SPECIFICATIONS
September 15, 2023

PASCAGOULA PUBLIC LIBRARY
REPAIRS AND RENOVATIONS

Jackson County Board of Supervisors
PO Box 998
Pascagoula, MS 39568-0998

JOB NO. 2020-36

BID DATE: January 11, 2024
@ Noon Local Time

9/15/2023

allred stolarski architects

Allred Stolarski Architects
711 Church Street
Ocean Springs, MS 39564

INDEX TO SPECIFICATIONS

ADVERTISEMENT FOR BIDS

Notice is hereby given that sealed bids or electronic bids will be received by the Board of Supervisors for Jackson County, until 12:00 noon (Ct) on January 11, 2024, and said bids are to be opened and read aloud at 1:00 p.m. in the Board of Supervisors' Meeting Room located in the Jackson County Services Building, 2915 Canty Street, Pascagoula, MS 39567.

Envelopes containing the bid must be sealed, addressed to Joshua Eldridge, Chancery clerk, and designated as a bid for the following items described, to wit:

Pascagoula Public Library
Repairs and Renovations

In accordance with plans and specifications prepared by:

Allred Stolarski Architects, PA
711 Church Street
Ocean Springs, Mississippi 39564
228-762-1975

Bid documents are being made available via hard copy or digital copy at www.asaplans.com and www.jacksoncoplans.com. Interested bidders should log-in or register for a free account to view and order bid documents. The cost of the bid documents is non-refundable and must be purchased through the website (hard copies and digital). For any questions relating to the electronic bid submittal process, please call Plan House at 662-407-0193.

When submitting an electronic bid, the bid must be submitted in "pdf" format and shall contain the same information and forms as required for the paper bids. Electronic bids must be secured with a bid bond. When submitting a bid electronically, the authorized signature shall be an electronic signature or handwritten in blue-ink signature. In the event that an electronically submitted bid has a corrupted attachment, the bid will be considered null and void. When bids are submitted electronically, the requirement for including a certificate of responsibility, or a statement that the bid enclosed does not exceed Fifty Thousand Dollars ($50,000.00), on the exterior of the bid envelope shall be deemed in compliance by including the same information as an attachment with the electronic bid submittal. Electronic bids shall be submitted at www.jacksoncoplans.com.

Sealed bids shall be marked "SEALED BID FOR PASCAGOULA PUBLIC LIBRARY, REPAIRS AND RENOVATIONS" and submitted in a sealed envelope addressed to Joshua Eldridge, Chancery Clerk, 2915 Canty Street, Suite R, Land Records Office, Pascagoula, MS 39567. Sealed bids may be delivered by mail or hand delivered. Bids must be accompanied by bid security in the form of Certified Check, Cashier's Check or acceptable Bid Bond, Payable to Jackson County Board of Supervisors, in amount equal to at least five percent (5%) of the base bid; such security to be forfeited as liquidated damages, not penalty, by any bidder who may be awarded the contract but who fails to carry out the terms of the proposal, execute the contract and post performance bond in the form and amount within the time specified. All bids will be publicly opened and read

aloud in the Board of Supervisors' Board Room in the Jackson County Services Complex. Bids received at any location other than the appropriate location, described above, or bids received after the noticed date and time for submittal will not be considered but will be returned to the bidder unopened.

All bids submitted in excess of $50,000.00 by a prime or subcontractor to do any erection, building, construction, repair, maintenance or related work, must comply with Section 31-3-21, Mississippi Code of 1972, by having a current Certificate of Responsibility from the State Board of Public Contractors. The current Certificate of Responsibility Number shall be indicated on the exterior of the sealed bid envelope before it can be opened. If the bid is not in excess of $50,000, "THIS BID SHALL NOT EXCEED $50,000", shall be indicated on the sealed bid envelope before it can be opened.

In the letting of public contracts in the State of Mississippi, preference shall be given to resident contractors, and a non-resident bidder domiciled in a state having laws granting preference to local contractors shall be awarded Mississippi public contracts only on the same basis as the non-resident bidder's state awards contracts to Mississippi contractors bidding under similar circumstances; and resident contractors actually domiciled in Mississippi, be they corporate, individuals, or partnerships, are to be granted preference over non-residents in awarding of contracts in the same manner and to the same extent as provided by the laws of the state of domicile of the non-resident. When a non-resident contractor submits a bid for a public project, he shall attach thereto a copy of his resident state's current law pertaining to such state's treatment of non-resident contractors.

No bid may be withdrawn after the scheduled closing time for a period of Sixty (60) days. The Jackson County Board of Supervisors reserves the right to reject any or all bids on any or all projects and to waive informalities.

GIVEN UNDER MY HAND AND OFFICIAL SEAL OF OFFICE, THIS THE 20th DAY OF NOVEMBER, 2023

BY: JOSHUA ELDRIDGE, CHANCERY CLERK
P.O. BOX 998
PASCAGOULA, MS 39568-0998

RUN: TWO (2) TIMES
NOVEMBER 26 AND
DECEMBER 3, 2023
OPEN: JANUARY 11, 2024
AT 1:00 P.M.

FORM OF PROPOSAL

A. INTRODUCTION

Two copies of this form, which is the Bidder's proposal, are to be completed, signed, and delivered to the Chancery Clerk of Jackson County, Jackson County Services Complex, 2915 Canty Street, Suite R, Land Records Office, Pascagoula, Mississippi, prior to the bid time specified. Contractors submitting a bid must complete this form and attach to one of the copies the bid bond or cashier's check as indicated in order to constitute a complete bid proposal.

B. PROJECT

PASCAGOULA PUBLIC LIBRARY
REPAIRS AND RENOVATIONS

C. ARCHITECT

Allred Stolarski Architects, PA
711 Church Street
Ocean Springs, Mississippi 39564

D. PROPOSAL

Pascagoula Public Library
Repairs and Renovations

BASE BID

I (or we) do hereby declare that I (or we) have carefully examined the contract documents, including all addenda, prepared by the consultant listed in Item C. of this proposal and I (or we) have a clear understanding of said documents and premises, and hereby propose to provide the necessary tools, machinery, apparatus and other means of construction, and to furnish all labor, materials, and services specified in the contract or called for in the said contract documents, including all taxes necessary, for the Project listed in Item B. above, for the lump sum price of:

_____

_____ Dollars $_____

E. ALTERNATES (See Descriptions in Section 01.900, ALTERNATES in the Project Manual)

ADDITIVE ALTERNATE #1

_____

_____ Dollars $_____

ADDITIVE ALTERNATE #2

_____

_____ Dollars $_____

F. CONTRACT TIME If the undersigned is notified of the acceptance of the bid within ninety (90) days of the time set for opening of bids, he agrees to execute a contract for the work as described in the contract documents. The undersigned also guarantees completion of this contract within Three Hundred (300) calendar days of the Notice to Proceed.

G. DAMAGES The undersigned agrees that the Owner may retain from this contract the sum indicated below from the amount of compensation to be paid him for each day after the above mentioned completion time, Sundays and Holidays included, that the work remains incomplete. This amount is agreed upon as the proper measure of the Liquidated Damage that the Owner will sustain per day, by failure of the undersigned to complete the contract, at the stipulated time, and is not to be construed, in any sense, as a penalty.

LIQUIDATION DAMAGES PER DIEM: $500.00 per day

H. BOND The undersigned agrees, if awarded the contract, to execute and deliver to the Owner at the time the contract documents are executed, a performance bond and a materials and labor bond in a form acceptable to the Owner, and in an amount equal to the contract sum. Failure to submit this bond at the time of the contract, or contracts, will cause forfeiture of bid security as liquidated damages.

I. BID SECURITY

The bid security attached in the sum of five percent (5%) of the Base Bid, in the amount of:

_____

_____. Dollars $_____

The Bid Security is to become the property of the Owner, as set forth in DIVISION 0, Section 00.118. Attached to this Proposal is the Bid Bond, executed as required.

J. DOCUMENTS

Each bidder by submittal of his bid represents and warrants that he has satisfied himself as to the requirements and provisions of the contract, or contracts, for this project and the documents included in this contract or contracts.

K. ADDENDUM

I/We acknowledge receipt of the following addenda:

No. _____ No. _____

No. _____ No. _____

L. SIGNATURES

Respectfully submitted,

_____

Name of Bidding Corporation or Company

_____

Authorized Signature Title

_____

Typed (or Printed) Name of Signatory

_____

Address (city and state)

_____

Current Certificate of Responsibility Number

Classification of Work Permitted Under
Certificate of Responsibility

NOTE: If bidder is a corporation, write state of incorporation under signature, and if a partnership, give full name of all partners.
Stamp or emboss corporate seal on this Proposal.

IMPORTANT: Non-resident (out of state) bidders shall attach to their bids a copy of their resident state's, city, county, parish, province, nation or political subdivision current law pertaining to such state's treatment of non-resident contractors. See DIVISION 0, Paragraph 00.102, NON-RESIDENT (OUT OF STATE) BIDDER REQUIREMENTS.

Non-Collusion/Debarment Affidavit: All bidders shall execute (in duplicate) the attached form.

NON-COLLUSION/DEBARMENT AFFIDAVIT

(Execute in duplicate)

I, _____,
(Name of person signing affidavit)

individually, and in my capacity as _____ of
(Title)

_____ do hereby certify under
(Name of Firm, Partnership, or Corporation)

penalty of perjury under the laws of the United States and the State of Mississippi that _____

_____, Bidder
(Name of Firm, Partnership, or Corporation)

on Project No. _____,

in _____ County(ies), Mississippi, has not either

directly or indirectly entered into any agreement, participated in any collusion; or otherwise taken any action in restraint of free competitive bidding in connection with this contract; nor have any of its corporate officers or principal owners.

Except as noted hereafter, it is further certified that said legal entity and its corporate officers, principal owners, managers, auditors and others in a position of administering federal funds:

a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in (b) above; and

d) Have not within a three-year period preceding this application/ proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

Initial here "_____" if exceptions are attached and made a part thereof. Any exceptions shall address to whom it applies, initiating agency and dates of such action.

Note: Exceptions will not necessarily result in denial of award but will be considered in determining bidder responsibility. Providing false information may result in criminal prosecution or administrative sanctions.

