at least ten (10) years of demonstrated working experience in the testing, adjusting and balancing of building HVAC systems.
   b. A direct employee of the TAB Contractor who is currently certified as NEBB Qualified TAB Supervisor with at least ten years of demonstrated working experience in the testing, adjusting and balancing of building HVAC systems.
   c. A registered Professional Engineer that specialized in the testing, adjusting and balancing of systems with a minimum of ten years of documented experience.

3. All testing, adjusting and balancing work shall be completed by a TAB technician. The TAB technician shall be either:
   a. An employee of the TAB Contractor and who is certified by AABC as a test and balance technician.
   b. An employee of the TAB Contractor and who is certified by NEBB as a qualified TAB technician.
   c. A registered Professional Engineer that specialized in the testing, adjusting and balancing of systems with a minimum of ten years of documented experience.

4. In addition to the technical capabilities described herein, the TAB Contractor demonstrates a production capability to plan, control, and integrate manpower and other resources necessary for successful contract completion.

5. TAB Contractor shall have received software training from the selected Controls Supplier applicable to the software and hardware which will be provided for this project.

6. TAB Contractor shall have on the project site all required software and hardware necessary from the selected Controls Supplier to perform testing, adjusting and balancing required tasks.

7. TAB Contractor shall be listed on the Bid Form on bid day.

8. TAB Contractor shall have at least five years documented experience in the testing, adjusting and balancing of commercial DDC controls. The Owner may ask to verify the qualifications and experience for all field installation technicians assigned to the project prior to the approval of the TAB Contractor.

9. TAB Contractor shall submit a statement acknowledging agreement with the applicable manufacturer’s design guidelines covering the installation of controls and the subsequent requirements of the TAB Contractor.

10. TAB Contractor shall attend a one hour familiarization session immediately following the project preconstruction meeting.

B. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor’s forms.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
1.06 PROJECT CONDITIONS
A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.07 COORDINATION
A. Notice: Provide seven (7) days' advance notice for each test. Include scheduled test dates and times.
B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.
C. The TAB Agent shall telephone the Engineer each day that the Agent is on-site while TAB work is being undertaken. Provide pencil copy handwritten data directly to the Engineer via fax while on-site TAB work is being undertaken.

PART 3 - EXECUTION [PART 2 - PRODUCTS (NOT APPLICABLE)]

3.01 EXAMINATION
A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the final submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201 "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

I. Examine two or three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

K. Examine system pumps to ensure absence of entrained air in the suction piping.

L. Examine operating safety interlocks and controls on HVAC equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION
A. Prepare a TAB plan that includes strategies and step-by-step procedures.
3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC’s "National Standards for Total System Balance," ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing," and in this Section.
1. Comply with requirements in ASHRAE 62.1-2010, Section 7.2.2 "Air Balancing."

B. Complete system-readiness checks and prepare reports. Verify the following:
1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Isolating and balancing valves are open and control valves are operational.

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydraulic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.05 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at constant speed pumps. Use the following procedures except for positive-displacement pumps:
1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
   a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Engineer and comply with requirements in Division 23 Section "Hydronic Pumps."
2. Check system resistance. With all control valves and shutoff valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Measure and record system resistance with balance valve, if installed, wide open. Adjust pump discharge balance, valve, if installed, until indicated water flow is achieved.
3.06 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchanger terminals and proceed as specified above for hydronic systems.

B. Measure water flow at variable speed pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed and the pump operating at the submittal design speed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

2. Check system resistance. With all control valves and shutoff valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Measure and record system resistance and system flow. Record and set VFC Maximum speed (HZ) such that the indicated design water flow rate is achieved.

a. Monitor motor and VFC performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor and VFC recorded Horsepower. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 10 percent of design.

C. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

D. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

E. Set calibrated balancing valves, if installed, at calculated pre-settings.

F. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

G. Measure flow at main balancing station and set main balancing device, if installed, to achieve flow that is 5 percent greater than indicated flow.

H. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.

2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.

3. Record settings and mark balancing devices.

I. Measure pump flow rate and make final measurements of pump amperage, voltage, pump and motor rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

J. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

K. Check settings and operation of each safety valve. Record settings.
B. Measure and record variable speed controller output speed, Hertz, voltage (each leg) and pump speed and pressures with all individual zone control valves wide open and at their balanced settings.

3.07 PROCEDURES FOR MOTORS

A. Motors: Test at final balanced conditions and record the following data:
   1. Manufacturer's name, model number, and serial number.
   4. Efficiency rating.
   5. Nameplate and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
   7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.08 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:
   1. Nameplate data.
   2. Airflow.
   3. Entering- and leaving-air temperature at full load.
   4. Voltage and amperage input of each phase at full load and at each incremental stage.
   5. Calculated kilowatt at full load.
   6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Airflow.
   3. Air pressure drop.
   4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Refrigerant suction pressure and temperature.

3.09 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
   1. Cooling-water flow rate: Zero to plus 5 percent.

3.10 FINAL REPORT

A. General: Prepare a certified written report, tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report’s binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
2. Fan curves.
3. Manufacturers’ test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect’s name and address.
6. Engineer’s name and address.
7. Contractor’s name and address.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
   a. Indicated versus final performance.
   b. Notable characteristics of systems.
   c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer’s name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
   a. Settings for outdoor-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Cooling coil, wet- and dry-bulb conditions.
   d. Face and bypass damper settings at coils.
   e. Fan drive settings including settings and percentage of maximum pitch diameter.
   f. Inlet vane settings for variable-air-volume systems.
   g. Settings for supply-air, static-pressure controller.
   h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.

E. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
1. Unit data:
   a. Unit identification.
   b. Location.
   c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm (L/s).
g. Water pressure differential in feet of head or psig (kPa).
h. Required net positive suction head in feet of head or psig (kPa).
i. Pump rpm.
j. Impeller diameter in inches (mm).
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test data (Indicated and Actual Values):
   a. Static head in feet of head or psig (kPa).
   b. Pump shutoff pressure in feet of head or psig (kPa).
   c. Actual impeller size in inches (mm).
   d. Full-open flow rate in gpm (L/s).
   e. Full-open pressure in feet of head or psig (kPa).
   f. Final discharge pressure in feet of head or psig (kPa).
   g. Final suction pressure in feet of head or psig (kPa).
   h. Final total pressure in feet of head or psig (kPa).
   i. Final water flow rate in gpm (L/s).
   j. Voltage at each connection.
   k. Amperage for each phase.

F. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit data: Include the following:
   a. Unit identification.
   b. Location.
   c. Unit make and model number.
   d. Manufacturer's compressor serial numbers.
   e. Compressor make.
   f. Compressor model and serial numbers.
   g. Refrigerant weight in lb (kg).
   h. Low ambient temperature cutoff in deg. F (deg. C).

2. Test data: Include design and actual values for the following:
   a. Inlet-duct static pressure in inches wg (Pa).
   b. Outlet-duct static pressure in inches wg (Pa).
   d. Leaving-air, dry-bulb temperature in deg. F (deg. C).
   e. Condenser entering-water temperature in deg. F (deg. C).
   h. Condenser entering-water pressure in feet of head or psig (kPa).
   i. Condenser leaving-water pressure in feet of head or psig (kPa).
   j. Condenser water pressure differential in feet of head or psig (kPa).
   k. Control settings.
   l. Unloader set points.
   m. Low-pressure-cutout set point in psig (kPa).
   n. High-pressure-cutout set point in psig (kPa).
   o. Suction pressure in psig (kPa).
q. Condenser refrigerant pressure in psig (kPa).
s. Oil pressure in psig (kPa).
t. Oil temperature in deg. F (deg. C).
u. Voltage at each connection.
v. Amperage for each phase.
w. The kW input.
x. Crankcase heater kW.
y. Number of fans.
z. Condenser fan rpm.
aa. Condenser fan airflow rate in cfm (L/s).
ab. Condenser fan motor make, frame size, rpm, and horsepower.
ac. Condenser fan motor voltage at each connection.
ad. Condenser fan motor amperage for each phase.

G. Instrument Calibration Reports:
1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

H. System Test Reports and Functional Test Reports:  For each system test, include the following:
1. Condition of controls (fully automatic or not).
2. Variable frequency drive Hertz.
3. All conditions denoted in the Procedures Section.
4. System static pressures at building automation sensors, both physical readings and controller readouts.
5. Temperature control verification results.

3.11 INSPECTIONS

A. Initial Inspection:
1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
   a. Measure airflow of at least 10 percent of air outlets.
   b. Measure water flow of at least 5 percent of terminals.
   c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
   d. Verify that balancing devices are marked with final balance position.
   e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:
1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Engineer of Record.
3. Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
   1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
   2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

END OF SECTION
PART 1 GENERAL

1.01 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY
   A. Section Includes:
      1. Insulation materials:
         a. Cellular glass.
         b. Flexible elastomeric.
         c. Mineral fiber.
      2. Insulating cements.
      3. Adhesives.
      5. Sealants.
      6. Factory-applied jackets.
      7. Field-applied jackets.
      8. Tapes.
     10. Corner angles.

1.03 SUBMITTALS
   A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any). Provide a scheduled listing in the submittal of each type of pipe service, duct service or equipment type that insulates with the thickness and jacket noted for each service and type.
   B. Field quality-control reports.

1.04 QUALITY ASSURANCE
   A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
      1. Insulation installed indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
      2. Insulation installed outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
   B. Storage: Insulation material shall be stored to prevent dirt and moisture contamination.

1.06 COORDINATION
   A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
   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.
SCHEDULING

A. Schedule insulation application after satisfactory pressure testing systems and, where required, after installing and testing heat tracing.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulosed glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Cell-U-Foam Corporation; Ultra-CUF.
      b. Pittsburgh Corning Corporation; Foamglas.
   2. Block insulation: ASTM C 552, Type I.
   3. Special-shaped insulation: ASTM C 552, Type III.
   4. Board insulation: ASTM C 552, Type IV.
   5. Preformed pipe insulation with factory applied ASJ or ASJ-SSL: Comply with ASTM C 552, Type II and Class 2.
   6. Factory fabricated shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aerocel and Aerocel (EPDM).
      b. Armacell LLC; AP Armaflex and UT Solaflex (EPDM).
      c. K-Flex USA; Insul-Sheet, K-Flex and Kflex HT (EPDM).
   2. Flexible elastomeric (EPDM) shall be suitable for continuous operation up to at least 250 deg. F and down to at least -40 deg. F and be U.V. resistant in accordance with ASTM G7/G90.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket or Type III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap.
      e. Owens Corning; All-Service Duct Wrap.

I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with
factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglass 700 Series.

J. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; Earthwool 1000.
      d. Manson Insulation Inc.; Alley-K.
      e. Owens Corning; Fiberglass Pipe Insulation.
   2. Type I, 850 deg. F (454 deg. C) materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.02 INSULATING CEMENTS

   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Insulco, Division of MFS, Inc.; Triple I.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg. F.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Products, Division of ITW; CP-96.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Aeroflex USA Inc.; Aeroseal.
      b. Armacell LCC; 520 Adhesive.
      c. Foster Products Corporation, H. B. Fuller Company; 85-75.
      d. K-Flex USA.
      e. RBX Corporation; Rubatex Contact Adhesive.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Products, Division of ITW; CP-82.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-82.
   c. ITW TACC, Division of Illinois Tool Works; S-90/80.
   d. Marathon Industries, Inc.; 225.
   e. Mon-Eco Industries, Inc.; 22-25.

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

F. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dow Chemical Company (The); 739, Dow Silicone.
   d. Speedline Corporation; Speedline Vinyl Adhesive.

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

2.04 MASTICS
A. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-35.
   b. Foster Products Corporation, H. B. Fuller Company; 30-90.
   c. ITW TACC, Division of Illinois Tool Works; CB-50.
   d. Marathon Industries, Inc.; 590.
   e. Mon-Eco Industries, Inc.; 55-40.
   f. Vimasco Corporation; 749.

   2. Water-vapor permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil (1.09-mm) dry film thickness.
   3. Service temperature range: Minus 20 to plus 180 deg. F.

2.05 SEALANTS
A. Joint Sealants:
1. Joint sealants for cellular glass, products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-76.
   b. Foster Products Corporation, H. B. Fuller Company; 30-45.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.

   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Permanently flexible, elastomeric sealant.
Service temperature range: Minus 100 to plus 300 deg. F.
Color: White or gray.
For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-76-8.
   b. Foster Products Corporation, H. B. Fuller Company; 95-44.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
Service temperature range: Minus 40 to plus 250 deg. F.
Color: Aluminum.
For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
Service temperature range: Minus 40 to plus 250 deg. F.
Color: White.
For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.06 FACTORY-APPLIED JACKETS
A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C 1136, Type II.
   4. FSP jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

2.07 FIELD-APPLIED JACKETS
A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules. Flame spread of 25 or less and smoke developed rating of 50 or less per ASTM E84.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Johns Manville; Zeston.
      c. Proto PVC Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.
   2. Adhesive: As recommended by jacket material manufacturer.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Products, Division of ITW; Metal Jacketing Systems.
      b. PABCO Metals Corporation; Surefit.
      c. RPR Products, Inc.; Insul-Mate.
      a. Finish and thickness are indicated in field-applied jacket schedules.
      b. Moisture barrier for indoor applications: 3-mil-thick, heat-bonded polyethylene and Kraft paper or 2.5-mil-thick Polysurlyn.
      c. Moisture barrier for outdoor applications: 3-mil-thick, heat-bonded polyethylene and Kraft paper or 2.5-mil-thick Polysurlyn.
      d. Factory-fabricated fitting covers:
         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union covers.
         5) End caps.
         6) Beveled collars.
         7) Valve covers.
         8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Polyguard; Alumaguard 60.