The bidder further certifies that the certification requirements contained in Section XI of Form FHWA 1273, will be or have been included in all subcontracts, material supply agreements, purchase orders, etc. except those procurement contracts for goods or services that are expected to be less than the Federal procurement small purchase threshold fixed at 10 U.S.C. 2304(g) and 41 U.S.C. 253(g) (currently $25,000) which are excluded from the certification requirements.

The bidder further certifies, to the best of his or her knowledge and belief, that:

1) No Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this contract, Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions will be completed and submitted.

The certification contained in (1) and (2) above is a material representation of fact upon which reliance is placed and a prerequisite imposed by Section 1352, Title 31, U.S. Code prior to entering into this contract. Failure to comply shall be subject to a civil penalty of not less than $10,000 and not more than $100,000. The bidder shall include the language of the certification in all subcontracts exceeding $100,000 and all subcontractors shall certify and disclose accordingly.

All of the foregoing and attachments (when indicated) is true and correct.

Executed on _____ _____

Signature

DIVISION 0 BIDDING REQUIREMENTS

00.100 INSTRUCTIONS TO BIDDERS

.101 PREPARATION OF BIDS

A. Prices quoted shall include all items of cost, expense, taxes, fees and charges incurred, or arising out of, the performance of the work to be performed under the Contract. Bids shall be submitted in duplicate and shall be signed in ink. If submitting electronically, blanks may be completed electronically, and the authorized signature may be a hand-written blue ink signature or an electronic signature. Any proposal on other than the required form will be considered informal and may be rejected. Erasures or other changes in proposal must be explained or noted over the initials of the proposer. Bids containing any conditions, omissions, unexplained erasures and alterations, or irregularities of any kind may be rejected as informal. The prices should be expressed in words and figures or they may be deemed informal and may be rejected. In case of discrepancy between the prices written in the proposal and those given in the figures, the price in writing will be considered as the proposal. Failure to submit all requested information will make a proposal irregular and subject to rejection. Bids shall be signed with the legal name of the corporation followed by the name of the state of incorporation and the legal signature of an officer authorized to bind the corporation to a contract.

.102 NON-RESIDENT (OUT OF STATE) PROPOSAL REQUIREMENTS

A. In the letting of public contracts preference shall be given to resident contractors, and a non-resident proposer domiciled in the state, city, county, parish, province, nation or political subdivision having laws granting preference to local contractors shall be awarded Mississippi public contracts only on the same basis as the non-resident proposer's state, city, county, parish, province, nation or political subdivision awards contracts to Mississippi contractors bidding under similar circumstances. Resident contractors actually domiciled in Mississippi, be they corporate, individuals, or partnerships, are to be granted preference over non-residents in awarding of contracts in the same manner and to the same extent as provided by the laws of the state, city, county, parish, province, nation or political subdivision of domicile of the non-resident. When a non-resident contractor submits a proposal for a public project, he shall attach thereto a copy of his resident state's current law pertaining to such state's treatment of non-resident contractors.

.103 SUBMITTAL OF BIDS

A. Sealed bids will be received at the time, date and place stated in the Advertisement for Bids. Bids shall be made on an unaltered Proposal Form furnished by the Architect, or copied from the project specification. Fill in all blank spaces and submit two copies. Bids shall be signed with name typed below signature and if a partnership, give full name of all partners. Where proposer is a corporation, bids must be signed with the legal signatures of an officer authorized to bind the corporation to a contract. Submit proposal in an opaque, sealed envelope addressed to the Owner and plainly mark on the outside of the envelope the project name (Pascagoula Public Library, Repairs and Renovations), and the name and address of the proposer, Certificate of Responsibility number or a statement that the proposal enclosed does not exceed Fifty Thousand Dollars. No proposer shall modify, withdraw or cancel his proposal or any part thereof for sixty (60) days after the time agreed upon for the receipt of bids. A Bid Bond must be completed and signed by each proposer and submitted with the proposal. Submit bids by mail or in person prior to the time for receiving bids set forth in the Advertisement for Bids. Mailed bids shall be to Joshua Eldridge, Chancery Clerk, PO Box 998, Pascagoula, MS 39568-0998. It is the Contractor's (Proposer's) responsibility to assure the delivery and receipt, of the sealed proposal, prior to the stated proposal date and time.

B. Submit "Electronic Bids" with the same information and requirements as for "Sealed Bids". However, electronic bids must be secured with a bid bond. When bids are submitted electronically, the requirement for including a certificate of responsibility, or a statement that the proposal enclosed does not exceed Fifty Thousand Dollars ($50,000.00) on the exterior of the proposal envelope shall be deemed in compliance by including the same information as an attachment with the electronic proposal submittal. Provide cover sheet with the following information:

   Pascagoula Public Library
   Repairs and Renovations
   Contractor's Name and Address
   Certificate of Responsibility No. ####
   PROPOSAL ATTACHED

   Proposers must ensure that their electronic submission can be accessed and viewed by the County immediately upon proposal opening. The County will consider any file that cannot be immediately accessed and viewed at the time of the opening (such as, encrypted files, password protected files, or incompatible files) to be blank or incomplete as context requires, and are therefore unacceptable. A proposer will not be permitted to unencrypt files, remove password protections, or resubmit documents after opening to make a file

viewable if those documents are required with the proposal. Electronic bids shall be submitted at www.jacksoncoplans.com for any questions relating to the electronic proposal process, please call Plan House at 662-407-0193

.104 DOCUMENTS

A. Documents include the Proposal Requirements; General, Supplementary Conditions, Technical Sections, Drawings plus Addenda which may be issued by the Architect during the proposal period. Proposal Documents may be viewed and/or obtained under the terms and conditions set forth in the Advertisement for Bids.

B. Specifications are to supplement the Drawings, the two co-operate; and, therefore, it will not necessarily be the province of these specifications to mention any portion of the construction which the drawings explain, and such portions as are only indicated on the Drawings; and, should items be required by these Specifications which are not indicated on the Drawings but are necessary to complete the entire Contract, as shown and intended, these items shall be furnished as though indicated. The decision of the Architect as to the proper interpretation of the Drawings and these Specifications shall be final.

.105 EXAMINATION OF DOCUMENTS AND SITE

A. Planholders shall carefully examine the Proposal Documents and the construction site to obtain first-hand knowledge of the scope and the conditions of the Work. Each Contractor, Subcontractor, and Sub-subcontractor, by submitting a proposal to perform any portion of the Work, represents and warrants that he has examined the Drawings, Specifications (Project Manual) and the site of the Work, and from his own investigation, has satisfied himself as to the scope, accessibility, nature and location of the Work; the character of the equipment and other facilities needed for the performance of the Work; the character and extent of the work to be performed; the local conditions; labor availability, practices and jurisdictions and other circumstances that may affect the performance of the Work. No additional compensation will be allowed by the Owner for the failure of such Contractor, Subcontractor, or Sub-subcontractor to inform himself as to conditions affecting the Work.

.106 INTERPRETATION OF DOCUMENTS

A. If any person contemplating submitting a proposal for the proposed Contract is in doubt as to the meaning of any part of the Drawings, Specifications (Project Manual), or other proposed Contract Documents, he may submit to the Architect, not later than ten (10) working days prior to the date set for opening bids, a written request for an interpretation or clarification. Proposers should act promptly and allow sufficient time for a reply to reach them before preparing their bids.

Any interpretation or clarification will be in the form of an Addendum duly issued. No alleged verbal interpretation or rulings will be held binding upon the Owner.

.107 SUBSTITUTIONS

A. Conditions governing the submission of substitutions for specific materials, products, equipment and processes are in the General Conditions and the Supplementary Conditions. Requests for substitutions must be received by the Architect/Engineer ten (10) working days prior to the established bid date.

.108 ADDENDA

A. Interpretations, clarifications, additions, deletions, and modifications to the Documents during the Bidding period will be issued in the form of Addenda and a copy of such Addenda will be mailed or delivered to each person who has been issued a set of the Proposal Documents. Addenda will be a part of the Proposal Documents and the Contract Documents, and receipt of them shall be acknowledged in the Form of Proposal.

.109 COMPLETION TIME

A. The Time of Completion is indicated on the Form of Proposal.

.110 CERTIFICATE OF RESPONSIBILITY

A. All bids submitted in excess of $50,000.00 by a prime or subcontractor to do any erection, building, construction, repair, maintenance or related work, must comply with Section 31-3-21, Mississippi Code of 1972, by securing a Certificate of Responsibility from the State Board of Public Contractors. Where applicable, the foregoing certificate number must be indicated on the exterior of the sealed bid envelope before it can be opened. When bids are submitted electronically, the requirement for including a certificate of responsibility, or a statement that the bid enclosed does not exceed Fifty Thousand Dollars ($50,000.00) on the exterior of the bid envelope shall be deemed in compliance by including the same information as an attachment with the electronic bid submittal. Provide cover sheet with the following information:

Pascagoula Public Library
Repairs and Renovations
Contractor's Name and Address
Certificate of Responsibility No. ####
FORM OF PROPOSAL ATTACHED

.111 MODIFICATION AND WITHDRAWAL OF BIDS

A. Prior to the time set for submission of bids, bids may be withdrawn or modified. Bids may be modified only on the official Form of Proposal

and must be signed by a person legally empowered to bind the proposal.

.112 DISQUALIFICATION

A. The Owner reserves the right to disqualify bids, before or after the opening, upon evidence of collusion with intent to defraud or other illegal practices relating to this proposal upon the part of the Proposer.

.113 SUBMISSION OF POST-PROPOSAL INFORMATION

A. Upon notification of acceptance the selected Contractor shall within fifteen (15) days, submit the following:
   1. A Schedule of Values for each major item of Work included in the Proposal.
   2. A designation of the portions of the Work proposed to be performed by the Contractor with his own force.
   3. A list of names of the subcontractors or other persons or organizations, including those who are to furnish materials and equipment fabricated to a special design proposed for such portions of the Work as may be designated in the Bidding Documents or as may be requested by the Architect/Engineer. The Contractor will be required to establish to the satisfaction of the Owner and the Architect the reliability and responsibility of the proposed Subcontractors and suppliers to furnish and perform the Work.