2.08 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with pressure sensitive acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Minimum width: 3 inches.
   3. Thickness: 11.5 mils.
   5. Elongation: 2 percent.
   6. Tensile strength: 40 lbf/inch in width.
   7. ASJ tape disks and squares: Precut disks or squares of ASJ tape.
   8. WVTR: 0.02 perms per ASTM E96.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic pressure sensitive adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   b. Compac Corp.; 110 and 111.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
   d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
2. Minimum width: 3 inches.
5. Elongation: 2 percent.
7. FSK tape disks and squares: Precut disks or squares of FSK tape.
8. WVTR: 0.02 perms per ASTM E96.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
   b. Compac Corp.; 130.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
   d. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
5. Elongation: 500 percent.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   b. Compac Corp.; 120.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
   d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
5. Elongation: 5 percent.
6. Tensile strength: 34 lbf/inch in width.

E. Bands:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products; Bands.
   b. PABCO Metals Corporation; Bands.
   c. RPR Products, Inc.; Bands.
2. Stainless steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal.
3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.

F. Insulation Pins and Hangers:
1. Capacitor-discharge weld pins: Copper- or zinc-coated steel pin (or other material as required for stainless or aluminum ductwork), fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated.
a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   1) AGM Industries, Inc.; CWP-1.
   2) GEMCO; CD.
   3) Midwest Fasteners, Inc.; CD.
   4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-head, capacitor discharge weld pins: Copper- or zinc-coated steel pin (or other material as required for stainless steel or aluminum duct), fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.

3. Metal, adhesively attached, perforated base insulation hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation-retaining washers: Self-locking washers formed from 0.016-inch- thick, sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.
   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

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

G. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
H. Wire: 0.062-inch soft-annealed, stainless steel.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Childers Products.
   c. PABCO Metals Corporation.
   d. RPR Products, Inc.

2.09 CORNER ANGLES
   A. Aluminum Corner Angles: 0.040-inch-thick, minimum 1 by 1 inch, aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 EXECUTION

3.01 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.

3.02 PREPARATION
   A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
   B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.
   C. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
      1. Carbon steel: Coat carbon steel operating at a service temperature below 60 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

3.03 GENERAL INSTALLATION REQUIREMENTS
   A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of 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.
   E. Install multiple layers of insulation with longitudinal and end seams staggered.
   F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
   G. Keep insulation materials dry during application and finishing.
   H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
   I. Install insulation with least number of joints practical.
   J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
      1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

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

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

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

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

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant. Fabricate a cellular glass "box" around the pump which is removable. Utilize flexible elastomeric at penetrations and seal with silicone. Allow for removal of suction diffuser screen if a suction diffuser is installed.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

4. Seal jacket to wall flashing with flashing sealant.

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

E. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

2. Pipe: Install insulation continuously through floor penetrations.

3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 7 Section "Firestopping."

3.05 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Insulation Installation on Pumps:
1. Fabricate custom fitted insulation pieces. Fit pieces around pumps and coincide joints with splits in pump casings. Fabricate joints with outward bolted flanges. Secure box sections together using a latching mechanism for easy removal of sections to maintain pump.

2. 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. Fabricate a cellular glass "box" around the pump which is removable. Utilize flexible elastomeric at penetrations and seal with silicone. Allow for removal of suction diffuser screen if a suction diffuser is installed.

3.06 GENERAL PIPE INSULATION INSTALLATION

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

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the gate valve bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate steam safety relief valves up to the bottom base and provide the minimum clearance to the nuts and bolts to remove the flanged safety relief valve.
6. 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.

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

8. 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.

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

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

11. Install insulation at coil connection piping not required to have a continuous vapor barrier such that the maximum length of uninsulated piping does not exceed 3" in length.

C. 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.

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

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

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

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

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

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.07 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For interior insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. 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. Seal all insulation terminations with vapor seal mastic. Provide minimum 3” wide ASJ butt strip at joints to maintain the vapor barrier.
5. For exterior insulation, utilize manufacturer’s standard weather barrier mastic under the jacketing.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer’s recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer’s written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Factory miter and tar together with a minimum of three segments for elbows. Secure insulation materials with wire or bands.
3. Secure fittings with 1/2” wide filament tape as recommended by the manufacturer.
4. Coat fittings with vapor seal with fab cloth embedded in it.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.08 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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

B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers’ recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

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

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

3.09 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.10 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers' recommended adhesive.
   1. Apply two (2) 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 overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof
sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.11 FIELD QUALITY CONTROL
A. Perform tests and inspections.
B. All insulation applications will be considered defective work if sample inspection reveals noncompliance with requirements.

3.12 EQUIPMENT INSULATION SCHEDULE
A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
C. Heat-exchanger (water-to-water for cooling service) insulation shall be:
   1. Flexible elastomeric: 1-1/2 inch thick.
D. Chilled-water pump insulation (including removable/replaceable suction diffuser cover) shall be one of the following:
   1. Flexible elastomeric: 2 inch thick.
   2. Cellular glass: 2-inch thick.

3.13 PIPING INSULATION SCHEDULE, GENERAL
A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from the materials listed is at the Contractor's option.
B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Underground piping.
   2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
C. Piping located within air handling units, including coil connections inside the airstream, shall be fully insulated.
D. Products shall not contain asbestos, lead, mercury or mercury compounds.
E. Products that come into contact with stainless steel shall be qualified as acceptable according to ASTM C795.

3.14 INDOOR PIPING INSULATION SCHEDULE
A. Condensate and Equipment Drain Water below 60 Deg. F:
   1. All pipe sizes: Insulation shall be the following:
      a. Flexible elastomeric: 3/4 inch thick.
B. Chilled Water, Heat Recovery, Glycol and Brine:
   1. 6” and smaller: Insulation shall be one of the following:
      a. Cellular glass: 1 inch thick.
      b. Mineral-fiber, preformed pipe, Type I: 1 inch thick.
      c. Flexible elastomeric: 1-inch thick.
   2. NPS 8 and larger: Insulation shall be one of the following:
      b. Mineral-fiber, preformed pipe, Type I: 1-1/2 inches thick.
      c. Flexible elastomeric: 1-1/2 inch thick.
   3. NPS ¾” and larger located within a mechanical room with an exterior door: Insulation shall be one of the following:
      b. Mineral-fiber, preformed pipe, Type I: 1-1/2 inches thick.
      c. Flexible elastomeric: 1-1/2 inches thick.
4. Chilled water piping within air handling units shall be insulated with 1 inch thick elastomeric covered with two coats of latex enamel provided by the elastomeric manufacturer (Like Armstrong WB finish).

C. Refrigerant Suction, Liquid, and Hot-Gas Piping and Tubing:
   1. NPS 1-1/2 and smaller: Insulation shall be the following:
      a. Cellular glass: 1 inch thick.
      b. Flexible elastomeric: 1 inch thick.
   2. NPS 1-5/8 and larger:
      b. Flexible elastomeric: 1-1/2 inches thick.

3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE
   A. Refrigerant Suction and Hot-Gas Piping and Tubing:
      1. All pipe sizes: Insulation shall be the following:
         a. Flexible elastomeric (EPDM): 2 inches thick.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE
   A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
   B. If more than one material is listed, selection from materials listed is Contractor's option.
   C. Piping exposed, within mechanical rooms:
      1. PVC: 20 mils thick.

3.17 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE
   A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket. Confirm that the vapor barrier of the insulation is 100% intact and repair as necessary prior to applying jacket.
   B. If more than one material is listed, selection from materials listed is Contractor's option.
   C. Piping, Exposed:
      1. Aluminum, stucco embossed: 0.032 inch thick.

END OF SECTION
SECTION 23 2113
HYDRONIC PIPING AND ACCESSORIES

PART 1 GENERAL

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

1.02 SUMMARY
   A. This Section includes piping, fittings and joining materials, joining methods, special-duty valves,
      and hydronic specialties for chilled water systems; makeup water for these systems; blowdown
      drain lines; air vent and safety valve piping and condensate drain piping.
   B. Related Sections include the following:
      1. Division 23 Section "Hydronic Pumps" for pumps, motors and accessories for hydronic
         piping.

1.03 SUBMITTALS
   A. Product Data: For each type of valve and hydronic specialty indicated. Include flow and
      pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing
      valves and automatic flow-control valves. Indicate materials and joining methods for each
      piping system in the submittal. Provide a project specific submittal schedule (by terminal unit
      and equipment tag) for all calibrated balance valves and automatic flow control valves which
      includes pressure drop and sizing information. Include pressure reducing valve flow ranges and
      adjustability ranges. Include safety valve capacity and settings. Include safety valve schedule
      noting ASME UV rating and location of installation.
   B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies,
      alignment guides, expansion joints and loops, and their attachment to the building structure.
      Detail location of anchors, alignment guides, and expansion joints and loops. Provide pipe
      coating submittal as required by Section "HVAC Insulation".
   C. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the
      following:
      1. Test procedures used.
      2. Test results that comply with requirements.
      3. Failed test results and corrective action taken to achieve requirements.
   D. Maintenance Data: For hydronic specialties and valves (including air control devices, hydronic
      specialties, expansion tanks and special duty valves) to include in maintenance manuals
      specified in Division 1.

1.04 QUALITY ASSURANCE
   A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel
      Code: Section IX, "Welding and Brazing Qualifications."
   B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials,
      products, and installation. Safety valves and pressure vessels shall bear the appropriate
      ASME label. Fabricate and stamp air separators and expansion tanks to comply with the
      ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
   C. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M
      "Structural Welding Code-Steel".

1.05 COORDINATION
   A. Coordinate layout and installation of hydronic piping and suspension system components with
      other construction, including light fixtures, HVAC equipment, ductwork, plumbing, fire-
      suppression-system components, and partition assemblies.
   B. Coordinate pipe sleeve installations for foundation wall penetrations.
C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations.
D. Coordinate pipe fitting pressure classes with products specified in related Sections.
E. Coordinate size and location of concrete bases.
F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Grooved mechanical joint fittings and couplings:
      a. Victaulic Company of America.
   2. Calibrated balancing valves and calibrated metering stations:
      a. Armstrong Pumps, Inc.
      c. Griswold Controls.
      d. ITT Bell & Gossett; ITT Fluid Technology Corp.
      e. MEPCO.
      f. Nexus.
      g. Preso.
      h. Taco, Inc.
      i. Tour and Anderson.
   3. Safety valves:
      a. Amtrol, Inc.
      b. Armstrong Pumps, Inc.
      c. Conbraco Industries, Inc.
      d. ITT McDonnell & Miller Div.; ITT Fluid Technology Corp.
      e. Kunkle Valve Division.
      f. Spence Engineering Company, Inc.
   6. Air separators:
      a. American Wheatley.
      b. Amtrol, Inc.
      c. Armstrong Pumps, Inc.
      d. ITT Bell & Gossett; ITT Fluid Technology Corp.
      e. Spirotherm, Inc.
      f. Taco, Inc.
   9. Hydronic accessories (air vents, etc.):
      a. American Wheatley.
      b. Amtrol.
      c. Armstrong Pumps, Inc.
      d. ITT Bell and Gossett; ITT Fluid Technology Corporation.
      e. Metraflex.
      f. Mueller.
      g. Spirotherm, Inc.
      h. Taco.
      i. Watts.
   10. Flexible connectors:
      a. Flex – Hose Company.
      b. Hyspan.
      c. Metraflex.
      d. Unasphere.
      e. Vibration Eliminator.
   11. Strainers:
a. Armstrong.
b. Flexonics.
c. Hayward.
d. Keckley.
e. Metraflex.
f. Mueller.
g. Watts.
h. Yarway.

2.02 PIPING MATERIALS AND SYSTEM COMPONENTS

A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

B. Hydronic piping components and installation shall be selected to be suitable for the following minimum non-shock working pressures and temperatures:
   1. Chilled water: 125 psig, 150 deg. F.
   2. Makeup water: 100 psig, 150 deg. F.
   3. Blowdown: 125 psig, 225 deg. F.
   4. Air vent: 125 psig, 225 deg. F.
   5. Safety valve piping: Equal to pressure of the piping system to which it is attached.

C. System components (including valves) shall be rated for no less than that specified herein regardless of maximum working pressures and temperatures listed above. Select components with higher component ratings than those listed herein as required to be suitable for working pressures and temperatures above. Account for system test pressures when selecting component ratings.

2.03 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B).

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K (ASTM B 88M, Type A).

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Wrought-Copper Fittings: ASME B16.22.

E. Wrought-Copper Unions: ASME B16.22.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper phosphorous alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

G. Flanges: Cast bronze of same pressure classification as connected piping system.

2.04 STEEL PIPE AND FITTINGS

A. Steel Pipe, NPS 2 (DN 50) and Smaller: ASTM A53/A53M or ASTM A106, Type F (furnace-butt welded), Grade B, Schedule 40, black steel, plain ends.

B. Steel Pipe, NPS 2-1/2 through NPS 10 (DN 65 through DN 250): ASTM A53/A53M or ASTM A106, Type E (electric-resistance welded), Grade B, Schedule 40, black steel, plain ends.

C. Steel Pipe, NPS 12 through NPS 20 (DN 300 through DN 500): ASTM A53/A53M or ASTM A106, Type E (electric-resistance welded) or Type S (seamless), Grade B, Standard weight, black steel, plain ends.
   1. Steel pipe nipples: ASTM A 733, made of ASTM A53/A53M, Schedule 40, black steel; seamless for NPS 2 (DN 50) and smaller and electric resistance welded for NPS 2-1/2 (DN 65) and larger.

D. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.


F. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.

G. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 125, and 250; raised ground face and bolt holes spot faced.
H. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

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

J. Wrought Cast- and Forged-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 or utilize slip-on flanges with multiple pass inner fillet weld radius up to inside pipe diameter.
   3. Facings: Raised face.

K. Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47 (ASTM A 47M), Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.

L. Grooved Mechanical-Joint Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings. Victaulic style 107N rigid coupling with type "EHP" EPDM gasket.

M. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

N. Gasket Material: Thickness, material, and type suitable for the chemical and thermal conditions of the fluid to be handled and design temperatures and pressures.

2.05 VALVES

A. Gate, globe, check, ball, and butterfly valves are specified in Division 23 Section "Valves."

B. Refer to Part 3 "Valve Applications" Article for applications of each valve.

C. Calibrated Balancing Valves, NPS 2 and Smaller: Cast bronze or forged brass body, Venturi measuring section, ball or plug type, minimum 175-psig CWP working pressure, 250 deg. F maximum operating temperature, TFE or PTFE seats and having threaded ends. Valves shall have calibrated orifice and be full shut off, connections for portable differential pressure meter with integral seals, equipped with setting indication and a memory stop to retain set position, integral points to register degree of valve position and preformed polyurethane insulation cover, and permanently marked direction of flow. Size to pass design flow at 85% of full open position with 12" wg pressure drop and an accuracy of ±5%. Utilize ½" calibrated ball valve line size when there is a choice of the proper flow range in both ½" and ¾" body sizes and then utilize ⅜" by ¼" increasers to the coil, control valve, or piping as required. Provide components in individual bags, one bag per terminal unit, with tags indicating the terminal unit number in the bag.

D. Calibrated Balancing Valves, NPS 2-1/2 and Larger: Cast-iron or steel body, ball, plug, butterfly or globe type, minimum 125-psig CWP working pressure, 250 deg. F maximum operating temperature, and having flanged connections. Butterfly valves shall be lug style, rated for 100 psig dead end service, 100% positive shutoff seats and seals suitable for the expected service and infinite adjustment (no notches). Valves shall have calibrated orifice, pitot or Venturi, connections for portable differential pressure meter with integral seals, and be equipped with setting indication and a memory stop to retain set position. Size to pass design flow at 85% of full open position with a maximum 12" wg pressure drop and an accuracy of ±5%.

E. Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV or Section VIII as required.
2.06 HYDRONIC SPECIALTIES

A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.

B. Automatic Air Vent: Designed to vent automatically with float principle; brass or bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 threaded discharge connection and NPS 1/2 threaded inlet connection.

C. Y-Pattern Strainers:

1. Threaded connections: 400-psig working water pressure; cast-iron body (ASTM A 126, Class B) in steel piping, bronze body in copper tubing, threaded connections for NPS 2 and smaller, No. 20 mesh (1/31" openings), tapped blow-off plug.

2. Flanged connections: 150-psig and 300-psig working water pressure to match pump construction; cast iron body (ASTM A126, Class B), flanged ends for NPS 2-1/2 and larger, 1/16" mesh through 4" NPS, 1/8" mesh larger than 4" NPS, bolted cover flange with tapered seats, tapped blow-off plug.

G. Flexible Connectors 2-1/2" and larger (heating water): Stainless-steel inner bellows with woven, flexible, stainless steel, wire-reinforcing protective jacket; 150-psig minimum working pressure at a simultaneous 250 deg. F minimum operating temperature. Connectors shall have flanged connections to match equipment connected and shall be capable of 3/4-inch misalignment.

H. Flexible Connectors 2" and Smaller: Synthetic polymer hose with stainless steel outer braid; male by female swivel ends or union end; 150 psig minimum working pressure and 250 deg. F operating temperature. Minimum length 12" for 1" and smaller and 18" for 1-1/4" to 2".

I. Flexible Connectors, 2-1/2" and larger (Chilled Water) Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; minimum operating temperatures of 170 deg. F at a simultaneous pressure of 225 psig; control units to limit movement beyond design limits of flexible connector.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

A. Chilled Water; NPS 2-1/2 and Larger: Standard weight steel pipe with welded and flanged joints.

C. Condensate Drain Lines: Type L (Type B) drawn temper or type DWV copper tubing with soldered joints.

D. Makeup Water Piping: Type L (Type B) drawn temper copper tubing with brazed joints.

E. Blowdown Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

F. Air Vent Piping: Same materials and joining methods as for piping specified for the service in which air vent is installed.

G. Safety Valve Inlet and Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.02 VALVE APPLICATIONS

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

1. Shutoff duty: Ball and butterfly valves.

B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line and branch line is less than 30 lineal feet long.

C. Install calibrated balancing valves in the return water line of each heating or cooling element, on constant speed pump discharges, at multiple bank coils, and elsewhere as required to
facilitate system balancing. Furnish all the calibrated balance valves on the project from the same manufacturer.

D. Install non-slam, center spring, wafer style dual-plate or globe style check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves on hot-water generators, unfired pressure vessels, both the tube side and the shell side of shell and tube heat exchangers and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor drain or the outdoors as indicated. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements. Furnish all the calibrated balance valves on the project from the same manufacturer.

3.03 PIPING INSTALLATIONS

A. Drawing plans, schematics and diagrams indicate general location and arrangement of piping systems. Indicated piping locations and arrangements as such were used to size pipe and calculate friction loss, expansion, pump sizing and other design considerations. Install piping as indicated unless deviations to layout are approved.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas. Do not install piping within the building’s exterior envelope insulation.

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 groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

G. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage. Install a drain on each floor of the building in the heating water system and pipe the drain discharge to housekeeping closet mop sink.

H. Install piping at a uniform grade of 1" in 40'-0" upward in direction of non-gravity flow except condensate drain piping shall slope 1/8" in 1'-0" in the direction of discharge. Provide uniform slope on condensate drain piping runs and threaded cleanouts at changes in direction such that cleanouts are located no further than 40 lineal feet apart.

I. Install solder connections in otherwise all-brazed tubing systems at threaded fitting adapters.

J. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

K. Unless otherwise indicated, install all branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe. Branch connections to terminal units (size ¾” and 1”) shall connect to the main pipe (top, side or bottom) as required for the best accessibility to piped components and terminal unit.

L. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blow-off connection for strainers smaller than NPS 2.

M. Maintain manufacturer’s recommended straight pipe upstream and downstream from each flow measuring device installation.

N. Unless otherwise indicated, install long radius elbows (flow centerline radius equals 1.5 times diameter) for iron and steel piping. Unless otherwise indicated, install long radius elbows (centerline flow radius equals 1.5 times nominal tube diameter) for copper tubing sizes greater than 1".
O. Install valves according to Division 23 Section “General Duty Valves for HVAC Piping.”

P. Install unions in piping, NPS 2 and smaller, adjacent to valves at final connections of equipment and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 and larger at final connections of equipment and elsewhere as indicated.

R. Identify piping as specified in Division 23 Section Identification for HVAC Piping and Equipment.”

T. Install protective coating on the installed cold service piping if required by Division 23 Section “HVAC Insulation”.

3.04 HANGERS AND SUPPORTS

A. Hanger, support and anchor devices as specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with requirements below for maximum spacing of supports.

B. Seismic restraints are specified in Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”

C. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for hydronic piping.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4– 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   2. NPS 1-1/2: Maximum span, 9 feet ; minimum rod size, 3/8 inch.
   3. NPS 2 –3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   4. NPS 4 –6: Maximum span, 10 feet; minimum rod size, 1/2 inch.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. NPS 1 and NPS 1-1/4: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

F. Support vertical runs at roof and at each floor and at 10-foot intervals between floors.

3.05 PIPE JOINT CONSTRUCTION

A. Refer to Division 23 Section "Common Work Results for HVAC" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping.

3.06 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting. Install copper tubing from the discharge of the automatic air vent routed to a floor drain.

C. Install strainers as shown on the Drawings with blowdown piping with ball valve and capped nipple or extend to nearest drain as noted on the Drawings.

G. Install flexible connectors for all inlet and outlet pump connections and other vibration producing equipment (except in-line pumps).

3.07 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall not be smaller than equipment connections.
B. Install temperature sensing wells in accessible locations close to connected equipment.
C. Install ports for pressure and temperature gages at coil inlet and outlet connections.

3.08 FIELD QUALITY CONTROL
A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Flush system with clean water. Clean strainers.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
   3. Check expansion tanks to determine that they are not air bound and that system is full of water. Submit final air pressure as a field test report.
   4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure noted in Part 2 of this specification. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Isolate pressure vessels (air separators, expansion tanks, heat exchangers, etc.) as appropriate. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
   5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
   6. Prepare written report of testing. Submit test reports.

3.09 ADJUSTING
A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
B. Perform these adjustments before operating the system:
   1. Open valves to fully open position. Close coil bypass valves.
   2. Check pump for proper direction of rotation.
   3. Set automatic fill valves for required system pressure.
   4. Check 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. Check operation of automatic bypass valves.
   7. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
   8. Lubricate motors and bearings.

3.10 FINAL SYSTEM CLEANING AND CHECKOUT
A. After balancing of the entire system is complete and the system has been run at maximum controlled temperature for eight hours, perform the following:
   1. Remove and clean or replace all strainer screens.
   2. Operate all manual air vents to remove trapped air.
   3. Confirm automatic air vents are functioning.
   4. Operate all relief and safety valves.
   5. Check system pre-charge, makeup pressure and relief valve settings.
   6. Confirm that all ASME data sheets are provided to the Owner's maintenance staff.
END OF SECTION
PART 1  GENERAL

1.01  RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02  SUMMARY
A. This Section includes the following:
   2. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.03  DEFINITIONS
A. Buna: Nitrile rubber.
B. EPDM: Ethylene propylene diene rubber.

1.04  SUBMITTALS
A. Product Data: Include certified performance curves and rated capacities, shipping installed and operating weights, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves. Include motor submittal information in accordance with Division 23 - Section 23 05 13. Indicate shaft coupling materials of construction and suitability for variable speed operation.
B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   1. Wiring diagrams: Power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.
C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals. Include pump alignment results.

1.05  QUALITY ASSURANCE
A. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.06  DELIVERY, STORAGE, AND HANDLING
A. Store pumps in dry location.
B. Retain protective covers for flanges and protective coatings during storage.
C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
D. Comply with pump manufacturer's written rigging instructions.

1.07  COORDINATION
A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.08  EXTRA MATERIALS
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Mechanical seals: One (1) mechanical seal for each pump.
PART 2 PRODUCTS

2.01 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 GENERAL PUMP REQUIREMENTS
A. Pump Units: Factory assembled and tested.
B. Motors: Refer to Division 23 Section "Common Motor Requirements" for general motor requirements. Select each motor to be non-overloading over the full range of the pump performance curve without utilizing any of the service factor.
C. Casing and Impeller Sizing: Sized such that a minimum 10% increase in rated head at the rated flow can be achieved within the same pump casing with the largest catalogued impeller size for that pump casing.

2.03 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS
A. Manufacturers:
   1. Armstrong Pumps Inc.
   2. Aurora Pump; Division of Pentair Pump Group.
   3. Bell & Gossett; Div. of ITT Industries.
   4. Taco, Inc.
B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for a minimum of 175-psig (1204-kPa) minimum working pressure and a continuous water temperature of 225 deg F (107 deg C), higher where scheduled.
C. Pump Construction:
   1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
   4. Mechanical seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPDM or Buna bellows and gasket. Include water slinger on shaft between motor and seal.
D. Motor: Single speed, with ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.04 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS
A. Manufacturers:
   1. Armstrong Pumps Inc.
   2. Aurora Pump; Division of Pentair Pump Group.
   3. Bell & Gossett; Div. of ITT Industries.
   4. Taco, Inc.
B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175-psig (1204-kPa) minimum working pressure and a continuous water temperature of 225 deg F (107 deg C).
C. Pump Construction:
   1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount
on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.

2. Impeller: ASTM B 584, cast bronze or 304 stainless steel; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.


4. Mechanical seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPDM or Buna bellows and gasket.

5. Packing seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.

6. Pump bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

D. Shaft Coupling:
1. Non-lubricated type, flexible synthetic rubber insert and interlocking drives to accommodate angular misalignment, parallel misalignment and end float.
2. Flexible element shall be replaceable without requiring moving the motor shaft or pump shafts. Provide two piece element.
3. Select components for at least 50,000 hours of operating life at twice the motor nameplate rated horsepower. Provide components suitable for continuously variable speed and variable torque applications.

4. Design references:
   a. Lovejoy: S-flex.
   b. TB Woods: Dura-Flex.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PUMP INSTALLATION

A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
D. Set base-mounted pumps on concrete pad. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
   1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches (19 to 38 mm) between pump base and foundation for grouting.
   2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.03 ALIGNMENT
   A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
   B. Comply with pump and coupling manufacturers’ written instructions for alignment. Document alignment readings and submit with O&M information.
   C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation" and HI 2.1-2.5, "Vertical Pumps for Nomenclature, Definitions, Application and Operation."

3.04 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. Install shutoff valves and check valves and flexible connectors that are same size as the piping drop connected to pumps (not the same size as the pump flanges, suction diffuser, nor triple duty valve if utilized).
   D. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
   E. Install strainers and thermometers at pumps as noted on the details. Clarify excessive strainer locations with the Engineer.
   F. Install liquid filled pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valves.
   G. Install electrical connections for power, controls, and devices.
   H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.05 STARTUP SERVICE
   A. Engage a factory-authorized service representative to perform startup service.

3.06 DEMONSTRATION
   A. Engage a factory authorized service representative to train Owner’s maintenance personnel to adjust, operate and maintain hydronic pumps are specified below:

END OF SECTION
SECTION 23 2300
REFRIGERANT PIPING

PART 1 GENERAL

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

1.02 SUMMARY
A. This Section includes refrigerant piping used for air-conditioning applications.

1.03 PERFORMANCE REQUIREMENTS
A. Line Test Pressure for Refrigerant R-410A:
1. Suction lines for air conditioning applications: 300 psig (2068 kPa).
2. Suction lines for heat pump applications: 535 psig (3689 kPa).

1.04 SUBMITTALS
A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
   1. Thermostatic expansion valves.
   2. Solenoid valves.
   3. Hot-gas bypass valves.
   4. Filter dryers.
   5. Strainers.
   6. Pressure-regulating valves.
B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
   1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
   2. Verify piping system design with equipment manufacturers. Obtain manufacturer’s written approval of pipe sizing, piping layout and all other system design features prior to system installation.
C. Welding certificates.
D. Field quality-control test reports.
E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.05 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.06 PRODUCT STORAGE AND HANDLING
A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.
1.07 COORDINATION
A. Coordinate layout and installation of refrigerant piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
B. Coordinate pipe sleeve installations for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Firestopping" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
D. Coordinate pipe fitting pressure classes with products specified in related Sections.

PART 2 PRODUCTS

2.01 COPPER TUBE AND FITTINGS
A. Copper Tube: ASTM B 280, Type ACR.
C. Wrought-Copper Unions: ASME B16.22, female pattern, brass-to-brass seat, ground joints, socket to socket connections.
D. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver) or BAg-2 (silver).
E. Flexible Connectors:
   2. End connections: Socket ends.
   3. Offset performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
   4. Pressure rating: Factory test at minimum 500 psig (3450 kPa).

2.02 VALVES AND SPECIALTIES
A. Packed-Angle Valves:
   1. Body and bonnet: Forged brass or cast bronze.
   2. Packing: Molded stem, back seating, and replaceable under pressure.
   3. Operator: Rising stem.
   5. Seal cap: Forged-brass or valox hex cap.
   7. Working pressure rating: 500 psig (3450 kPa).

B. Check Valves:
   1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
   2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
   7. Maximum operating pressure: 0.50 psig (3.4 kPa).
   8. Working pressure rating: 500 psig (3450 kPa).

C. Service Valves:
   1. Body: Forged brass with brass cap including key end to remove core.
   2. Core: Removable ball-type check valve with stainless-steel spring.
   5. Working pressure rating: 500 psig (3450 kPa).
D. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
   2. Solenoid tube, plunger, closing spring and seat orifice: Stainless steel.
   5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and normally closed ac coil.

E. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   1. Body and bonnet: Ductile iron and steel, with neoprene O-ring seal.
   5. Working pressure rating: 400 psig (2760 kPa).

F. Thermostatic Expansion Valves: Comply with ARI 750.
   1. Body, bonnet and seal cap: Forged brass or steel.
   4. Capillary and bulb: Copper tubing filled with refrigerant charge.
   5. Suction temperature: 40 deg. F (4.4 deg C) or to match system conditions.
   7. Reverse-flow option (for heat-pump applications).
   10. Size and operating conditions: As recommended by manufacturer of evaporator.
   11. Hot gas bypass provisions: Provide side connection and external equalizer line.

G. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
   1. Body, bonnet and seal cap: Ductile iron or steel.
   2. Solenoid tube, plunger, closing springer and seat orifice: Stainless steel.
   5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and ac coil.
   7. Set pressure: Adjustable.
   8. Throttling range: Maximum 5 psig (34 kPa), sized for capacity equal to last step of compressor unloading.

H. Straight-Type Strainers:
   2. Screen: 100-mesh stainless steel in liquid lines less than 1-1/4”, 60 mesh in larger lines.
      40 mesh in suction lines.
   6. Select mesh size in accordance with manufacturer’s recommendations.
I. Angle-Type Strainers:
   1. Body: Forged brass or cast bronze.
   2. Drain plug: Brass hex plug.
   3. Screen: 100-mesh monel in liquid lines less than 1-1/4", 60 mesh in larger lines. 40 mesh in suction lines.
   5. Working pressure rating: 500 psig (3450 kPa).
   7. Select mesh size in accordance with manufacturer’s recommendations.

J. Moisture/Liquid Indicators:
   2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
   3. Indicator: Color coded to show moisture content in ppm.
   5. End connections: Socket.

K. Replaceable-Core Filter Dryers: Comply with ARI 730.
   1. Body and cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
   2. Filter media: 10 micron, pleated with integral end rings; stainless-steel support. Replaceable.
   4. Designed for reverse flow (for heat-pump applications).
   5. End connections: Socket.
   7. Maximum pressure loss: 1.0 psig at rated flow.
   8. Rated flow: In accordance with evaporator manufacturer’s recommendations.

L. Mufflers:
   2. End connections: Socket.
   3. Working pressure rating: 500 psig (3450 kPa).
   5. Maximum pressure loss: 0.5 psig at rated flow.

M. Receivers: Comply with ARI 495.
   1. Comply with ASME Boiler and Pressure Vessel Code for receivers larger than 6 inches; listed and labeled by an NRTL.
   2. Comply with UL 207; listed and labeled by an NRTL.
   4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
   5. End connections: Socket.

N. Liquid Accumulators: Comply with ARI 495.
   2. End connections: Socket.
   3. Working pressure rating: 500 psig (3450 kPa).
2.03 REFRIGERANTS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Atofina Chemicals, Inc.
      2. DuPont Company; Fluorochemicals Div.
      3. Honeywell, Inc.; Genetron Refrigerants.
      4. INEOS Fluor Americas LLC.
   B. ASHRAE 34, R-410A: Pentfluoroethane/Difluoromethane.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS FOR REFRIGERANT R-410A
   A. Suction Lines, Hot Gas Lines and Liquid Lines for Conventional Air-Conditioning Applications:
      Copper, Type ACR and wrought-copper fittings with brazed joints.
      1. Above ground outside building and on roof: Drawn temper tubing.
      2. Above ground within building: Annealed temper (soft) tubing.
      3. Below ground: Type L (B) tubing.
   B. Safety-Relief-Valve Discharge Piping: Copper, Type L (B), drawn-temper tubing and wrought-copper fittings with brazed joints.

3.02 VALVE AND SPECIALTY APPLICATIONS
   A. Install packed-angle valves in suction and discharge lines of compressor for gage taps at hot gas bypass regulators and directly on each side of strainers and dryers.
   B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
   C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
   D. Install check valves in condenser liquid lines on multiple condenser systems.
   E. Except as otherwise indicated, install packed-angle valves on inlet and outlet side of filter dryers, strainers and evaporators.
   F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top. Install all wiring and conduit necessary for a complete functioning installation.
   G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
      1. Install valve so diaphragm case is warmer than bulb.
      2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
      3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
      4. Install in accordance with evaporator manufacturer’s instructions.
   H. Install packed angle valve in liquid line between receiver shutoff valve and thermostatic expansion valve for system charging.
   I. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
   J. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube, in liquid line leaving receiver, in liquid line leaving condenser and on leaving side of liquid solenoid valves.
   K. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
      1. Solenoid valves.
      2. Thermostatic expansion valves.
      3. Hot-gas bypass valves.
4. Compressor suction valves.

L. Install replaceable core filter dryers in liquid line between compressor and thermostatic expansion valve and in the suction line at the compressor.

M. Install receivers sized to accommodate pump-down charge. Install solenoid valves in liquid lines of systems with pump out or pump down compressor control.

N. Install flexible connectors at compressors.

3.03 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

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

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

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

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

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

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

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation. Pipe passing through exterior building walls shall be caulked weathertight with non-hardening epoxy type waterproof compound.

N. Install unions to allow removal of solenoid valves, pressure-regulating valves, and expansion valves and at connections to compressors and evaporators.

O. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

P. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

Q. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
R. Seal penetrations through fire and smoke barriers according to Division 07 Section "Firestopping."
S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
T. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.

3.04 PIPE JOINT CONSTRUCTION
A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.05 HANGERS AND SUPPORTS
A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs.
   2. Spring hangers to support vertical runs.
   3. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
   2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
   3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).
   4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
   5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
   6. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
   7. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
   8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
   9. NPS 4 (DN 100): Maximum span, 10 feet; minimum rod size, 1/2 inch (13 mm).

3.06 FIELD QUALITY CONTROL
A. Perform tests and inspections and prepare test reports.
B. Tests and Inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
   a. Fill system with nitrogen to the required test pressure.
   b. System shall maintain test pressure at the manifold gage throughout duration of test.
   c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
   d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.07 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
   4. Charge system with a new filter-dryer core in charging line.

3.08 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION
1.01 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY
   A. Section Includes:
      1. Packaged, air-cooled chillers.

1.03 DEFINITIONS
   A. BAS: Building automation system.
   B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
   C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.
   D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and referenced to ARI standard rating conditions.
   E. kW/Ton (kW/kW): The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons (kW) at any given set of rating conditions.
   F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and intended for operating conditions other than ARI standard rating conditions.

1.04 SUBMITTALS
   A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
   B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
      1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances and methods of field assembly, components, location and size of each field connection.
      2. Wiring diagrams: For power, signal, and control wiring.
   C. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.
   D. Warranty: Sample of special warranty.

1.05 QUALITY ASSURANCE
   A. ARI Certification: Certify chiller according to ARI 590 certification program(s).
   B. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.
   C. ASHRAE Compliance:
      1. ASHRAE 15 for safety code for mechanical refrigeration.
      2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.
   E. ASME Compliance: Fabricate and label chiller to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and include an ASME U-stamp and nameplate certifying compliance.
   F. Comply with NFPA 70.
G. Comply with requirements of UL and UL Canada and include label by a qualified testing agency showing compliance.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Ship chillers from the factory fully charged with refrigerant.
B. Ship each oil-lubricated chiller with a full charge of oil.
   1. Ship oil factory installed in chiller.

1.07 COORDINATION
A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Coordinate fencing (if provided) with maintenance access, pad size and chiller placement.
B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.
C. Coordinate sizes and locations of equipment supports, and roof penetrations with actual equipment provided.

1.08 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fails in materials or workmanship within specified warranty period.
   1. Extended warranties include, but are not limited to, the following:
      a. Complete chiller including refrigerant and oil charge.
      b. Parts and labor.
      c. Loss of refrigerant charge for any reason.
   2. Warranty period: Two (2) years from date of Substantial Completion.

PART 2 PRODUCTS
2.01 PACKAGED, AIR-COOLED CHILLERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Corporation; a United Technologies company.
   2. Daikin Applied.
   3. Trane; a division of American Standard.
   4. YORK International Corporation.
B. Description: Factory-assembled and run-tested chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.
C. Fabricate base, frame, and attachment to chiller components strong enough to resist chiller movement during a seismic event when chiller base is anchored to field support structure.
D. Cabinet:
   1. Base: Galvanized-steel base extending the perimeter of chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
   2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported by base.
   4. Finish: Coat base, frame and casing with a corrosion-resistant coating capable of withstanding a 500 hour salt spray test according to ASTM B 117.
   5. Sound-reduction package designed to reduce sound power level to be below 89 dBA overall A-weighted sound power level (AHRI-370-2011 A-weighted 50 HZ to 10,000 HZ) at full load without affecting performance. Sound reduction package may consist of any or all of the following:
      a. Acoustic enclosure around compressors.
      b. Reduced-speed fans with acoustic treatment.
      c. Other manufacturer measures as required to meet specified levels.
E. Compressors:
1. Description: Scroll-type, hermetically sealed.
2. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
3. Rotors: Manufacturer's standard one- or two-rotor design.
4. Each compressor provided with suction and discharge shutoff valves, crankcase oil heater, and suction strainer.

F. Service: Easily accessible for inspection and service.

G. Capacity Control: On-off compressor cycling and modulating slide-valve assembly or port unloaders combined with hot-gas bypass, if necessary, to achieve performance indicated.
1. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating range: From 100 to 10 percent of design capacity.
3. Condenser-air unloading requirements over operating range: Constant-design entering condenser-air temperature.
4. For units equipped with a variable frequency controller, capacity control shall be both "valve-less" and "step-less," requiring no slide valve or capacity-control valve(s) to operate at reduced capacity.

H. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.
1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.
2. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
3. Factory-installed and pressure-tested piping with isolation valves and accessories.
4. Oil compatible with refrigerant and chiller components.
5. Positive visual indication of oil level.

I. Vibration Control:
1. Vibration balance: Balance chiller compressors and drive assemblies to provide a precision balance that is free of noticeable vibration over the entire operating range.
   a. Over-speed test: 25 percent above design operating speed.
2. Isolation: Mount individual compressors on vibration isolators.

J. Compressor Motors:
1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, induction type with inherent thermal-overload protection on each phase.

K. Compressor Motor Controllers:
1. Variable frequency controller:
   a. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.
   b. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
   c. Enclosure: Unit mounted, NEMA 250, Type 3R, with hinged full-front access door with lock and key.
   d. Integral disconnecting means: Door-interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.
   e. Technology: Pulse width modulated (PWM) output suitable for constant or variable torque loads.
   f. Motor current at start shall not exceed the rated load amperes, providing no electrical inrush.
   g. Motor protection: Controller shall protect motor against over-voltage and under-voltage, phase loss, reverse phase, overcurrent, over-temperature and ground fault.
   h. Automatic reset and restart: Capable of three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or
fault correction. Controller shall be capable of automatic restart on phase-loss and over-voltage and under-voltage trips.

i. Visual indication: On face of controller enclosure or chiller control enclosure, indicating the following conditions:
   1) Power on.
   2) Run.
   3) Over-voltage.
   4) Line fault.
   5) Overcurrent.
   6) External fault.
   7) Motor speed (percent).
   8) Fault or alarm status (code).
   9) Motor output voltage.
  10) Input kilovolt amperes.
  11) Total power factor.
  12) Input kilowatts.
  13) Input kilowatts hours.
  14) Three phase input voltage.
  15) Three phase output voltage.
  16) Three phase input current.
  17) Three phase output current.
  18) Output frequency (Hertz).
  19) Elapsed operating time (hours).
  20) Diagnostic and service parameters.

j. Operator interface: At controller or chiller control panel with start-stop and auto manual selector with manual-speed-controller potentiometer.