.114 AWARD

A. The Owner reserves the right to accept any or to reject any and all bids without compensation to proposers and to waive irregularities and informalities. The Architect, in making his recommendation, will consider the following elements:
   1. Whether the Contractor has experience in the type of work involved.
   2. Whether the Contractor has adequate plant, equipment and personnel to perform the work properly and expeditiously.
   3. Whether the Contractor has a suitable financial status and reputation for meeting obligations incident to work of the kind specified.
   4. Whether the proposal price is reasonable and equitable in relation to the Owner's needs and the extent of the work involved. The successful Contractor will be required to enter into a contract with the Owner within seven (7) days of notice by the Owner that his bid has been accepted. Failure to enter into contract within the established time limit without proper justification shall be considered grounds for forfeiture of the bid bond.

.115 LIQUIDATED DAMAGES

A. The successful Contractor by entering into a contract for the construction of the project described in this specification, hereby agrees

to be subject to the assessment of Liquidated Damages in the amount set forth in the Form of Proposal PER DIEM that the project remains unacceptable for substantial completion.

.116 FORM OF CONTRACT

A. The contract for the construction of the project shall be AIA Document A101.

.117 BONDS

A. A Performance Bond and Labor and Material Payment Bond will be required by the Owner. Refer to the supplementary conditions for additional information.

.118 BID SECURITY

A. Each proposal must be accompanied by Cashier's or Certified Check of the proposer, or a bid bond accompanied with the form of bid bond attached herein, duly executed by the bidder as principal and having as surety thereon a surety company approved by the Owner in the amount of 5% of the bid. Electronic bids must be secured with a bid bond. Such checks or bid bonds will be returned to all except the three lowest proposers within three (3) days after the opening of bids, and the remaining checks or bid bonds will be returned promptly after the Owner has made an award of contract, or, if no award has been made within Sixty (60) days after the date of the opening of bids, upon demand of the bidder at any time thereafter, so long as he has not been notified of the acceptance of his proposal.

END OF DIVISION

AIA® Document A201™ - 2017

General Conditions of the Contract for Construction

for the following PROJECT:
(Name and location or address)

Pascagoula Public Library
Repairs and Renovations

THE OWNER:
(Name, legal status and address)

Jackson County Board of Supervisors
PO Box 998
Pascagoula, MS 39568

THE ARCHITECT:
(Name, legal status and address)

Allred Stolarski Architects, PA
711 Church Street
Ocean Springs, MS 39564

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

For guidance in modifying this document to include supplementary conditions, see AIA Document A503™, Guide for Supplementary Conditions.

TABLE OF ARTICLES

Init.

INDEX
(Topics and numbers in bold are Section headings.)

ARTICLE 1 GENERAL PROVISIONS

§ 1.1 Basic Definitions

§ 1.1.1 The Contract Documents

The Contract Documents are enumerated in the Agreement between the Owner and Contractor (hereinafter the Agreement) and consist of the Agreement, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, Addenda issued prior to execution of the Contract, other documents listed in the Agreement, and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a Construction Change Directive, or (4) a written order for a minor change in the Work issued by the Architect. Unless specifically enumerated in the Agreement, the Contract Documents do not include the advertisement or invitation to bid, Instructions to Bidders, sample forms, other information furnished by the Owner in anticipation of receiving bids or proposals, the Contractor's bid or proposal, or portions of Addenda relating to bidding or proposal requirements.

§ 1.1.2 The Contract

The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations, or agreements, either written or oral. The Contract may be amended or modified only by a Modification. The Contract Documents shall not be construed to create a contractual relationship of any kind (1) between the Contractor and the Architect or the Architect's consultants, (2) between the Owner and a Subcontractor or a Sub-subcontractor, (3) between the Owner and the Architect or the Architect's consultants, or (4) between any persons or entities other than the Owner and the Contractor. The Architect shall, however, be entitled to performance and enforcement of obligations under the Contract intended to facilitate performance of the Architect's duties.

§ 1.1.3 The Work

The term "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment, and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

§ 1.1.4 The Project

The Project is the total construction of which the Work performed under the Contract Documents may be the whole or a part and which may include construction by the Owner and by Separate Contractors.

§ 1.1.5 The Drawings

The Drawings are the graphic and pictorial portions of the Contract Documents showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules, and diagrams.

§ 1.1.6 The Specifications

The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the Work, and performance of related services.

§ 1.1.7 Instruments of Service

Instruments of Service are representations, in any medium of expression now known or later developed, of the tangible and intangible creative work performed by the Architect and the Architect' s consultants under their respective professional services agreements. Instruments of Service may include, without limitation, studies, surveys, models, sketches, drawings, specifications, and other similar materials.

§ 1.1.8 Initial Decision Maker

The Initial Decision Maker is the person identified in the Agreement to render initial decisions on Claims in accordance with Section 15.2. The Initial Decision Maker shall not show partiality to the Owner or Contractor and shall not be liable for results of interpretation or decisions rendered in good faith.

§ 1.2 Correlation and Intent of the Contract Documents

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

§ **1.2.1.1** The invalidity of any provision of the Contract Documents shall not invalidate the Contract or its remaining provisions. If it is determined that any provision of the Contract Documents violates any law, or is otherwise invalid or unenforceable, then that provision shall be revised to the extent necessary to make that provision legal and enforceable. In such case the Contract Documents shall be construed, to the fullest extent permitted by law, to give effect to the parties' intentions and purposes in executing the Contract.

§ **1.2.2** Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade.

§ **1.2.3** Unless otherwise stated in the Contract Documents, words that have well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings.

§ 1.3 Capitalization

Terms capitalized in these General Conditions include those that are (1) specifically defined, (2) the titles of numbered articles, or (3) the titles of other documents published by the American Institute of Architects.

§ 1.4 Interpretation

In the interest of brevity the Contract Documents frequently omit modifying words such as " all" and "any" and articles such as "the" and "an," but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

§ 1.5 Ownership and Use of Drawings, Specifications, and Other Instruments of Service

§ **1.5.1** The Architect and the Architect's consultants shall be deemed the authors and owners of their respective Instruments of Service, including the Drawings and Specifications, and retain all common law, statutory, and other reserved rights in their Instruments of Service, including copyrights. The Contractor, Subcontractors, Sub-subcontractors, and suppliers shall not own or claim a copyright in the Instruments of Service, Submittal or distribution to meet official regulatory requirements or for other purposes in connection with the Project is not to be construed as publication in derogation of the Architect's or Architect's consultants' reserved rights.

§ **1.5.2** The Contractor, Subcontractors, Sub-subcontractors, and suppliers are authorized use and reproduce the Instruments of Service provided to them, subject to any protocols established pursuant to Sections 1.7 and 1.8, solely and exclusively for execution of the Work. All copies made under this authorization shall bear the copyright notice, if any, shown on the Instruments of Service. The Contractor, Subcontractors, Sub-subcontractors, and suppliers may not use the Instruments of Service on other projects or for additions to the Project outside the scope of the Work without the specific written consent of the Owner, Architect, and the Architect's consultants.

§ 1.6 Notice

§ **1.6.1** Except as otherwise provided in Section 1.6.2, where the Contract Documents require one party to notify or give notice to the other party, such notice shall be provided in writing to the designated representative of the party to whom the notice is addressed and shall be deemed to have been duly served if delivered in person, by mail, by courier, or by electronic transmission if a method for electronic transmission is set forth in the Agreement.

§ **1.6.2** Notice of Claims as provided in Section 15.1.3 shall be provided in writing and shall be deemed to have been duly served only if delivered to the designated representative of the party to whom the notice is addressed by certified or registered mail, or by courier providing proof of delivery.

§ 1.7 Digital Data Use and Transmission

The parties shall agree upon protocols governing the transmission and use of Instruments of Service or any other information or documentation in digital form. The parties will use AIA Document E203™-2013, Building Information Modeling and Digital Data Exhibit, to establish the protocols for the development, use, transmission, and exchange of digital data.

§ 1.8 Building Information Models Use and Reliance

Any use of, or reliance on, all or a portion of a building information model without agreement to protocols governing the use of, and reliance on, the information contained in the model and without having those protocols set forth in AIA Document E203™- 2013, Building Information Modeling and Digital Data Exhibit, arid the requisite AIA Document G202™-20l3, Project Building Information Modeling Protocol Form, shall be at the using or relying party's sole risk

and without liability to the other party and its contractors or consultants, the authors of, or contributors to, the building information model, and each of their agents and employees.

ARTICLE 2 OWNER

§ 2.1 General

§ **2.1.1** The Owner is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Owner shall designate in writing a representative who shall have express authority to bind the Owner with respect to all matters requiring the Owner's approval or authorization. Except as otherwise provided in Section 4.2.1, the Architect does not have such authority. The term "Owner" means the Owner or the Owner's authorized representative.

§ 2.1.2 The Owner shall furnish to the Contractor, within fifteen days after receipt of a written request, information necessary and relevant for the Contractor to evaluate, give notice of, or enforce mechanic's lien rights. Such information shall include a correct statement of the record legal title to the property on which the Project is located, usually referred to as the site, and the Owner's interest therein.

§ 2.2 Evidence of the Owner's Financial Arrangements

§ **2.2.1** Prior to commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract. The Contractor shall have no obligation to commence the Work until the Owner provides such evidence. If commencement of the Work is delayed under this Section 2.2.1, the Contract Time shall be extended appropriately.

§ **2.2.2** Following commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract only if (1) the Owner fails make payments to the Contractor as the Contract Documents require; 2) the Contractor identifies in writing a reasonable concern regarding the Owner's ability to make payment when due; or (3) a change in the Work materially changes the Contract Sum. If the Owner fails to provide such evidence as required, within fourteen days of the Contractor's request, the Contractor may immediately stop the Work and, in that event, shall notify the Owner that the Work has stopped. However, if the request is made because a change in the Work materially changes the Contract Sum under (3) above, the Contractor may immediately stop only that portion of the Work affected by the change until reasonable evidence is provided. If the Work is stopped under this Section 2.2.2, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shutdown, delay and start-up, plus interest as provided in the Contract Documents.

§ **2.2.3** After the Owner furnishes evidence of financial arrangements under this Section 2.2, the Owner shall not materially vary such financial arrangements without prior notice to the Contractor.