L. Refrigerant Circuits:
   1. Refrigerant type: R-410A. Classified as Safety Group A1 according to ASHRAE 34.
   2. Refrigerant compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
   3. Refrigerant circuit: Each shall include a thermal- or electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
   4. Pressure relief device:
      a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
      b. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.

M. Evaporator:
   1. Description: Brazed-plate and frame design.
      a. Plate: stainless steel.
      b. Fluid nozzles: Terminated with mechanical coupling or flanged end connections for connection to field piping.
      c. Remote mounting: Designed for remote field mounting where indicated. Provide kit for field installation.

N. Air-Cooled Condenser:
   1. Plate-fin coil with integral sub-cooling on each circuit, rated at 450 psig (3103 kPa).
      a. Construct coil casing of galvanized steel.
      b. Construct coils of copper tubes mechanically bonded to aluminum fins.
      c. Coat coils with a baked-epoxy, corrosion-resistant coating after fabrication.
      d. Hail protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.

3. Fan motors: Totally enclosed non-ventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings. Equip each motor with overload protection integral to either the motor or chiller controls.

4. Fan Guards: Steel safety guards with corrosion-resistant coating.

O. Electrical Power:

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point, field-power connection to chiller.

2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.

3. Wiring shall be numbered and color-coded to match wiring diagram.

4. Install factory wiring outside of an enclosure in a raceway.

5. Field-power interface shall be to NEMA KS 1, heavy-duty, non-fused disconnect switch.
   a. Disconnect means shall be interlocked with door operation.
   b. Minimum short circuit withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A at operating voltage. Rating shall be in accordance with UL 508.

6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
   a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
   b. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

7. Provide each motor with overcurrent protection.

8. Overload relay sized according to UL 1995 or an integral component of chiller control microprocessor.


10. Provide power factor correction capacitors to correct compressor power factor to 0.90 at full load.

11. Control transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
    a. Power unit-mounted controls where indicated.
    b. Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.


13. For chiller electrical power supply, indicate the following:
    a. Current and phase to phase for all three phases.
    b. Voltage, phase to phase, and phase to neutral for all three phases.
    c. Three-phase real power (kilowatts).
    d. Three-phase reactive power (kilovolt amperes reactive).
    e. Power factor.
    f. Running log of total power versus time (kilowatt-hours).
    g. Fault log, with time and date of each.

P. Controls:

1. Standalone and microprocessor based.

2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure.

3. Operator interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units, display the following information:
   a. Date and time.
   b. Operating or alarm status.
   c. Operating hours.
   d. Outdoor-air temperature if required for chilled-water reset.
e. Temperature and pressure of operating set points.
f. Entering and leaving temperatures of chilled water.
g. Refrigerant pressures in evaporator and condenser.
h. Saturation temperature in evaporator and condenser.
i. No cooling load condition.
j. Elapsed time meter (compressor run status).
k. Pump status.
l. Anti-recycling timer status.
m. Percent of maximum motor amperage.
n. Current-limit set point.
o. Number of compressor starts.

4. BAS interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.

Q. Insulation:
   1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   3. Factory-applied insulation over cold surfaces of chiller components.
      a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
   4. Apply protective coating to exposed surfaces of insulation to protect insulation from weather.

R. Accessories:
   1. Factory-furnished, chilled-water flow switches for field installation.
   2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigerant circuit.
   3. Factory-furnished spring isolators for field installation.

2.02 SOURCE QUALITY CONTROL

A. Perform functional tests of chillers before shipping.
B. Factory run test each air-cooled chiller with water flowing through evaporator.
C. For chillers located outdoors, rate sound power level according to ARI 370.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.
B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.
   1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 CHILLER INSTALLATION

A. Install chillers on support structure indicated.
B. Equipment Mounting: Install chiller on concrete bases using restrained spring isolators. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
   1. Minimum deflection: 1 inch (25 mm).
   2. 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 concrete base.
C. Maintain manufacturer's recommended clearances for service and maintenance.
D. Charge chiller with refrigerant and fill with oil if not factory installed.
E. Install separate devices furnished by manufacturer and not factory installed.

3.03 CONNECTIONS
A. Comply with requirements for piping specified in Division 23 Section "Hydronic Piping" and Division 23 Section "Refrigerant Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to chiller to allow service and maintenance.
C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a flange or mechanical coupling.
D. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.

3.04 STARTUP SERVICE
A. Engage a factory-authorized service representative to perform startup service.

3.05 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers.

END OF SECTION
PART 1 - GENERAL

1.01 RELATED DOCUMENTS
A. This Section supplements Division 1, General Requirements.
B. Where contradictions occur between this Section and Division 1, the more stringent of the two shall apply. Architect and Engineer shall decide which is most stringent.
C. Provisions of this section shall also apply to all sections of Division 26 thru Division 28.
D. The specifications are complementary to the drawings and their requirements shall have the same priority as the drawings.

1.02 COORDINATION WITH OTHER TRADES
A. Contract Documents:
   1. General: The Contract Documents are diagrammatic, showing certain physical relationships which must be established within the electrical work and its interface with other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing material quantities.
   2. Work out all conditions in advance of installation. If necessary, and before work proceeds in those areas, prepare coordination drawings showing all work in congested areas. Provide additional work necessary to overcome congested conditions at no increase in contract sum.
   3. Coordinate the electrical work to the progress of the work of other trades.
   4. Complete the entire installation as soon as the condition of the building will permit.
   5. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install electrical and electric systems within the cavity space allocation in the following order:
      a. Lighting.
      b. Steam and condensate piping.
      c. Plumbing piping.
      d. Mechanical ductwork.
      e. Fire sprinkler piping.
      f. Air diffusers.
      g. Domestic water piping.
      h. Hydronic piping.
      i. Pneumatic control piping.
B. Discrepancies:
   1. Examine Drawings and Specifications.
   2. Report any discrepancies to the Engineer and obtain written instructions before proceeding.
   3. Should there be a conflict within or between the Specifications or Drawings, the more stringent or higher quality requirements shall apply. The determination of the more stringent or higher quality shall lie with the Architect.
   4. Items called for in either specifications or drawings shall be required as if called for in both.
   5. Be responsible for providing proper documentation of equipment product data and shop drawings to all entities providing service.

1.03 COORDINATION WITH EXISTING OCCUPIED AREAS
A. Minimize disruptions to operation of electrical systems in occupied areas.
B. Coordinate any required disruptions with the Owner, one week in advance.
C. Provide temporary connections to prevent long disruptions.
1.04 DELEGATED DESIGN BY CONTRACTOR
   A. The construction of this building requires the Contractor to design several systems or subsystems. All such designs shall be the complete responsibility of the Contractor.
   B. Systems or subsystems which require engineering responsibility by the Contractor include, but are not limited to:
      1. Any system not fully detailed.
      2. Equipment supports, not fully detailed.
      3. Conduit hangers and anchors not specified in these documents, or catalogued by the manufacturer.

1.05 REGULATORY REQUIREMENTS
   A. Codes: Comply with the codes adopted by authority having jurisdiction (which shall include but not be limited to):
      1. Applicable editions of NFPA.
      2. Requirements of Fire Departments serving the project.
      3. Regulations of the Health Department having jurisdiction.
      4. Regulations of the Office of State Fire Marshal or its equivalent.
      5. Americans with Disabilities Act (ADA).
   B. Other Regulations: Comply with the latest applicable regulations and ordinances of the following:
      1. U. S. and State Department of Labor Safety Regulations pertaining to the completed project.
      2. Clean Air Act.
      4. Requirements of product listings by nationally recognized listing agencies as recognized by the Occupational Safety and Hazards Agency (OSHA) and the Architect.
   C. Contradictions: Where Codes are contradictory, follow the most stringent, unless otherwise indicated in Plans or Specifications. Architect shall determine which is most stringent.
   D. Codes are a minimum requirement approved by the AHJ, in many cases the Project Documents will exceed the minimum requirements of the codes, Project Documents must be be followed.
   E. Inspections and Tests:
      1. Inspections and tests required shall be completed by a third party NETA Testing Agency/Contractor. Contractor shall arrange for all required inspections and testing.
      2. Contractor shall pay all inspections and testing charges.
      3. Notify Engineer two (2) business days before tests.
      4. Inspections reports and Test Reports shall be provide to the Architect for review and shall be included in the final Record Documents.

1.06 INSTALLATION GENERAL REQUIREMENTS
   A. Furnish, apply, install, connect, erect, clean, and condition manufactured materials and equipment as recommended in manufacturer's printed directions (maintained on job site during installation).
   B. Provide all attachment devices and materials necessary to secure materials together or to other materials.
   C. Make allowance for ample and normal expansion and contraction for all building components and piping systems that are subject to such.
   D. Install materials only when conditions of temperature, moisture, humidity, and conditions of adjacent building components are conducive to achieving the best installation results.
   E. Erect, install, and secure components in a structurally sound and appropriate manner.
   F. Where necessary, temporarily brace, shore, or otherwise support members until final connections are installed.
G. Leave all temporary bracing, shoring, or other structural supports in place as long as practical for safety and to maintain proper alignment.
H. Handle materials in a manner to prevent scratching, abrading, distortion, chipping, breaking, or other disfigurement.
I. Conduct work in a manner to avoid injury or damage to previously placed work. Any work so impaired or damaged shall be replaced at no expense to Owner.
J. Fabricate and install materials true to line, plumb, and level.
K. Leave finished surfaces smooth and flat, free from wrinkles, warps, scratches, dents, and other imperfections.
L. Furnish materials in longest practical lengths and largest practical sizes to avoid all unnecessary jointing.
M. Make all joints secure, tightly fitted, and as inconspicuous as possible by the best accepted practice in joining and fabricating.
N. Contact Engineer for mounting height or position of any unit not specifically indicated or located on Drawings or specified in Specifications.
O. Job mixed multi-component materials used in the work shall be mixed in such regulated and properly sized batches that material can be used before it begins to "set."

PART 2 - PRODUCTS

2.01 GENERAL

A. Certain products are specified without equals. Substitutions for these will not be considered.
B. Follow substitution instructions in Front End Documents for any manufacturer not listed in the Project Manual or the drawings that the contractor may want considered for substitution.
C. Coordination of general equivalents and substitutions: Where Contract Documents permit selection from several general equivalents, or where substitutions are authorized, coordinate clearance and other interface requirements with electrical and other work.
   1. Provide necessary additional items so that selected or substituted item operates equivalent to the basis of design and properly fits in the available space allocated for the basis of design.
   2. Provide all features which are standard and specified on the basis of design.
   3. Contractor is responsible for assuring that piping, conduit, duct, flue, and other service locations for general equivalents or substitutions do not cause access, service, or operational difficulties any greater than would be encountered with the basis of design. Acceptance by the Architect does not imply acceptance of any deviations from contract documents requirements.
   4. Confirm if modifications to electrical, structural or architectural requirements for substituted or general equivalents are needed such as: wire size, conduit size, MCA, MOCP, weight, support, etc. Coordinate with General and Electrical Contractors prior to bid.

PART 3 – EXECUTION

3.01 COORDINATION OF ELECTRICAL INSTALLATION.

A. Inspection and Preparation:
   1. Examine the work interfacing with electrical work, and the conditions under which the work will be performed, and notify the Architect of conditions detrimental to the proper completion of the work.
2. Do not proceed with the work until unsatisfactory conditions have been corrected. Lack of notifying Architect of conditions is in no way cause for change order request.

B. Layout:
1. Layout the electrical work in conformity with the Contract Drawings, Coordination Drawings and other Shop Drawings, product data and similar requirements so that the entire electrical plant will perform as an integrated system, properly interfaced with other work, recognizing that portions of the work are shown only in diagrammatic form.
2. Where coordination requirements conflict with individual system requirements, comply with the Architect's decision on resolution of the conflict.
3. Take necessary field measurements to determine space and connection requirements.
4. Provide sizes and shapes of equipment so the final installation conforms to the intent of the Contract Documents.

C. Integrate electrical work in ceiling spaces with suspension system, light fixtures and other work so that required performances of each will be achieved.

3.02 PRODUCT INSTALLATION
A. Manufacturer's Instructions:
1. Except where more stringent requirements are indicated, comply with the product manufacturer's instructions and recommendations.
2. Consult with manufacturer's technical representatives, who are recognized as technical experts, for specific instructions on special project conditions.
3. If a conflict exists, notify the Architect / Engineer in writing and obtain his instruction before proceeding with the work in question.

B. Movement of Equipment:
1. Wherever possible, arrange for the movement and positioning of equipment so that enclosing partitions, walls and roofs will not be delayed or need to be removed.
2. Otherwise, advise Contractor of opening requirements to be maintained for the subsequent entry of equipment.

C. Heavy Equipment:
1. Coordinate the movement of heavy items with shoring and bracing so that the building structure will not be overloaded during the movement and installation.
2. Where electrical products to be installed on an existing roof are too heavy to be hand-carried, do not transport across the existing roof deck; position by crane or other device so as to avoid overloading the roof deck.

D. Return Air Path: Coordinate electrical work in return air plenum to avoid obstructing return air path.
1. Do not make changes in layout which will reduce return air path cross-sectional areas.
2. Report any obstructions by work of other Divisions to Architect.

E. Support:
1. Anchor and secure all equipment to the building substrate and structure.

F. Clearances:
1. Install conduit and cables:
   a. Straight and true.
   b. Aligned with other work and with general lines of the building.
   c. Concealed, where possible, in occupied spaces.
   d. Out-of-the-way with maximum passageway and headroom remaining in each space.
2. Except as otherwise indicated, arrange electrical services and overhead equipment with a minimum of:
   a. 7'6" headroom in storage spaces. Do not obstruct windows, doors or other openings.
3. Give the right-of-way to piping systems required to slope for drainage (over other service lines and ductwork).
3.03 PROTECTION OF WORK
A. All conduit ends, panelboards, motor controls, disconnecting means, and equipment left unconnected shall be capped, plugged or otherwise properly protected to prevent damage or the intrusion of foreign matter.
B. Any equipment or conduit system found to have been damaged or contaminated shall be replaced or cleaned to the Engineer's satisfaction.

3.04 ADJUSTING
A. Adjust all equipment and system components as shown or as otherwise required to result in intended system operation.
B. At completion of work, provide written certification that all systems are functioning properly without defects.

3.05 START-UP
A. Assign a Start-Up Coordinator to this project.
B. The Start-Up Coordinator shall develop detailed start-up procedures, equipment checkout procedure and data forms for recording compliance with contract document performance criteria, and will assist in developing schedules for checkout and Owner acceptance.
C. The Start-Up Coordinator shall be responsible for maintaining documentation of Start-Up activities until final acceptance of the project.
D. The documentation shall be kept current by the Start-Up Coordinator and shall be available for inspection at all times. At the time of acceptance of the project, the Start-Up Coordinator shall surrender 3 completed copies of the documentation to the Owner's representative.
   1. Coordinate with the mechanical installation the requirements for the startup of mechanical and plumbing systems:
      a. All equipment, components, and systems have been set, started-up, and adjusted including checking the following: proper equipment electrical rotation, control connections, factory trained technician startup, etc.
      b. All electric power connections, disconnects, fuses, circuit breakers, etc. are properly sized and installed.

3.06 TRAINING
A. Refer to Division 1 sections of the specifications regarding requirements of Record Drawings, Operation and Maintenance Manual submittal and systems training.
   1. Demonstrate that each system operates properly.
   2. Explain the operation of each system to the Owner's Representative.
   3. Explain use of O&M manual in operating and maintaining systems.
   4. Date, time, and duration of training will be determined by Owner.
   5. Training agendas and schedules shall be developed and approved by Owner, Commissioning Authority, Engineer, and Architect prior to training.
   6. Document and turn over to owner the training sessions on DVD and placed in O&M Manuals. At the end of all sessions, compile all sessions on a single DVD and turn over to owner as part of the O & M manuals.
B. For specific systems requiring extended instruction, refer to individual Division 26 sections.

END OF SECTION
SECTION 26 0505
SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Electrical demolition.

1.02 RELATED REQUIREMENTS
A. Section 01 7000 - Execution and Closeout Requirements: Additional requirements for alterations work.

1.03 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Sustainable Design Documentation: Submit certification of removal and appropriate disposal of abandoned cables containing lead stabilizers.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT
A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify field measurements and circuiting arrangements are as indicated.
B. Verify that abandoned wiring and equipment serve only abandoned facilities.
C. Demolition drawings are based on casual field observation and existing record documents.
D. Report discrepancies to Architect before disturbing existing installation.
E. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION
A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
B. Coordinate utility service outages with utility company.
C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
   2. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK
A. Remove, relocate, and extend existing installations to accommodate new construction.
B. Remove abandoned wiring to source of supply.
C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
E. Disconnect and remove abandoned panelboards and distribution equipment.
F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
G. Repair adjacent construction and finishes damaged during demolition and extension work.
H. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
I. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR
A. See Section 01 7419 - Construction Waste Management and Disposal for additional requirements.
B. Clean and repair existing materials and equipment that remain or that are to be reused.
C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION
SECTION 26 0519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Single conductor building wire.
B. Wiring connectors.
C. Electrical tape.
D. Heat shrink tubing.
E. Oxide inhibiting compound.
F. Wire pulling lubricant.
G. Cable ties.

1.02 RELATED REQUIREMENTS
A. Section 07 8400 - Firestopping.
B. Section 26 0505 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.
C. Section 26 0526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS
G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
N. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
P. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
Q. UL 854 - Service-Entrance Cables; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
   3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
C. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS
A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F (-10 degrees C), unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS
A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
C. Nonmetallic-sheathed cable is not permitted.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS
A. Provide products that comply with requirements of NFPA 70.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductors for Grounding and Bonding: Also comply with Section 26 0526.

H. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.

I. Conductor Material:
   1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
   2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
   3. Tinned Copper Conductors: Comply with ASTM B33.

J. Minimum Conductor Size:
   1. Branch Circuits: 12 AWG.
      a. Exceptions:
         1) 20 A, 120 V circuits longer than 75 feet (23 m): 10 AWG, for voltage drop.
         2) 20 A, 277 V circuits longer than 150 feet (46 m): 10 AWG, for voltage drop.
   2. Control Circuits: 14 AWG.

K. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

L. Conductor Color Coding:
   1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
   2. Color Coding Method: Integrally colored insulation.
      a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
   3. Color Code:
      a. 480Y/277 V, 3 Phase, 4 Wire System:
         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.
         4) Neutral/Grounded: Gray.
      b. 208Y/120 V, 3 Phase, 4 Wire System:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
         4) Neutral/Grounded: White.
      c. Equipment Ground, All Systems: Green.
      d. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
      e. For control circuits, comply with manufacturer’s recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Manufacturers:
   1. Copper Building Wire:
d. Substitutions: See Section 01 6000 - Product Requirements.

B. Description: Single conductor insulated wire.

C. Conductor Stranding:
   1. Feeders and Branch Circuits:
      b. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation:
   1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.

2.04 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 26 0526.

C. Wiring Connectors for Splices and Taps:
   1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
   2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.

D. Wiring Connectors for Terminations:
   1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
   2. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
   3. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors where connectors are required.
   4. Conductors for Control Circuits: Use crimped terminals for all connections.

E. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F (105 degrees C) for standard applications and 302 degrees F (150 degrees C) for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

F. Mechanical Connectors: Provide bolted type or set-screw type.

G. Compression Connectors: Provide circumferential type or hex type crimp configuration.

H. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

2.05 WIRING ACCESSORIES

A. Electrical Tape:
   1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
   2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
   3. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil (0.76 mm); suitable for continuous temperature environment up to 194 degrees F (90 degrees C) and short-term 266 degrees F (130 degrees C) overload service.
4. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil (3.2 mm); suitable for continuous temperature environment up to 176 degrees F (80 degrees C).
5. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil (2.3 mm).

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
E. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that interior of building has been protected from weather.
B. Verify that work likely to damage wire and cable has been completed.
C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
D. Verify that field measurements are as indicated.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION
A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION
A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated without specific routing, determine exact routing required.
   3. Arrange circuiting to minimize splices.
   4. Include circuit lengths required to install connected devices within 10 ft (3.0 m) of location indicated.
   5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
   6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
   7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
   8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install products in accordance with manufacturer's instructions.
C. Perform work in accordance with NECA 1 (general workmanship).
D. Installation in Raceway:
   1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
   2. Pull all conductors and cables together into raceway at same time.
   3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

E. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
   1. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.

F. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet (1.5 m) of slack.

G. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

H. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

I. Make wiring connections using specified wiring connectors.
   1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
   2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
   3. Do not remove conductor strands to facilitate insertion into connector.
   4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
   5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

J. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
   1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
   2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
      b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.

K. Insulate ends of spare conductors using vinyl insulating electrical tape.

L. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

M. Identify conductors and cables in accordance with Section 26 0553.

N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

O. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL
   A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.

D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION
SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Grounding and bonding requirements.
B. Conductors for grounding and bonding.
C. Connectors for grounding and bonding.

1.02 RELATED REQUIREMENTS
A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
   1. Includes oxide inhibiting compound.
B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
E. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Verify exact locations of underground metal water service pipe entrances to building.
   2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
   3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements for submittals procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
D. Field quality control test reports.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS
A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
D. Bonding and Equipment Grounding:
   1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
   2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
   3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
   4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
   5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
   6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
   7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
      a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
      b. Metal gas piping.
      c. Metal process piping.
   8. Provide bonding for interior metal air ducts.
   10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.
E. Pole-Mounted Luminaires: Also comply with Section 26 5600.

2.02 GROUNDING AND BONDING COMPONENTS
A. General Requirements:
   1. Provide products listed, classified, and labeled as suitable for the purpose intended.
   2. Provide products listed and labeled as complying with UL 467 where applicable.
B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:
   1. Use insulated copper conductors unless otherwise indicated.
      a. Exceptions:
         1) Use bare copper conductors where installed underground in direct contact with earth.
         2) Use bare copper conductors where directly encased in concrete (not in raceway).
C. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
   a. Exceptions:
      1) Use mechanical connectors for connections to electrodes at ground access wells.
3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
   a. Exceptions:
      1) Use exothermic welded connections for connections to metal building frame.
4. Manufacturers - Mechanical and Compression Connectors:
   e. Substitutions: See Section 01 6000 - Product Requirements.
5. Manufacturers - Exothermic Welded Connections:
   c. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that work likely to damage grounding and bonding system components has been completed.
   B. Verify that field measurements are as indicated.
   C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Perform work in accordance with NECA 1 (general workmanship).
   C. Make grounding and bonding connections using specified connectors.
      1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
      2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
      3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
      4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
      5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
   D. Identify grounding and bonding system components in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL
   A. See Section 01 4000 - Quality Requirements, for additional requirements.
   B. Inspect and test in accordance with NETA ATS except Section 4.
   C. Perform inspections and tests listed in NETA ATS, Section 7.13.
   D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION
SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS
   A. Section 05 5000 - Metal Fabrications: Materials and requirements for fabricated metal supports.
   B. Section 26 0533.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
   C. Section 26 0533.16 - BOXES: Additional support and attachment requirements for boxes.

1.03 REFERENCE STANDARDS
   D. MFMA-4 - Metal Framing Standards Publication; 2004.
   E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
   F. NFPA 70 - National Electrical Code: Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
   G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
      2. Coordinate the work with other trades to provide additional framing and materials required for installation.
      3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
      4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
      5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
   B. Sequencing:
      1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.05 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer’s standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.
   C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
   D. Installer's Qualification Statement: Include evidence of compliance with specified requirements.
E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE
A. Comply with NFPA 70.
B. Comply with applicable building code.
C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
D. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.
E. Installer Qualifications for Field-Welding: As specified in Section 05 5000.
F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS
2.01 SUPPORT AND ATTACHMENT COMPONENTS
A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
      a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
      c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
B. Materials for Metal Fabricated Supports: Comply with Section 05 5000.
C. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
   2. Conduit Clamps: Bolted type unless otherwise indicated.
   3. Manufacturers:
D. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
   1. Manufacturers:
   e. Substitutions: See Section 01 6000 - Product Requirements.

E. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
   2. Channel Material:
      a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
   3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch (2.66 mm).
   4. Minimum Channel Dimensions: 1-5/8 inch (41 mm) width by 13/16 inch (21 mm) height.
   5. Manufacturers:
      d. Substitutions: See Section 01 6000 - Product Requirements.
   e. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

F. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
   1. Minimum Size, Unless Otherwise Indicated or Required:
      a. Equipment Supports: 1/2 inch (13 mm) diameter.
      b. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch (6 mm) diameter.
      c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch (10 mm) diameter.
      d. Trapeze Support for Multiple Conduits: 3/8 inch (10 mm) diameter.
      e. Outlet Boxes: 1/4 inch (6 mm) diameter.
      f. Luminaires: 1/4 inch (6 mm) diameter.

G. Anchors and Fasteners:
   1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
   2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
   3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
   6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
   7. Sheet Metal: Use sheet metal screws.
   8. Wood: Use wood screws.
   9. Plastic and lead anchors are not permitted.
   10. Powder-actuated fasteners are permitted only as follows:
       a. Where approved by Architect.
       b. Use only threaded studs; do not use pins.
   11. Hammer-driven anchors and fasteners are permitted only as follows:
       a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction (when specified).
       b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction (when specified).
   12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
b. Channel Material: Use galvanized steel.
c. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch (2.66 mm) minimum base metal thickness.
d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

13. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

14. Manufacturers - Mechanical Anchors:
   e. Substitutions: See Section 01 6000 - Product Requirements.

15. Manufacturers - Powder-Actuated Fastening Systems:
   e. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field measurements are as indicated.
B. Verify that mounting surfaces are ready to receive support and attachment components.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Perform work in accordance with NECA 1 (general workmanship).
C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
H. Field-Welding (where approved by Architect): Comply with Section 05 5000.
I. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 03 3000.
   5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
J. Conduit Support and Attachment: Also comply with Section 26 0533.13.
K. Box Support and Attachment: Also comply with Section 26 0533.16.

L. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

M. Secure fasteners according to manufacturer's recommended torque settings.

N. Remove temporary supports.

O. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION
SECTION 26 0533.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Galvanized steel rigid metal conduit (RMC).
B. Intermediate metal conduit (IMC).
C. Flexible metal conduit (FMC).
D. Liquidtight flexible metal conduit (LFMC).
E. Electrical metallic tubing (EMT).
F. Conduit fittings.
G. Accessories.

1.02 RELATED REQUIREMENTS
A. Section 07 8400 - Firestopping.
B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.
C. Section 26 0526 - Grounding and Bonding for Electrical Systems.
   1. Includes additional requirements for fittings for grounding and bonding.
D. Section 26 0529 - Hangers and Supports for Electrical Systems.
E. Section 26 0533.16 - BOXES.
F. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS
A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.
D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.
F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.
G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
J. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
L. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
M. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
N. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements for submittals procedures.
   B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
   C. Shop Drawings:
      1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
      2. Include proposed locations of roof penetrations and proposed methods for sealing.
   D. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

1.06 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
   C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS
2.01 CONDUIT APPLICATIONS
   A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
   B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
   C. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
   D. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
   E. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
      1. Locations subject to physical damage include, but are not limited to:
         a. Where exposed below 8 feet (2.4 m), except within electrical and communication rooms or closets.
         b. Where exposed below 20 feet (6.1 m) in warehouse areas.
   F. Exposed, Exterior: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
G. Connections to Vibrating Equipment:
   1. Dry Locations: Use flexible metal conduit.
   2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
   3. Maximum Length: 6 feet (1.8 m) unless otherwise indicated.
   4. Vibrating equipment includes, but is not limited to:
      a. Transformers.
      b. Motors.