§ **2.2.4** Where the Owner has designated information furnished under this Section 2.2 as "confidential," the Contractor shall keep the information confidential and shall not disclose it to any other person. However, the Contractor may disclose "confidential" information, after seven (7) days' notice to the Owner, where disclosure is required by law, including a subpoena or other form of compulsory legal process issued by a court or governmental entity, or by court or arbitrator(s) order. The Contractor may also disclose "confidential" information to its employees, consultants, sureties, Subcontractors and their employees, Sub-subcontractors, and others who need to know the content of such information solely and exclusively for the Project and who agree to maintain the confidentiality of such information.

§ 2.3 Information and Services Required of the Owner

§ **2.3.1** Except for permits and fees that are the responsibility of the Contractor under the Contract Documents, including those required under Section 3.7.1, the Owner shall secure and pay for necessary approvals, easements, assessments and charges required for construction, use or occupancy of permanent structures or for permanent changes in existing facilities.

§ **2.3.2** The Owner shall retain an architect lawfully licensed to practice architecture, or an entity lawfully practicing architecture, in the jurisdiction where the Project is located. That person or entity is identified as the Architect in the Agreement and is referred to throughout the Contract Documents as if singular in number.

§ **2.3.3** If the employment of the Architect terminates, the Owner shall employ a successor to whom the Contractor has no reasonable objection and whose status under the Contract Documents shall be that of the Architect.

§ **2.3.4** The Owner shall furnish surveys describing physical characteristics, legal limitations and utility locations for the site of the Project, and a legal description of the site. The Contractor shall be entitled to rely on the accuracy of information furnished by the Owner but shall exercise proper precautions relating to the safe performance of the Work.

§ **2.3.5** The Owner shall furnish information or services required of the Owner by the Contract Documents with reasonable promptness. The Owner shall also furnish any other information or services under the Owner's control and relevant to the Contractor's performance of the Work with reasonable promptness after receiving Contractor's written request for such information or services.

§ **2.3.6** Unless otherwise provided in the Contract Documents, the Owner shall furnish to the Contractor one copy of the Contract Documents for purposes of making reproductions pursuant to Section 1.5.2.

§ 2.4 Owner's Right to Stop the Work

If the Contractor fails to correct Work that is not in accordance with the requirements of the Contract Documents as required by Section 12.2 or repeatedly fails to carry out Work in accordance with the Contract Documents , the Owner may issue a written order to the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however , the right of the Owner to stop the Work shall not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity, except to the extent required by Section 6.1.3.

§ 2.5 Owner's Right to Carry Out the Work

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a ten-day period after receipt of notice from the Owner to commence and continue correction of such default or neglect with diligence and promptness , the Owner may, without prejudice to other remedies the Owner may have, correct such default or neglect. Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Architect and the Architect may, pursuant to Section 9.5.1, withhold or nullify a Certificate for Payment in whole or in part, to the extent reasonably necessary to reimburse the Owner for the reasonable cost of correcting such deficiencies, including Owner's expenses and compensation for the Architect's additional services made necessary by such default, neglect, or failure. If current and future payments are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner. If the Contractor disagrees with the actions of the Owner or the Architect, or the amounts claimed as costs to the Owner, the Contractor may file a Claim pursuant to Article 15.

ARTICLE 3 CONTRACTOR

§ 3.1 General

§ **3.1.1** The Contractor is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Contractor shall be lawfully licensed, if required in the jurisdiction where the Project is located. The Contractor shall designate in writing a representative who shall have express authority to bind the Contractor with respect to all matters under this Contract. The term "Contractor" means the Contractor or the Contractor's authorized representative.

§ **3.1.2** The Contractor shall perform the Work in accordance with the Contract Documents.

§ **3.1.3** The Contractor shall not be relieved of its obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Architect in the Architect's administration of the Contract, or by tests, inspections or approvals required or performed by persons or entities other than the Contractor.

§ 3.2 Review of Contract Documents and Field Conditions by Contractor

§ **3.2.1** Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become generally familiar with local conditions under which the Work is to be performed, and correlated personal observations with requirements of the Contract Documents

§ **3.2.2** Because the Contract Documents are Complementary, the Contractor shall, before starting each portion of the Work, carefully study and compare the various Contract Documents relative to that portion of the Work, as well as the information furnished by the Owner pursuant to Section 2.3.4, shall take field measurements of any existing conditions related to that portion of the Work, and shall observe any conditions at the site affecting it. These obligations are for the purpose of facilitating coordination and construction by the Contractor arid are not for the purpose of discovering errors, omissions, or inconsistencies in the Contract Documents; however, the Contractor shall promptly report to the Architect any errors, inconsistencies or omissions discovered by or made known to the Contractor as a request for information in

such form as the Architect may require. It is recognized that the Contractor's review is made in the Contractor's capacity as a contractor and not as a licensed design professional, unless otherwise specifically provided in the Contract Documents.

§ **3.2.3** The Contractor is not required to ascertain that the Contract Documents are in accordance with applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, but the Contractor shall promptly report to the Architect any nonconformity discovered by or made known to the contractor as a request for information in such form as the Architect may require.

§ **3.2.4** If the Contractor believes that additional cost or time is involved because of clarifications or instructions the Architect issues in response to the Contractor's notices or requests for information pursuant to Sections 3.2.2 or 3.2.3, the Contractor shall submit Claims as provided in Article 15. If the Contractor fails to perform the obligations of Sections 3.2.2 or 3.2.3, the Contractor shall pay such costs and damages to the Owner, subject to Section 15.1.7, as would have been avoided if the Contractor had performed such obligations. If the Contractor performs those obligations, the Contractor shall not be liable to the Owner or Architect for damages resulting from errors, inconsistencies or omissions in the Contract Documents, for differences between field measurements or conditions and the Contract Documents, or for nonconformities of the Contract Documents to applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities.

§ 3.3 Supervision and Construction Procedures

§ **3.3.1** The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. The Contractor shall be solely responsible for, and have control over, construction means, methods, techniques, sequences, and procedures, and for coordinating all portions of the Work under the Contract. If the Contract Documents give specific instructions concerning construction means, methods, techniques, sequences, or procedures, the Contractor shall evaluate the jobsite safety thereof and shall be solely responsible for the jobsite safety of such means, methods, techniques, sequences, or procedures. If the Contractor determines that such means, methods, techniques, sequences or procedures may not be safe, the Contractor shall give timely notice to the Owner and Architect, and shall propose alternative means, methods, techniques, sequences, or procedures. The Architect shall evaluate the proposed alternative solely for conformance with the design intent for the completed construction. Unless the Architect objects to the Contractor's proposed alternative, the Contractor shall perform the Work using its alternative means, methods, techniques, sequences, or procedures.

§ **3.3.2** The Contractor shall be responsible to the Owner for acts and omissions of the Contractor's employees, Subcontractors and their agents and employees, and other persons or entities performing portions of the Work for, or on behalf of, the Contractor or any of its Subcontractors.

§ **3.3.3** The Contractor shall be responsible for inspection of portions of Work already performed to determine that such portions are in proper condition to receive subsequent Work.

§ 3.4 Labor and Materials

§ **3.4.1** Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools; construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

§ **3.4.2** Except in the case of minor changes in the Work approved by the Architect in accordance with Section 3.12.8 or ordered by the Architect in accordance with Section 7.4, the Contractor may make substitutions only with the consent of the Owner, after evaluation by the Architect and in accordance with a Change Order or Construction Change Directive.

§ **3.4.3** The Contractor shall enforce strict discipline and good order among the Contractor's employees and other persons carrying out the Work. The contractor shall not permit employment of unfit persons or persons not properly skilled in tasks assigned to them.

§ 3.5 Warranty

§ **3.5.1** The Contractor warrants to the Owner and Architect that materials and equipment furnished under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise. The Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects, except for those inherent in the quality of the Work the Contract Documents require or permit. Work, materials, or

equipment not conforming to these requirements may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, alterations to the Work not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage. If required by the Architect, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

§ **3.5.2** All material, equipment, or other special warranties required by the Contract Documents shall be issued in the name of the Owner, or shall be transferable to the Owner, and shall commence in accordance with Section 9.8.4.

§ 3.6 Taxes

The Contractor shall pay sales, consumer, use and similar taxes for the Work provided by the Contractor that are legally enacted when bids are received or negotiations concluded, whether or not yet or merely scheduled to go into effect.

§ 3.7 Permits, Fees, Notices and Compliance with Laws

§ **3.7.1** Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for the building permit as well as for other permits, fees, licenses, and inspections by government agencies necessary for proper execution and completion of the Work that are customarily secured after execution of the Contract and legally required at the time bids are received or negotiations concluded.

§ **3.7.2** The Contractor shall comply with and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities applicable to performance of the Work.

§ **3.7.3** If the Contractor performs Work knowing it to be contrary to applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction.

§ 3.7.4 Concealed or Unknown Conditions

If the Contractor encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the Contractor shall promptly provide notice to the Owner and the Architect before conditions are disturbed and in no event later than 14 days after first observance of the conditions. The Architect will promptly investigate such conditions and if the Architect determines that they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will recommend that an equitable adjustment be made in the Contract Sum or Contract Time, or both. If the Architect determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Architect shall promptly notify the Owner and Contractor, stating the reasons. If either party disputes the Architect's determination or recommendation, that party may submit a Claim as provided in Article 15.

§ 3.7.5 If, in the course of the Work, the Contractor encounters human remains or recognizes the existence of burial markers, archaeological sites or wetlands not indicated in the Contract Documents, the Contractor shall immediately suspend any operations that would affect them and shall notify the Owner and Architect. Upon receipt of such notice, the Owner shall promptly take any action necessary to obtain governmental authorization required to resume the operations. The Contractor shall continue to suspend such operations until otherwise instructed by the Owner but shall continue with all other operations that do not affect those remains or features. Requests for adjustments in the Contract Sum and Contract Time arising from the existence of such remains or features may be made as provided in Article 15.

§ 3.8 Allowances

§ **3.8.1** The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct, but the Contractor shall not be required to employ persons or entities to whom the Contractor has reasonable objection.

§ **3.8.2** Unless otherwise provided in the Contract Documents,

.1 allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;

.2 Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit, and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum but not in the allowances; and

.3 whenever costs are more than or less than allowances, the Contract Sum shall be adjusted accordingly by Change Order. The amount of the Change Order shall reflect (1) the difference between actual costs and the allowances under Section 3.8.2.1 and (2) changes in Contractor's costs under Section 3.8.2.2.

§ **3.8.3** Materials and equipment under an allowance shall be selected by the Owner with reasonable promptness.