2.02 CONDUIT REQUIREMENTS
A. Fittings for Grounding and Bonding: Also comply with Section 26 0526.
B. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
C. Provide products listed, classified, and labeled as suitable for the purpose intended.
D. Minimum Conduit Size, Unless Otherwise Indicated:
   1. Branch Circuits: 3/4 inch (21 mm) trade size.
   2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
   3. Control Circuits: 3/4 inch (21 mm) trade size.
E. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)
A. Manufacturers:
   4. Substitutions: See Section 01 6000 - Product Requirements.
B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
C. Fittings:
   1. Manufacturers:
      d. Substitutions: See Section 01 6000 - Product Requirements.
   2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
      a. Do not use die cast zinc fittings.
   3. Material: Use steel or malleable iron.
      a. Do not use die cast zinc fittings.
   4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 INTERMEDIATE METAL CONDUIT (IMC)
A. Manufacturers:
   4. Substitutions: See Section 01 6000 - Product Requirements.
B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
C. Fittings:
   1. Manufacturers:
2.05 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

C. Fittings:
   1. Manufacturers:
      d. Substitutions: See Section 01 6000 - Product Requirements.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use steel or malleable iron.
      a. Do not use die cast zinc fittings.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:
   1. Manufacturers:
      d. Substitutions: See Section 01 6000 - Product Requirements.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use steel or malleable iron.
      a. Do not use die cast zinc fittings.

2.07 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   4. Substitutions: See Section 01 6000 - Product Requirements.
B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Fittings:
   1. Manufacturers:
      d. Substitutions: See Section 01 6000 - Product Requirements.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use steel or malleable iron.
      a. Do not use die cast zinc fittings.
      a. Do not use indenter type connectors and couplings.
   5. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.
   6. Embedded Within Concrete (where permitted): Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

2.08 ACCESSORIES
   A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil (0.51 mm).
   B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
   C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
   D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force (890 N).
   E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
   F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that mounting surfaces are ready to receive conduits.
   C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Perform work in accordance with NECA 1 (general workmanship).
   C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
   D. Install intermediate metal conduit (IMC) in accordance with NECA 101.
   E. Conduit Routing:
      1. Unless dimensioned, conduit routing indicated is diagrammatic.
      2. When conduit destination is indicated without specific routing, determine exact routing required.
      3. Conceal all conduits unless specifically indicated to be exposed.
      4. Conduits in the following areas may be exposed, unless otherwise indicated:
         a. Electrical rooms.
         b. Mechanical equipment rooms.
         c. Within joists in areas with no ceiling.
      5. Unless otherwise approved, do not route conduits exposed:
a. Across floors.  
b. Across roofs.  
c. Across top of parapet walls.  
d. Across building exterior surfaces.

6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.

7. Arrange conduit to maintain adequate headroom, clearances, and access.

8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.

9. Arrange conduit to provide no more than 150 feet (46 m) between pull points.

10. Route conduits above water and drain piping where possible.

11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.

12. Maintain minimum clearance of 6 inches (150 mm) between conduits and piping for other systems.

13. Maintain minimum clearance of 12 inches (300 mm) between conduits and hot surfaces. This includes, but is not limited to:
   a. Heaters.  
   b. Hot water piping.  
   c. Flues.

F. Conduit Support:
   1. Secure and support conduits in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
   3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
   4. Use conduit strap to support single surface-mounted conduit.
      a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
   5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
   6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
   7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
   8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
   9. Use of spring steel conduit clips for support of conduits is not permitted.
   10. Use of wire for support of conduits is not permitted.
   11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

G. Connections and Terminations:
   1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
   2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
   3. Use suitable adapters where required to transition from one type of conduit to another.
   4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
   5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

H. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Provide suitable modular seal where conduits penetrate exterior wall below grade.
7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
9. Provide metal escutcheon plates for conduit penetrations exposed to public view.
10. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

I. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
3. Where conduits are subject to earth movement by settlement or frost.

J. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

K. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches (300 mm) at each end.

L. Provide grounding and bonding in accordance with Section 26 0526.
M. Identify conduits in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL
A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING
A. Clean interior of conduits to remove moisture and foreign matter.
3.05 PROTECTION
   A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION
SECTION 26 0533.16

BOXES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches (1,650 cu cm).

1.02 RELATED REQUIREMENTS
A. Section 07 8400 - Firestopping.
B. Section 08 3100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
C. Section 26 0526 - Grounding and Bonding for Electrical Systems.
D. Section 26 0529 - Hangers and Supports for Electrical Systems.
E. Section 26 0533.13 - Conduit for Electrical Systems:
   1. Conduit bodies and other fittings.
   2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
F. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
G. Section 26 2813 - Fuses: Spare fuse cabinets.

1.03 REFERENCE STANDARDS
A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.
E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2018.
F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
   4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures and floor boxes.
C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
D. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, and floor boxes.
E. Maintenance Materials: Furnish the following for Owner’s use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Keys for Lockable Enclosures: Two of each different key.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS
2.01 BOXES
A. General Requirements:
   1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
   2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
   3. Provide products listed, classified, and labeled as suitable for the purpose intended.
   4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
   5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
B. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
   1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
   2. NEMA 250 Environment Type, Unless Otherwise Indicated:
      a. Indoor Clean, Dry Locations: Type 1, painted steel.
      b. Outdoor Locations: Type 3R, painted steel.
   3. Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
      a. Provide hinged-cover enclosures unless otherwise indicated.
      b. Boxes 6 square feet (0.56 sq m) and Larger: Provide hinged-cover enclosures.
4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
   a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
6. Manufacturers:
   d. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that mounting surfaces are ready to receive boxes.
   C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
   C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
   D. Provide separate boxes for emergency power and normal power systems.
   E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
   F. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
   G. Box Locations:
      1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 3100 as required where approved by the Architect.
      2. Unless dimensioned, box locations indicated are approximate.
      3. Locate boxes as required for devices installed under other sections or by others.
         a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 2726.
      4. Locate boxes so that wall plates do not span different building finishes.
      5. Locate boxes so that wall plates do not cross masonry joints.
      6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
      7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Install in separate stud cavities, if not possible, provide minimum 6 inches (150 mm) horizontal separation unless otherwise indicated.
      8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches (610 mm) horizontal separation.
      9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
         a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches (610 mm) separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
         b. Do not install flush-mounted boxes with area larger than 16 square inches (0.0103 sq m) or such that the total aggregate area of openings exceeds 100 square inches (0.0645 sq m) for any 100 square feet (9.29 sq m) of wall area.
10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0533.13.

11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
   a. Within joists in areas with no ceiling.
   b. Electrical rooms.
   c. Mechanical equipment rooms.

H. Box Supports:
   1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
   3. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.

I. Install boxes plumb and level.

J. Floor-Mounted Cabinets: Mount on properly sized nominal 4 inch (100 mm) high concrete pad constructed in accordance with Section 03 3000.

K. Install boxes as required to preserve insulation integrity.

L. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.

M. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

O. Close unused box openings.

P. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

Q. Provide grounding and bonding in accordance with Section 26 0526.

R. Identify boxes in accordance with Section 26 0553.

3.03 CLEANING
   A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION
   A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION
PART 1  GENERAL
1.01  SECTION INCLUDES
   A. Electrical identification requirements.
   B. Identification nameplates and labels.
   C. Wire and cable markers.
   D. Voltage markers.
   E. Floor marking tape.
   F. Warning signs and labels.

1.02  RELATED REQUIREMENTS
   A. Section 09 9113 - Exterior Painting.
   B. Section 09 9123 - Interior Painting.
   C. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

1.03  REFERENCE STANDARDS
   C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
   D. NFPA 70E - Standard for Electrical Safety in the Workplace; 2015.

1.04  ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
   B. Sequencing:
      1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
      2. Do not install identification products until final surface finishes and painting are complete.

1.05  SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements for submittals procedures.
   B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
   C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.
   D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.06  QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.

1.07  FIELD CONDITIONS
   A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.
PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:
   1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
      a. Enclosed switches, circuit breakers, and motor controllers:
         1) Identify voltage and phase.
         2) Identify power source and circuit number. Include location.
         3) Identify load(s) served. Include location.
      b. Enclosed Contactors:
         1) Identify ampere rating.
         2) Identify voltage and phase.
         3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
         4) Identify coil voltage.
         5) Identify load(s) and associated circuits controlled. Include location.
   2. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
   3. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
   4. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
   5. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
   6. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
   7. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
      a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches (76 mm) wide, painted in accordance with Section 09 9123 and 09 9113.
   8. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.

B. Identification for Conductors and Cables:
   1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
   2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
   3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
      a. At each source and load connection.
      b. Within boxes when more than one circuit is present.
      c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
   4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.

C. Identification for Raceways:
   1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet (6.1 m).
2. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet (6.1 m).
   a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches (76 mm) wide.
      1) Field-Painting: Comply with Section 09 9123 and 09 9113.
      2) Vinyl Color Coding Electrical Tape: Comply with Section 26 0519.
3. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.

D. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.
2. Use voltage markers or color coded boxes to identify systems other than normal power system.
   a. Color-Coded Boxes: Field-painted in accordance with Section 09 9123 and 09 9113 per the same color code used for raceways.
3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
   a. For exposed boxes in public areas, use only identification labels.
4. Use warning labels to identify electrical hazards for boxes containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".

E. Identification for Devices:
1. Wiring Device and Wallplate Finishes: Comply with Section 26 2726.
2. Use identification label to identify fire alarm system devices.
3. Use engraved wallplate to identify serving branch circuit for all receptacles.
4. Use engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
1. Materials:
   a. Indoor Clean, Dry Locations: Use plastic nameplates.
   b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch (1.6 mm); engraved text.
   a. Exception: Provide minimum thickness of 1/8 inch (3 mm) when any dimension is greater than 4 inches (100 mm).
3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.
4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.
5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch (25 mm) high; Four, located at corners for larger sizes.

B. Identification Labels:
1. Manufacturers:
   d. Substitutions: See Section 01 6000 - Product Requirements.
   a. Use only for indoor locations.
3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
1. Minimum Size: 1 inch (25 mm) by 2.5 inches (64 mm).
2. Legend:
   a. System designation where applicable:
      1) Emergency Power System: Identify with text "EMERGENCY".
      2) Fire Alarm System: Identify with text "FIRE ALARM".
   b. Equipment designation or other approved description.
   c. Other information as indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
   a. System Designation: 1 inch (25 mm).
   b. Equipment Designation: 1/2 inch (13 mm).
   c. Other Information: 1/4 inch (6 mm).
   d. Exception: Provide minimum text height of 1 inch (25 mm) for equipment located more than 10 feet (3.0 m) above floor or working platform.
5. Color:

D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch (25 mm) by 2.5 inches (64 mm).
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/4 inch (6 mm).
5. Color: Black text on white background unless otherwise indicated.

E. Format for Caution and Warning Messages:
1. Minimum Size: 2 inches (51 mm) by 4 inches (100 mm).
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch (13 mm).
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:
1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
2. Legend: Power source and circuit number or other designation indicated.
   a. Include voltage and phase for other than 120 V, single phase circuits.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch (5 mm).
5. Color: Black text on clear background.

G. Format for Control Device Identification:
1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
2. Legend: Load controlled or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch (5 mm).
5. Color: Black text on clear background.

2.03 WIRE AND CABLE MARKERS

A. Manufacturers:
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

D. Legend: Power source and circuit number or other designation indicated.

E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
   1. Do not use handwritten text.

F. Minimum Text Height: 1/8 inch (3 mm).

G. Color: Black text on white background unless otherwise indicated.

2.04 VOLTAGE MARKERS

A. Manufacturers:
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.

C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

D. Minimum Size:
   1. Markers for Equipment: 1 1/8 by 4 1/2 inches (29 by 110 mm).
   2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
   3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches (29 by 110 mm).
   4. Markers for Junction Boxes: 1/2 by 2 1/4 inches (13 by 57 mm).

E. Legend:
   1. Markers for Voltage Identification: Highest voltage present.
   2. Markers for System Identification:
      b. Other Systems: Type of service.

F. Color: Black text on orange background unless otherwise indicated.

2.05 FLOOR MARKING TAPE

A. Manufacturers:
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlaminate, 3 inches (76 mm) wide, with alternating black and white stripes.

2.06 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:
   1. Materials:
      a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
      b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.

3. Minimum Size: 7 by 10 inches (178 by 254 mm) unless otherwise indicated.

C. Warning Labels:
   1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
      a. Do not use labels designed to be completed using handwritten text.
   3. Minimum Size: 2 by 4 inches (51 mm by 102 mm) unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION
   A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
      3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
      4. Elevated Equipment: Legible from the floor or working platform.
      5. Branch Devices: Adjacent to device.
      6. Interior Components: Legible from the point of access.
      7. Conduits: Legible from the floor.
      8. Boxes: Outside face of cover.
      9. Conductors and Cables: Legible from the point of access.
     10. Devices: Outside face of cover.
   C. Install identification products centered, level, and parallel with lines of item being identified.
   D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing.
   E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
   F. Secure rigid signs using stainless steel screws.
   G. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL
   A. See Section 01 4000 - Quality Requirements, for additional requirements.
   B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION
SECTION 26 2813
FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Fuses.
   B. Spare fuse cabinet.

1.02 RELATED REQUIREMENTS
   A. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
   B. Section 26 2913 - Enclosed Controllers: Fusible switches.