§ **3.9 Superintendent**

§ **3.9.1** The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project site during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor.

§ **3.9.2** The Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the name and qualifications of a proposed superintendent. Within 14 days of receipt of the information, the Architect may notify the Contractor, stating whether the Owner or the Architect (1) has reasonable objection to the proposed superintendent or (2) requires additional time for review. Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.

§ **3.9.3** The Contractor shall not employ a proposed superintendent to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not change the superintendent without the Owner's consent, which shall not unreasonably be withheld or delayed.

§ **3.10 Contractor's Construction and Submittal Schedules**

§ **3.10.1** The Contractor, promptly after being awarded the Contract, shall submit for the Owner' s and Architect's information a Contractor's construction schedule for the Work. The schedule shall contain detail appropriate for the Project, including (1) the date of commencement of the Work, interim schedule milestone dates, and the date of Substantial Completion; (2) an apportionment of the Work by construction activity; and (3) the time required for completion of each portion of the Work. The schedule shall provide for the orderly progression of the Work to completion and shall not exceed time limits current under the Contract Documents. The schedule shall be revised at appropriate intervals as required by the conditions of the Work and Project.

§ **3.10.2** The Contractor, promptly after being awarded the Contract and thereafter as necessary to maintain a current submittal schedule, shall submit a submittal schedule for the Architect's approval. The Architect's approval shall not be unreasonably delayed or withheld. The submittal schedule shall (1) be coordinated with the Contractor's construction schedule, and (2) allow the Architect reasonable time to review submittals. If the Contractor fails to submit a submittal schedule, or fails to provide submittals in accordance with the approved submittal schedule, the Contractor shall not be entitled to any increase in Contract Sum or extension of Contract Time based on the time required for review of submittals.

§ **3.10.3** The Contractor shall perform the Work in general accordance with the most recent schedules submitted to the Owner and Architect.

§ **3.11 Documents and Samples at the Site**

The Contractor shall make available, at the Project site, the Contract Documents, including Change Orders, Construction Change Directives, and other Modifications, in good order and marked currently to indicate field changes and selections made during construction, and the approved Shop Drawings, Product Data, Samples, and similar required submittals. These shall be in electronic form or paper copy, available to the Architect and Owner, and delivered to the Architect for submittal to the Owner upon completion of the Work as a record of the Work as constructed.

§ **3.12 Shop Drawings, Product Data and Samples**

§ **3.12.1** Shop Drawings are drawings, diagrams, schedules, and other data specially prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the Work.

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

§ **3.12.3** Samples are physical examples that illustrate materials, equipment, or workmanship, and establish standards by which the Work will be judged.

§ **3.12.4** Shop Drawings, Product Data, Samples, and similar submittals are not Contract Documents. Their purpose is to demonstrate how the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents for those portions of the Work for which the Contract Documents require submittals. Review by the Architect is subject to the limitations of Section 4.2.7. Informational submittals upon which the Architect is not expected to take responsive action may be so identified in the Contract Documents. Submittals that are not required by the Contract Documents may be returned by the Architect without action.

§ **3.12.5** The Contractor shall review for compliance with the Contract Documents, approve, and submit to the Architect, Shop Drawings, Product Data, Samples, and similar submittals required by the Contract Documents, in accordance withthe submittal schedule approved by the Architect or, in absence of an approved submittal schedule, with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of Separate Contractors.

§ **3.12.6** By submitting Shop Drawings, Product Data, Samples, and similar submittals, the Contractor represents to the Owner and Architect that the Contractor has (1) reviewed and approved them, (2) determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and (3) checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

§ **3.12.7** The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples, or similar submittals, until the respective submittal has been approved by the Architect

§ **3.12.8** The Work shall be in accordance with submittals except that the Contractor shall not be relieved of responsibility for deviations from the requirements of the Contract Documents by the Architect's approval of Shop Drawings, Product Data, Samples, or similar submittals, unless the contractor has specifically notified the Architect of such deviation at the time of submittal and (1) the Architect has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or similar submittals, by the Architect's approval thereof.

§ **3.12.9** The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples, or similar submittals, to revisions other than those requested by the Architect on previous submittals. In the absence of such notice, the Architect's approval of a resubmission shall not apply to such revisions.

§ **3.12.10** The Contractor shall not be required to provide professional services that constitute the practice of architectureor engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures. The Contractor shall not be required to provide professional services in violation of applicable law.

§ **3.12.10.1** If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of the Contractor by the Contract Documents, the Owner and the Architect will specify all performance and design criteria that such services must satisfy. The Contractor shall be entitled to rely upon the adequacy and accuracy of the performance and design criteria provided in the Contract Documents. The Contractor shall cause such services or certifications to be provided by an appropriately licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings, 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 the Architect. The Owner and the Architect shall be entitled to rely upon the adequacy and accuracy of the services, certifications, and approvals performed or provided by such design professionals, provided the Owner and Architect have specified to the Contractor the performance and design criteria that such services must satisfy. Pursuant to this Section 3.12.10, the Architect will review and approve or take other appropriate action on submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents.

§ **3.12.10.2** If the Contract Documents require the Contractor's design professional to certify that the Work has been performed in accordance with the design criteria, the Contractor shall furnish such certifications to the Architect at the time and in the form specified by the Architect.

§ **3.13 Use of Site**
The Contractor shall confine operations at the site to areas permitted by applicable laws, statutes, ordinances, codes, rules and regulations, lawful orders of public authorities, and the Contract Documents and shall not unreasonably encumber the site with materials or equipment.

§ **3.14 Cutting and Patching**
§ **3.14.1** The Contractor shall be responsible for cutting, fitting, or patching required to complete the Work or to make its parts fit together properly. All areas requiring cutting, fitting, or patching shall be restored to the condition existing prior to the cutting, fitting, or patching, unless otherwise required by the Contract Documents.

§ **3.14.2** The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or Separate Contractors by cutting, patching, or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter construction by the Owner or a Separate Contractor except with written consent of the Owner and of the Separate Contractor. Consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold, from the Owner or a Separate Contractor, its consent to cutting or otherwise altering the Work.

§ **3.15 Cleaning Up**
§ **3.15.1** The Contractor shall keep the premises and surrounding area free from accumulation of waste materials and rubbish caused by operations under the Contract. At completion of the Work, the Contractor shall remove waste materials, rubbish, the Contractor's tools, construction equipment, machinery, and surplus materials from and about the Project.

§ **3.15.2** If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and the Owner shall be entitled to reimbursement from the Contractor.

§ **3.16 Access to Work**
The Contractor shall provide the Owner and Architect with access to the Work in preparation and progress wherever located.

§ **3.17 Royalties, Patents and Copyrights**
The Contractor shall pay all royalties and license fees. The Contractor shall defend suits or claims for infringement of copyrights and patent rights and shall hold the Owner and Architect harmless from loss on account thereof, but shall not be responsible for defense or loss when a particular design, process, or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications, or other documents prepared by the Owner or Architect. However, if an infringement of a copyright or patent is discovered by, or made known to, the Contractor, the Contractor shall be responsible for the loss unless the information is promptly furnished to the Architect.

§ **3.18 Idemnification**
§ **3.18.1** To the fullest extent permitted by law, the Contractor shall indemnify and hold harmless the Owner, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work, provided that such claim, damage, loss, or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), but only to the extent caused by the negligent acts or omissions of the Contractor, a Subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss, or expense is caused in part by a party indemnified hereunder. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity that would otherwise exist as to a party or person described in this Section 3.18.

§ **3.18.2** In claims against any person or entity indemnified under this Section 3.18 by an employee of the Contractor, a Subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable , the indemnification obligation under Section 3.18.1 shall not be limited by a limitation on amount or type of damages,

compensation, or benefits payable by or for the Contractor or a Subcontractor under workers' compensation acts, disability benefit acts, or other employee benefit acts.

ARTICLE 4 ARCHITECT

§ 4.1 General

§ **4.1.1** The Architect is the person or entity retained by the Owner pursuant to Section 2.3.2 and identified as such in the Agreement.

§ **4.1.2** Duties, responsibilities, and limitations of authority of the Architect as set forth in the Contract Documents shall not be restricted, modified, or extended without written consent of the Owner, Contractor, and Architect. Consent shall not be unreasonably withheld.

§ 4.2 Administration of the Contract

§ **4.2.1** The Architect will provide administration of the Contract as described in the Contract Documents and will be an Owner's representative during construction until the date the Architect issues the final Certificate for Payment. The Architect will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

§ **4.2.2** The Architect will visit the site at intervals appropriate to the stage of construction, or as otherwise agreed with the Owner, to become generally familiar with the progress and quality of the portion of the Work completed, and to determine in general if the Work observed is being performed in a manner indicating that the Work, when fully completed, will be in accordance with the Contract Documents. However, the Architect will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The Architect will not have control over, charge of, or responsibility for the construction means, methods, techniques, sequences or procedures, or for the safety precautions and programs in connection with the Work, since these are solely the Contractor's rights and responsibilities under the Contract Documents.

§ **4.2.3** On the basis of the site visits, the Architect will keep the Owner reasonably informed about the progress and quality of the portion of the Work completed, and promptly report to the Owner (1) known deviations from the Contract Documents, (2) known deviations most recent construction schedule submitted by the Contractor, and (3) defects and deficiencies observed in the Work. The Architect will not be responsible for the Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. The Architect will not have control over or charge of, and will not be responsible for acts or omissions of, the Contractor, Subcontractors, or their agents or employees, or any other persons or entities performing portions of the Work.

§ **4.2.4 Communications**

The Owner and Contractor shall include the Architect in all communications that relate to or affect the Architect' s services or professional responsibilities. The Owner shall promptly notify the Architect of the substance of any direct communications between the Owner and the Contractor otherwise relating to the Project. Communications by and with the Architect's consultants shall be through the Architect. Communications by and with Subcontractors and suppliers shall be through the Contractor. Communications by and with Separate Contractors shall be through the Owner. The Contract Documents may specify other communication protocols.

§ **4.2.5** Based on the Architect's evaluations of the Contractor's Applications for Payment, the Architect will review and certify the amounts due the Contractor and will issue Certificates for Payment in such amounts.