1.03 REFERENCE STANDARDS
   A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.
   B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
      2. Coordinate fuse requirements according to manufacturer’s recommendations and nameplate data for actual equipment to be installed.
      3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer’s standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
      1. Spare Fuse Cabinet: Include dimensions.
   C. Maintenance Materials: Furnish the following for Owner’s use in maintenance of project.
      1. See Section 01 6000 - Product Requirements, for additional provisions.
      2. Extra Fuses: One set(s) of three for each type and size installed.
      3. Fuse Pullers: One set(s) compatible with each type and size installed.
      4. Spare Fuse Cabinet Keys: Two.

1.06 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
   C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Bussmann, a division of Eaton Corporation:  
   D. Substitutions: See Section 01 6000 - Product Requirements.

2.02 APPLICATIONS
   A. Individual Motor Branch Circuits: Class RK1, time-delay.

2.03 FUSES
   A. Provide products listed, classified, and labeled as suitable for the purpose intended.
   B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required 
      for a complete operating system.
   C. Provide fuses of the same type, rating, and manufacturer within the same switch.
   D. Comply with UL 248-1.
   E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and 
      ratings as indicated.
   F. Voltage Rating: Suitable for circuit voltage.
   G. Class R Fuses: Comply with UL 248-12.
      1. Class RK1, Time-Delay Fuses:
      2. Class RK1, Fast-Acting, Non-Time-Delay Fuses:
      3. Class RK5, Time-Delay Fuses:
      4. Class RK5, Fast-Acting, Non-Time-Delay Fuses:
   H. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to 
      achieve selective coordination.
   I. Provide the following accessories where indicated or where required to complete installation:
      1. Fuseholders: Compatible with indicated fuses.
      2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for 
         fuses with larger ampere ratings.

2.04 SPARE FUSE CABINET
   A. Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, 
      suitably sized to store spare fuses and fuse pullers specified.
   B. Finish: Manufacturer's standard, factory applied grey finish unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations 
      and nameplate data for equipment.
   B. Verify that mounting surfaces are ready to receive spare fuse cabinet.
   C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Do not install fuses until circuits are ready to be energized.
   B. Install fuses with label oriented such that manufacturer, type, and size are easily read.
   C. Install spare fuse cabinet where indicated.
   D. Identify spare fuse cabinet in accordance with Section 26 0553.

END OF SECTION
SECTION 26 2913
ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:
   1. Magnetic motor starters.
B. Overcurrent protective devices for motor controllers, including overload relays.
C. Control accessories:
   1. Auxiliary contacts.
   2. Pilot devices.
   3. Control and timing relays.
   4. Control power transformers.
   5. Control terminal blocks.

1.02 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
B. Section 26 0529 - Hangers and Supports for Electrical Systems.
C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
D. Section 26 2813 - Fuses: Fuses for fusible switches.
   1. Includes requirements for spare fuses and spare fuse cabinets.
E. Section 26 2923 - Variable-Frequency Motor Controllers.

1.03 REFERENCE STANDARDS

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2018.
G. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
J. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
6. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
   1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of enclosed controllers and adjacent equipment with all required clearances indicated.
   2. Include wiring diagrams showing all factory and field connections.
   3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
   4. Include documentation of listed series ratings upon request.
   5. Include documentation demonstrating selective coordination upon request.
D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
E. Field Quality Control Test Reports.
F. Project Record Documents: Record actual installed locations of controllers and final equipment settings.
   1. Include nameplate data of actual installed motors and associated overload relay selections and settings.
G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Electronic Trip Circuit Breakers: Provide one portable test set.
   3. Indicating Lights: Two of each different type.
   4. See Section 26 2813 for requirements for spare fuses and spare fuse cabinets.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
B. Handle carefully in accordance with manufacturer’s written instructions to avoid damage to internal components, enclosure, and finish.

1.08 FIELD CONDITIONS
A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS
C. Schneider Electric; Square D Products: www.schneider-electric.us.
E. Substitutions: See Section 01 6000 - Product Requirements.
F. Source Limitations: Furnish enclosed motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 ENCLOSED CONTROLLERS
A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.
D. Service Conditions:
   1. Provide controllers and associated components suitable for operation under the following service conditions without derating:
      a. Altitude:
         1) Class 1 Km Equipment (devices utilizing power semiconductors, e.g. variable frequency controllers): Less than 3,300 feet (1,000 m).
         2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet (2,000 m).
      b. Ambient Temperature: Between 32 degrees F (0 degrees C) and 104 degrees F (40 degrees C).
   2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
E. Short Circuit Current Rating:
   1. Provide controllers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.
F. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
G. Conductor Terminations: Suitable for use with the conductors to be installed.
H. Enclosures:
2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1 or Type 12.
   b. Outdoor Locations: Type 3R or Type 4.
3. Finish: Manufacturer's standard unless otherwise indicated.

I. Instrument Transformers:
2. Select suitable ratio, burden, and accuracy as required for connected devices.

J. Magnetic Motor Starters: Combination type unless otherwise indicated.
1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).
2. Configuration: Full-voltage non-reversing unless otherwise indicated.
3. Minimum Starter Size: NEMA Size 0.
4. Use of non-standard starter sizes smaller than specified standard NEMA sizes is not permitted.
5. Disconnects: Disconnect switch type.
   a. Disconnect Switches: Fusible type unless otherwise indicated.
   b. Provide externally operable handle with means for locking in the OFF position.
      Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
   c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
6. Overload Relays: Solid-state type unless otherwise indicated.
7. Pilot Devices Required:
   a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings.
   b. Single-Speed, Non-Reversing Starters:
      1) Pushbuttons: START-STOP.
      2) Selector Switches: HAND/OFF/AUTO.
      3) Indicating Lights: Red ON, Green OFF.
   c. Single-Speed, Reversing Starters:
      1) Pushbuttons: FOR-REV-STOP.
      2) Selector Switches: FOR/OFF/REV.
      3) Indicating Lights: Red FOR, Red REV, Green OFF.
   d. Two-Speed Starters:
      1) Pushbuttons: FAST-OFF-SLOW.
      2) Selector Switches: SLOW/OFF/FAST.
      3) Indicating Lights: Red FAST, Red SLOW, Green OFF.

2.03 OVERCURRENT PROTECTIVE DEVICES
A. Overload Relays:
1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
3. Trip-free operation.
4. Visible trip indication.
5. Resettable.
   a. Employ manual reset unless otherwise indicated.
   b. Employ automatic reset or remote reset where indicated.
c. Do not employ automatic reset with two-wire control.

6. Solid-State Overload Relays:
   a. Selectable inverse-time trip class rating; available ratings of Class 10, 20, and 30, minimum.
   b. Adjustable full load current.
   c. Phase loss protection.
   d. Phase imbalance protection.
   e. Ground fault protection.
   f. Ambient temperature insensitive.
   g. Thermal memory.
   h. Trip test function.
   i. Provide isolated alarm contact.

B. Fusible Disconnect Switches:
   1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
   2. Fuse Clips: As required to accept indicated fuses.
   3. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

2.04 CONTROL ACCESSORIES

A. Auxiliary Contacts:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

B. Pilot Devices:
   1. Comply with NEMA ICS 5; heavy-duty type.
   2. Nominal Size: 30 mm.
   3. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
   4. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
   5. Indicating Lights: Push-to-test type unless otherwise indicated.
   6. Provide LED lamp source for indicating lights and illuminated devices.

C. Control and Timing Relays:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of relays indicated or required to perform necessary functions.
   3. Timing Relays: Electronic or pneumatic as indicated.
      a. Adjustable Timing Range: As indicated on drawings.
   4. Multi-Speed Motor Starters: Employ accelerating relays, decelerating relays, and compelling relays where indicated.
   5. Accelerating Relays: Starts motor at low speed and then accelerates automatically through definite time intervals for each successive speed until selected speed is attained.
   6. Decelerating Relays: Allows motor to decelerate automatically through definite time intervals for each successive speed until selected speed is attained.
   7. Compelling Relays: Requires motor to start at low speed before a higher speed can be selected.

D. Control Power Transformers:
   1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices, plus _____ VA spare capacity.
2. Include primary and secondary fuses.
E. Control Terminal Blocks: Include 25 percent spare terminals.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field measurements are as indicated.
B. Verify that ratings of enclosed controllers are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive enclosed controllers.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Install controllers in accordance with NECA 1 (general workmanship).
C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
D. Provide required support and attachment in accordance with Section 26 0529.
E. Install enclosed controllers plumb and level.
F. Provide grounding and bonding in accordance with Section 26 0526.
G. Install all field-installed devices, components, and accessories.
H. Provide fuses complying with Section 26 2813 for fusible switches as indicated.
I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
J. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.
K. Identify enclosed controllers in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL
A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Inspect and test in accordance with NETA ATS, except Section 4.
C. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.
D. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
E. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

3.04 ADJUSTING
A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING
A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.
B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES
A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. See Section 01 7900 - Demonstration and Training, for additional requirements.
C. Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.
D. Training: Train Owner’s personnel on operation, adjustment, and maintenance of enclosed controllers and associated devices.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.
   3. Instructor: Manufacturer’s authorized representative.
   4. Location: At project site.

3.07 PROTECTION
   A. Protect installed enclosed controllers from subsequent construction operations.

END OF SECTION
SECTION 26 2923
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Variable frequency controllers.

1.02 RELATED REQUIREMENTS
   A. Section 26 0529 - Hangers and Supports for Electrical Systems.
   B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS
   C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2018.
   E. NFPA 70 - National Electrical Code: Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
   C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
   D. Test Reports: Indicate field test and inspection procedures and test results.
   E. 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.
   F. Manufacturer's Field Reports: Indicate start-up inspection findings.
   G. Operation Data: NEMA ICS 7.1. Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.
   H. Maintenance Data: NEMA ICS 7.1. Include routine preventive maintenance schedule.
   I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      1. See Section 01 6000 - Product Requirements, for additional provisions.
      2. Extra Air Filters: Two of each type.

1.05 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles (160 km) of Project.
   C. Products: Listed, classified, and labeled as suitable for the purpose intended.
   D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
1.06 DELIVERY, STORAGE, AND HANDLING
   A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
   B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Variable Frequency Motor Controllers:
      4. Schneider Electric; Square D Products: www.schneider-electric.us.
      8. Yaskawa Electric America, Inc.: http://www.yaskawadrive.com
   B. Substitutions: See Section 01 6000 - Product Requirements.
   C. Source Limitations: Furnish variable frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 DESCRIPTION
   A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7. Select unspecified features and options in accordance with NEMA ICS 3.1.
      1. Employ microprocessor-based inverter logic isolated from power circuits.
      2. Design for ability to operate controller with motor disconnected from output.
      3. Design to attempt five automatic restarts following fault condition before locking out and requiring manual restart.
   B. Enclosures: NEMA 250, Type 1, suitable for equipment application in places accessible only to qualified personnel.
   C. Finish: Manufacturer's standard enamel.

2.03 OPERATING REQUIREMENTS
   A. Rated Input Voltage: as indicated on the drawings, three phase, 60 Hertz.
   B. Motor Nameplate Voltage: As indicated on the drawings, three phase, 60 Hertz.
   C. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
   D. Operating Ambient: 0 degrees C to 40 degrees C.
   E. Minimum Efficiency at Full Load: 96 percent.
   F. Volts Per Hertz Adjustment: Plus or minus 10 percent.
   G. Current Limit Adjustment: 60 to 110 percent of rated.
   H. Acceleration Rate Adjustment: 0.5 to 30 seconds.
   I. Deceleration Rate Adjustment: 1 to 30 seconds.
   J. Input Signal: 4 to 20 mA DC.

2.04 COMPONENTS
   A. Display: Provide integral digital display to indicate output voltage, output frequency, and output current.
   B. Status Indicators: Separate indicators for overcurrent, overvoltage, ground fault, overtemperature, and input power ON.
C. Furnish HAND-OFF-AUTOMATIC selector switch and manual speed control.
D. Include undervoltage release.
E. Control Power Source: Integral control transformer.
F. Door Interlocks: Furnish mechanical means to prevent opening of equipment with power connected, or to disconnect power if door is opened; include means for defeating interlock by qualified persons.
G. Safety Interlocks: Furnish terminals for remote contact to inhibit starting under both manual and automatic mode.
H. Control Interlocks: Furnish terminals for remote contact to allow starting in automatic mode.
I. Manual Bypass: Furnish contactor, motor running overload protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch to allow maintenance of inverter during bypass operation.
J. Emergency Stop: Use dynamic brakes for emergency stop function.
K. Disconnecting Means: Include integral circuit breaker on the line side of each controller.
L. Wiring Terminations: Match conductor materials and sizes indicated.

2.05 SOURCE QUALITY CONTROL
A. Shop inspect and perform standard productions tests for each controller.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that surface is suitable for controller installation.
B. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.
C. Verify that field measurements are as indicated on shop drawings.

3.02 INSTALLATION
A. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.
B. Provide required support and attachment in accordance with Section 26 0529.
C. Tighten accessible connections and mechanical fasteners after placing controller.
D. Provide fuses in fusible switches; refer to Section 26 2813 for product requirements.
E. Select and install overload heater elements in motor controllers to match installed motor characteristics.
F. Identify variable frequency controllers in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL
A. Provide the service of the manufacturer's field representative to prepare and start controllers.
B. Perform field inspection and testing in accordance with Section 01 4000.
C. Inspect and test in accordance with NETA ATS, except Section 4.
D. Perform inspections and tests listed in NETA ATS, Section 7.17. The insulation-resistance test on control wiring listed as optional is not required.

3.04 ADJUSTING
A. Make final adjustments to installed controller to assure proper operation of load system. Obtain performance requirements from installer of driven loads.

3.05 CLOSEOUT ACTIVITIES
A. Demonstrate operation of controllers in automatic and manual modes.
3.06 MAINTENANCE

A. See Section 01 7000 - Execution Requirements, for additional requirements relating to maintenance service.

B. Provide a separate maintenance contract for specified maintenance service.

C. Provide service and maintenance of controllers for one year from Date of Substantial Completion.

END OF SECTION