§ **4.2.6** The Architect has authority to reject Work that does not conform to the Contract Documents. Whenever the Architect considers it necessary or advisable, the Architect will have authority to require inspection or testing of the Work in accordance with Sections 13.4.2 and 13.4.3, whether or not the Work is fabricated, installed or completed. However, neither this authority of the architect nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Architect to the Contractor, Subcontractors, suppliers, their agents or employees, or other persons or entities performing portions of the Work.

§ **4.2.7** The Architect will review and approve, or take other appropriate action upon, the Contractor's submittals such as Shop Drawings, Product Data, and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Architect's action will be taken in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness while allowing sufficient time in the Architect's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of

other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect's review of the Contractor's submittals shall not relieve the Contractor of the obligations under Sections 3.3, 3.5, and 3.12. The Architect's review shall not constitute approval of safety precautions or of any construction means, methods, techniques, sequences, or procedures. The Architect's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

§ **4.2.8** The Architect will prepare Change Orders and Construction Change Directives, and may order minor changes in the Work as provided in Section 7.4. The Architect will investigate and make determinations and recommendations regarding concealed and unknown conditions as provided in Section 3.7.4.

§ **4.2.9** The Architect will conduct inspections to determine the date or dates of Substantial Completion and the date of final completion; issue Certificates of Substantial Completion pursuant to Section 9.8; receive and forward to the Owner, for the Owner's review and records, written warranties and related documents required by the Contract and assembled by the Contractor pursuant to Section 9.10; and issue a final Certificate for Payment pursuant to Section 9.10.

§ **4.2.10** If the Owner and Architect agree, the Architect will provide one or more Project representatives to assist in carrying out the Architect's responsibilities at the site. The Owner shall notify the Contractor of any change in the duties, responsibilities and limitations of authority of the Project representatives.

§ **4.2.11** The Architect will interpret and decide matters concerning performance under, and requirements of, the Contract Documents on written request of either the Owner or Contractor. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness.

§ **4.2.12** Interpretations and decisions of the Architect will be consistent with the intent of, and reasonably inferable from, the Contract Documents and will be in writing in the form of drawings. When making such interpretations and decisions, the Architect will endeavor to secure faithful performance by both Owner and Contractor, will not show partiality to either, and will not be liable for results of interpretations or decisions rendered in good faith.

§ **4.2.13** The Architect's decisions on matters relating to aesthetic effect will be final if consistent with the intent expressed in the Contract Documents.

§ **4.2.14** The Architect will review and respond to requests for information about the Contract Documents. The Architect ' s response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness. If appropriate, the Architect will prepare and issue supplemental Drawings and Specifications in response to the requests for information.

ARTICLE 5 SUBCONTRACTORS

§ **5.1 Definitions**

§ **5.1.1** A Subcontractor is a person or entity who has a direct contract with the Contractor to perform a portion of the Work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" does not include a Separate Contractor or the subcontractors of a Separate Contractor.

§ **5.1.2** A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site. The term "Sub-subcontractor is referred to throughout the Contract Documents, as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

§ **5.2.2 Award of Subcontracts and Other Contracts for Portions of the Work**

§ **5.2.1** Unless otherwise stated in the Contract Documents, the Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the persons or entities proposed for each principal portion of the Work, including those who are to furnish materials or equipment fabricated to a special design. Within 14 days of receipt of the information, the Architect may notify the Contractor whether the Owner or the Architect (1) has reasonable objection to any such proposed person or entity or (2) requires additional time for review. Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.

§ **5.2.2** The Contractor shall not contract with a proposed person or entity to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not be required to contract with anyone to whom the Contractor has made reasonable objection.

§ **5.2.3** If the Owner or Architect has reasonable objection to a person or entity proposed by the Contractor, the Contractor shall propose another to whom the Owner or Architect has no reasonable objection. If the proposed but rejected Subcontractor was reasonably capable of performing the Work, the Contract Sum and Contract Time shall be increased or decreased by the difference, if any, occasioned by such change, and an appropriate Change Order shall be issued before commencement of the substitute Subcontractor's Work. However, no increase in the Contract Sum or Contract Time shall be allowed for such change unless the Contractor has acted promptly and responsively in submitting names as required.

§ **5.2.4** The Contractor shall not substitute a Subcontractor, person, or entity for one previously selected if the Owner or Architect makes reasonable objection to such substitution.

§ **5.3 Subcontractual Relations**

By appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities, including the responsibility for safety of the Subcontractor's Work that the Contractor, by these Contract Documents, assumes toward the Owner and Architect. Each subcontract agreement shall preserve and protect the rights of the Owner and Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies, and redress against the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The contractor shall make available to each proposed Subcontractor, prior

§ **5.4 Contingent Assignment of Subcontracts**

§ **5.4.1** Each subcontract agreement for a portion of the Work is assigned by the Contractor to the Owner, provided that

- **.1** assignment is effective only after termination of the Contract by the Owner for cause pursuant to Section 14.2 and only for those subcontract agreements that the Owner accepts by notifying the Subcontractor and Contractor; and
- **.2** assignment is subject to the prior rights of the surety, if any, obligated under bond relating to the Contract.

When the Owner accepts the assignment of a subcontract agreement, the Owner assumes the Contractor's rights and obligations under the subcontract.

§ **5.4.2** Upon such assignment, if the Work has been suspended for more than 30 days, the Subcontractor's compensation shall be equitably adjusted for increases in cost resulting from the suspension.

§ **5.4.3** Upon assignment to the Owner under this Section 5.4, the Owner may further assign the subcontract to a successor contractor or other entity. If the Owner assigns the subcontract to a successor contractor or other entity, the Owner shall nevertheless remain legally responsible for all of the successor contractor's obligations under the subcontract.

ARTICLE 6 CONSTRUCTION OWNER OR BY SEPARATE CONTRACTORS

§ **6.1 Owner's Right to Perform Construction and to Award Separate Contracts**

§ **6.1.1** The term "Separate Contractor(s)" shall mean other contractors retained by the Owner under separate agreements. The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and with Separate Contractors retained under Conditions of the Contract substantially similar to those of this Contract, including those provisions of the Conditions of the Contract related to insurance and waiver of subrogation.

§ **6.1.2** When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Owner-Contractor Agreement.

§ **6.1.3** The Owner shall provide for coordination of the activities of the Owner's own forces and of each Separate Contractor with the Work of the Contractor, who shall cooperate with them. The Contractor shall participate with any Separate Contractors and the Owner in reviewing their construction schedules. The Contractor shall make any revisions to its construction schedule deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, Separate Contractors, and the Owner until subsequently revised.

§ **6.1.4** Unless otherwise provided in the Contract Documents, when the Owner performs construction or operations related to the Project with the Owner's own forces or with Separate Contractors, the Owner or its Separate Contractors shall have the same obligations and rights that the Contractor has under the Conditions of the Contract, including, without excluding others, those stated in Article 3, this Article 6, and Articles 10, 11, and 12.

§ **6.2 Mutual Responsibility**

§ **6.2.1** The Contractor shall afford the Owner and Separate Contractors reasonable opportunity for introduction and storage of their materials and equipment and performance of their activities, and shall connect and coordinate the Contractor's construction and operations with theirs as required by the Contract Documents.

§ **6.2.2** If part of the Contractor's Work depends for proper execution or results upon construction or operations by the Owner or a Separate Contractor, the Contractor shall, prior to proceeding with that portion of the Work, promptly notify the Architect of apparent discrepancies or defects in the construction or operations by the Owner or Separate Contractor that would render it unsuitable for proper execution and results of the Contractor's Work. Failure of the Contractor to notify the Architect of apparent discrepancies or defects prior to proceeding with the Work shall constitute an acknowledgment that the Owner's or Separate Contractor's completed or partially completed construction is fit and proper to receive the Contractor's Work. The Contractor shall not be responsible for discrepancies or defects in the construction or operations by the Owner or Separate Contractor that are not apparent.

§ **6.2.3** The Contractor shall reimburse the Owner for costs the Owner incurs that are payable to a Separate Contractor because of the Contractor's delays, improperly timed activities or defective construction. The Owner shall be responsible to the Contractor for costs the Contractor incurs because of a Separate contractor's delays, improperly timed activities, damage to the Work or defective construction.

§ **6.2.4** The Contractor shall promptly remedy damage that the Contractor wrongfully causes to completed or partially completed construction or to property of the Owner or Separate Contractor as provided in Section 10.2.5.

§ **6.2.5** The Owner and each Separate Contractor shall have the same responsibilities for cutting and patching as are described for the Contractor in Section 3.14.

§ **6.3 Owner's Right to Clean Up**

If a dispute arises among the Contractor, Separate Contractors, and the Owner as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, the Owner may clean up and the Architect will allocate the cost among those responsible.

ARTICLE 7 CHANGES IN THE WORK

§ **7.1 General**

§ **7.1.1** Changes in the Work may be accomplished after execution of the Contract, and without invalidating the Contract, by Change Order, Construction Change Directive or order for a minor change in the Work, subject to the limitations stated in this Article 7 and elsewhere in the Contract Documents.

§ **7.1.2** A Change Order shall be based upon agreement among the Owner, Contractor, and Architect. A Construction Change Directive requires agreement by the Owner and Architect and may or may not be agreed to by the Contractor. An order for a minor change in the Work may be issued by the Architect. alone

§ **7.1.3** Changes in the Work shall be performed under applicable provisions of the Contract Documents. The Contractor shall proceed promptly with changes in the Work, unless otherwise provided in the Change Order, Construction Change Directive, or order for a minor change in the Work.

§ **7.2. Change Orders**

§ **7.2.1** A Change Order is a written instrument prepared by the Architect and signed by the Owner, Contractor, and Architect stating their agreement upon all of the following:

red by the Architect and signed by the Owner, Contractor, and Architect stating their agreement upon all of the following:

- **.1** The change in the Work;
- **.2** The amount of the adjustment, if any, in the Contract Sum; and
- **.3** The extent of the adjustment, if any, in the Contract Time.

§ **7.3 Construction Change Directives**

§ **7.3.1** A Construction Change Directive is a written order prepared by the Architect and signed by the Owner and Architect, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Owner may be Construction Change Directive, without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions, or other revisions, the Contract Sum and Contract Time being adjusted accordingly.

§ **7.3.2** A Construction Change Directive shall be used in the absence of total agreement on the terms of a Change Order.

§ **7.3.3** If the Construction Change Directive provides for an adjustment to the Contract Sum, the adjustment shall be based on one of the following methods:

- **.1** Mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;
- **.2** Unit prices stated in the Contract Documents or subsequently agreed upon;
- **.3** Cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee; or
- **.4** As provided in Section 7.3.4.

§ **7.3.4** If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Architect shall determine the adjustment on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, an amount for overhead and profit as set forth in the Agreement, or if no such amount is set forth in the Agreement, a reasonable amount. In such case, and also under Section 7.3.3.3, the Contractor shall keep and present, in such form as the Architect may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provide in the Contract Documents, costs for the purposes of this Sceion 7.3.4 shall be limited to the following:

- **.1** Costa of labor, including applicable payroll taxes, fringe benefits required by agreement or custom, workers' compensation insurance, and other employee costs approved by the Architect;
- **.2** Costs of materials, supplies, and equipment, including cost of transportation, whether incorporated or consumed;
- **.3** Rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others;
- **.4** Costs of premiums for all bonds and insurance, permit fees, and sales, use, or similar taxes, directly related to the change; and
- **.5** Costs of supervision and field office personnel directly attributable to the change.

§ **7.3.5** If the contractor disagrees with the adjustment in the contract Time, the contractor may make a Claim in accordance with applicable provisions of Article 15.

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

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

§ **7.3.8** The amount of credit to be allowed by the Contractor to the Owner for a deletion or change that results in a net decrease in the Contract Sum shall be actual net cost as confirmed by the Architect. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on the basis of net increase, if any, with respect to that change.

§ **7.3.9** Pending final determination of the total cost of a Construction Change Directive to the Owner, the Contractor may request payment for Work completed under the Construction Change Directive in Applications for Payment. The Architect will make an interim determination for purposes of monthly certification for payment for those costs and certify for payment the amount that the Architect determines, in the Architect's professional judgment, to be reasonably justified. The Architect's interim determination of cost shall adjust the Contract Sum on the same basis as a Change Order, subject to the right of either party to disagree and assert a Claim in accordance with Article 15.

§ **7.3.10** When the Owner and Contractor agree with a determination made by the Architect concerning the adjustments in the Contract Sum and Contract Time, or otherwise reach agreement upon the adjustments, such agreement shall be effective immediately and the Architect will prepare a Change Order. Change Orders may be issued for all or any part of a Construction Change Directive.

§ **7.4 Minor Changes in the Work**

The Architect may order minor changes in the Work that are consistent with the intent of the Contract Documents and do not involve an adjustment in the Contract Sum or an extension of the Contract Time. The Architect's order for minor changes shall be in writing. If the Contractor believes that the proposed minor change in the Work will affect the Contract Sum or Contract Time, the Contractor shall notify the Architect and shall not proceed to implement the change in the Work. If the Contractor performs the Work set forth in the Architect's order for a minor change without prior notice to the Architect that such change will affect the Contract Sum or Contract Time, the Contractor waives any adjustment to the Contract Sum or extension of the Contract Time.

ARTICLE 8 TIME

§ **8.1 Definitions**

§ **8.1.1** Unless otherwise provide Contract Time is the period of time, including authorized adjustments, allotted in the Contract Documents for Substantial Completion of the Work.

§ **8.1.2** The date of commencement of the Work is the date established in the Agreement.

§ **8.1.3** The date of Substantial Completion is the date certified by the Architect in accordance with Section 9.8.

§ **8.1.4** The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

§ **8.2 Progress and Completion**

§ **8.2.1** Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement, the Contractor confirms that the Contract Time is a reasonable period for performing the Work.

§ **8.2.2** The Contractor shall not knowingly, except by agreement or instruction of the Owner in writing, commence the Work prior to the effective date of insurance required to be furnished by the Contractor and Owner.

§ **8.2.3** The Contractor shall proceed expeditiously with adequate forces and shall achieve Substantial Completion within the Contract Time.

§ **8.3 Delays and Extensions of Time**

§ **8.3.1** If the Contractor is delayed at any time in the commencement or progress of the Work by (1) an act or neglect of the Owner or Architect, of an employee of either, or of a Separate contractor; (2) by changes ordered in the Work; (3) by labor disputes, fire, unusual delay in deliveries, unavoidable casualties, adverse weather conditions documented in accordance with Section 15.1.6.2, or other causes beyond the Contractor's control; (4) by delay authorized by the Owner pending mediation and binding dispute resolution; or (5) by other causes that the Contractor asserts, and the Architect determines, justify delay, then the Contract Time shall be extended for such reasonable time as the Architect may determine

§ **8.3.2** Claims relating to time shall be made in accordance with applicable provisions of Article 15.

§ **8.3.3** This Section 8.3 does not preclude recovery of damages for delay by either party under other provisions of the Contract Documents.

ARTICLE 9 PAYMENTS AND COMPLETION

§ 9.1 Contract Sum

§ **9.1.1** The Contract Sum is stated in the Agreement and, including authorized adjustments, is the total amount payable by the Owner to the Contractor for performance of the Work under the Contract Documents.

§ **9.1.2** If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are materially changed so that application of such unit prices to the actual quantities causes substantial inequity to the Owner or Contractor, the applicable unit prices shall be equitably adjusted.

§ 9.2 Schedule of Values

Where the Contract is based on a stipulated sum or Guaranteed Maximum Price, the Contractor shall submit a schedule of values to the Architect before the first Application for Payment, allocating the entire Contract Sum to the various portions of the Work. The schedule of values shall be prepared in the form, and supported by the data to substantiate its accuracy, required by the Architect. This schedule, unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's Applications for Payment. Any changes to the schedule of values shall be submitted to the Architect and supported by such data to substantiate its accuracy as the Architect may require, and unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's subsequent Applications for Payment.

§ 9.3 Applications for Payment

§ **9.3.1** At least ten days before the date established for each progress payment, the Contractor shall submit to the Architect an itemized Application for Payment prepared in accordance with the schedule of values, if required under Section 9.2, for completed portions of the Work. The application shall be notarized, if required, and supported by all data substantiating the Contractor's right to payment that the Owner or Architect require, such as copies of requisitions, and releases and waivers of liens from Subcontractors and suppliers, and shall reflect retainage if provided for in the Contract Documents.

§ **9.3.1.1** As provided in Section 7.3 9, such applications may include requests for payment on account of changes in the Work that have been properly authorized by Construction Change Directives, or by interim determinations of the Architect, but not yet included n Change Orders.

§ **9.3.1.2** Applications for Payment shall not include requests for payment for portions of the Work for which the Contractor does not intend to pay a Subcontractor or supplier, unless such Work has been performed by others whom the Contractor intends to pay.

§ **9.3.2** Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner' s title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance, storage, and transportation to the site, for such materials and equipment stored off the site.

§ **9.3.3** The Contractor warrants that title to all Work covered by an Application Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon of an Application for Payment all Work for which Certificates for Payment have been issued and payments received from the owner shall, to the best of the Contractor's knowledge, information, and belief, be free and clear of liens, claims security interests, or encumbrances, in favor of the Contractor, Subcontractors, suppliers, or other persons or entities that provided labor, materials, and equipment relating to the Work.

§ 9.4 Certificates for Payment

§ **9.4.1** The Architect will, within seven days after receipt of the Contractor's Application for Payment, either (1) issue to the Owner a Certificate for Payment in the full amount of the Application for Payment, with a copy to the Contractor; or (2) issue to the Owner a Certificate for Payment for such amount as the Architect determines is properly due, and notify the Contractor and Owner of the Architect's reasons for withholding certification in part as provided in Section 9.5.1; or

(3) withhold certification of the entire Application for Payment, and notify the Contractor and Owner of the Architect's reason for withholding certification in whole as provided in Section 9.5.1.

§ **9.4.2** The issuance of a Certificate for Payment will constitute a representation by the Architect to the Owner, based on the Architect's evaluation of the Work and the data in the Application for Payment, that, to the best of the Architect's knowledge, information, and belief, the Work has progressed to the point indicated, the quality of the Work is in accordance with the Contract Documents, and that the Contractor is entitled to payment in the amount certified. The foregoing representations are subject to an evaluation of the Work for conformance with Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion, and to specific qualifications expressed by the Architect. However, the issuance of a Certificate for Payment will not be a representation that the Architect has (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work; (2) reviewed construction means, methods, techniques, sequences, or procedures; (3) reviewed copies of requisitions received from Subcontractors and suppliers and other data requested by the Owner to substantiate the Contractor's right to payment; or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Sum.

§ **9.5 Decisions to Withhold Certification**

§ **9.5.1** The Architect may withhold a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect the Owner, if in the Architect's opinion the representations to the Owner required by Section 9.4.2 cannot be made. If the Architect is unable to certify payment in the amount of the Application, the Architect will notify the Contractor and Owner as provided in Section 9.4.1. If the Contractor and Architect cannot agree on a revised amount, the Architect will promptly issue a Certificate for Payment for the amount for which the Architect is able to make such representations to the Owner. The Architect may also withhold Certificate for Payment or, because of subsequently discovered evidence, may nullify the whole or a part of a Certificate for Payment previously issued, to such extent as may be necessary in the Architect's opinion to protect the Owner from loss for which the Contractor is responsible, including loss resulting from acts and omissions described in Section 3.3.2, because of

.1 defective Work not remedied;

.2 third party claims filed or reasonable evidence indicating probable filing of such claims, unless security acceptable to the Owner is provided by the Contractor;

.3 failure of the Contractor to make payments properly to Subcontractors or suppliers for labor, materials or equipment;

.4 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;

.5 damage to the Owner or a Separate Contractor;

.6 reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay; or

.7 repeated failure to carry out the Work in accordance with the Contract Documents.

§ **9.5.2** When either party disputes the Architect's decision regarding a Certificate for Payment under Section 9.5.1, in whole or in part, that party may submit a Claim in accordance with Article 15.

§ **9.5.3** When the reasons for withholding certification are removed, certification will be made for amounts previously withheld.

§ **9.5.4** If the Architect withholds certification for payment under Section 9.5.1.3, the Owner may, at its sole option, issue joint checks to the Contractor and to any Subcontractor or supplier to whom the Contractor failed to make payment for Work properly performed or material or equipment suitably delivered. If the Owner makes payments by joint check, the Owner shall notify the Architect and the Contractor shall reflect such payment on its next Application for Payment.

§ **9.6 Progress Payments**

§ **9.6.1** After the Architect had issued a Certificate for Payment, the Owner shall make payment in the manner and within the time provided in the Contract Documents, and shall so notify the Architect.

§ **9.6.2** The Contractor shall pay each Subcontractor, no later than seven days after receipt of payment from the Owner, the amount to which the Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of the Subcontractor's portion of the Work. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in a similar manner.

§ **9.6.3** The Architect will, on request, furnish to a Subcontractor, if practicable, information regarding percentages of completion or amounts applied for by the Contractor and action taken thereon by the Architect and Owner on account of portions of the Work done by such Subcontractor.

§ **9.6.4** The Owner has the right to request written evidence from the Contractor that the Contractor has properly paid Subcontractors and suppliers amounts paid by the Owner to the Contractor for subcontracted Work. If the Contractor fails to furnish such evidence within seven days, the Owner shall have the right to contact Subcontractors and suppliers to ascertain whether they have been properly paid. Neither the Owner nor Architect shall have an obligation to pay, or to see to the payment of money to, a Subcontractor or supplier, except as may otherwise be required by law.

§ **9.6.5** The Contractor's payments to suppliers shall be treated in a manner similar to that provided in Sections 9.6.2, 9.6.3 and 9.6.4.

§ **9.6.6** A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

§ **9.6.7** Unless the Contractor provides the Owner with a payment bond in the full penal sum of the Contract Sum, payments received by the Contractor for Work properly performed by Subcontractors or provided by suppliers shall be held by the Contractor for those Subcontractors or suppliers who performed Work or furnished materials, or both, under contract with the Contractor for which payment was made by the Owner. Nothing contained herein shall require money to be placed in a separate account and not commingled with money of the Contractor, create any fiduciary liability or tort liability on the part of the Contractor for breach of trust, or entitle any person or entity to an award of punitive damages against the Contractor for breach of the requirements of this provision.

§ **9.6.8** Provided the Owner has fulfilled its payment obligations under the Contract Documents, the Contractor shall defend and indemnify the Owner from all loss, liability, damage or expense, including reasonable attorney's fees and litigation expenses, arising out of any lien claim or other claim for payment by any Subcontractor or supplier of any tier. Upon receipt of notice of a lien claim for payment, the Owner shall notify the Contractor. If approved by the applicable court, when required, the Contractor may substitute a surety bond for the property against which the lien or other claim for payment has been asserted.

§ **9.6.7 Failure of Payment**
If the Architect does not issue a Certificate for Payment, through no fault of the Contractor, within seven days after receipt of the Contractor's Application for Payment, or if the Owner does not pay the Contractor within seven days after the date established in the Contract Documents, the amount certified by the Architect or awarded by binding dispute resolution, then the Contractor may, upon seven additional days' notice to the Owner and Architect, stop the Work until payment of the amount owing has been received. The Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shutdown, delay and start-up, plus interest as provided for in the Contract Documents.

§ **9.8 Substantial Completion**
§ **9.8.1** Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use.

§ **9.8.2** When the Contractor considers that the Work portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall prepare and submit to the Architect a comprehensive list of items to be completed or corrected prior to final payment. Failure to include an item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

§**9.8.3** Upon receipt of the Contractor's list, the Architect will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Architect's inspection discloses any item, whether or not included on the Contractor's list, which is not sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work or designated portion thereof for its intended use, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the Architect. In such case, the Contractor shall then submit a request for another inspection by the Architect to determine Substantial Completion.

§ **9.8.4** When the Work or designated portion thereof is substantially complete, the Architect will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion; establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance; and fix the time within which the Contractor shall finish all items on the list accompanying the Certificate. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.

§ **9.8.5** The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in the Certificate. Upon such acceptance, and consent of surety if any, the Owner shall make payment of retainage applying to the Work or designated portion thereof. Such payment shall be adjusted for Work that is incomplete or not in accordance with the requirements of the Contract Documents.

§ 9.9 Partial Occupancy or Use

§ **9.9.1** The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor, provided such occupancy or use is consented to by the insurer and authorized by public authorities having jurisdiction over the Project. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. When the Contractor considers a portion substantially complete, the Contractor shall prepare and submit a list to the Architect as provided under Section 9.8.2. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by written agreement between the Owner and Contractor or, if no agreement is reached, by decision of the Architect.

§ **9.9.2** Immediately prior to such partial occupancy or use, the Owner, Contractor, and Architect shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.

§ **9.9.3** Unless otherwise agreed upon, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

§ 9.10 Final Completion and Final Payment

§ **9.10.1** Upon receipt of the Contractor's notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Architect will promptly make such inspection. When the Architect finds the Work acceptable under the Contract Documents and the Contract fully performed, the Architect will promptly issue a final Certificate for Payment stating that to the best of the Architect's knowledge, information and belief, and on the basis of the Architect's on-site visits and inspections, the Work has been completed in accordance with the Contract Documents and that the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. The Architect's final Certificate for Payment will constitute a further representation that conditions listed in Section 9.10.2 as precedent to the Contractor's being entitled to final payment have been fulfilled.

§ **9.10.2** Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Architect (1) an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied, (2) a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect, (3) a written statement that the Contractor knows of no reason that the insurance will not be renewable to cover the period required by the Contract Documents, (4) consent of surety, if any, to final payment, (5) documentation of any special warranties, such as manufacturers' warranties or specific Subcontractor warranties, and (6) if required by the Owner, other date establishing payment or satisfaction of obligations, such as receipts and releases and waivers of liens, claims, security interests, or encumbrances arising out of the contract, to the extent and in such form as may be designated by the Owner. If a Subcontractor refuses to furnish a release or waiver required by the Owner, the Contractor may furnish a bond satisfactory to the Owner to indemnify the Owner against such lien, claim, security interest, or encumbrance. If a lien, claim, security interest, or encumbrance remains unsatisfied after payments are made, the contractor shall refund to the Owner all money that the Owner may be compelled to pay in discharging the lien, claim, security interest, or encumbrance, including all costs and reasonable attorneys' fees.

§ **9.10.3** If, after Substantial Completion of the Work, final completion thereof is materially delayed through no fault of the Contractor or by issuance of Change Orders affecting final completion, and the Architect so confirms, the Owner shall, upon application by the Contractor and certification by the Architect, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed, corrected, and accepted. If the remaining balance for Work not fully completed or corrected is less than retainage stipulated in the Contract Documents, and if bonds have been furnished, the written consent of the surety to payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by the Contractor to the Architect prior to certification of such payment. Such payment shall be made under terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

§ **9.10.4** The making of final payment shall constitute a waiver of Claims by the Owner except those arising from

- **.1** liens, Claims, security interests, or encumbrances arising out of the Contract and unsettled;
- **.2** failure of the Work to comply with the requirements of the Contract Documents;
- **.3** terms of special warranties required by the Contract Documents, or
- **.4** audits performed by the Owner, if permitted by the Contract Documents, after final payment.

§ **9.10.5** Acceptance of final payment by the Contractor, a Subcontractor, or a supplier, shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time offinal Application for Payment.

ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY

§ 10.1 Safety Precautions and Programs

The Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the performance of the Contract.

§ 10.2 Safety of Persons and Property

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

- **.1** employees on the work and other persons who may be affected thereby;
- **.2** The Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor, a Subcontractor, or a Sub-subcontractor; and
- **.3** Other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designed for removal, relocation, or replacement in the course of construction.

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

§ **10.2.3** The Contractor shall implement, erect, and maintain, as required by existing conditions and performance of the Contract, reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards; promulgating safety regulations; and notifying the owners and users of adjacent sites and utilities of the safeguards.

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

§ **10.2.5** The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Sections 10.2.1.2 and 10.2.1.3 caused in whole or in part by the contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible under Sections 10.2.1.2 and 10.2.1.3. The contractor may make a Claim for the cost to remedy the damage or loss to the extent such damage or loss is attributable to acts or omissions of the Owner or Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the contractor's obligations under Section 3.18.

§ **10.2.6** The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner and Architect.

§ 10.2.7 The Contractor shall not permit any part of the construction or site to be loaded so as to cause damage or create an unsafe condition.

§ **10.2.8 Injury or Damage to Person or Property**
If either party suffers injury or damage to person or property because of an ac or omission of the other party, or of others for whose acts such party is legally responsible, notice of the injury or damage, whether or not insured, shall be given to the other party within a reasonable time not exceeding 21 days after discovery. The notice shall provide sufficient detail to enable the other party to investigate the matter.

§ 10.3 Hazardous Materials and Substances
§ 10.3.1 The Contractor is responsible for compliance with any requirements included in the Contract Documents regarding hazardous materials or substances. If the Contractor encounters a hazardous material or substance not addressed in the Contract Documents and if reasonable precautions will be inadequate to prevent foreseeable bodily injury or death to persons resulting from a material or substance, including but not limited to asbestos or polychlorinated biphenyl (PCB), encountered on the site by the Contractor, the Contractor shall, upon recognizing the condition, immediately stop Work in the affected area and notify the Owner and Architect of the condition.

§ 10.3.2 Upon receipt of the Contractor's notice, the Owner shall obtain the services of a licensed laboratory to verify the presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to cause it to be rendered harmless. Unless otherwise required by the Contract Documents, the Owner shall furnish in writing to the Contractor and Architect the names and qualifications of persons o entities who are to perform tests verifying the presence or absence of the material or substance or who are to perform the task of removal or safe containment of the material or substance. The Contractor and the Architect will promptly reply to the Owner in writing stating whether or not either has reasonable objection to the persons or entities proposed by the Owner. If either the Contractor or Architect has an objection to a person or entity proposed by the Owner, the Owner shall propose another to whom the Contractor and the Architect have no reasonable objection. When the material or substance has been rendered harmless, Work in the affected area shall resume upon written agreement of the Owner and Contractor. By Change Order, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable additional costs of shutdown, delay, and start-up.

§ **10.3.3** To the fullest extent permitted by law, the Owner shall indemnify and hold harmless the Contractor, Subcontractors, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work in the affected area if in fact the material or substance presents the risk of bodily injury or death as described in Section 10.3.1 and has not been rendered harmless, provided that such claim, damage, loss, or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), except to the extent that such damage, loss, or expense is due to the fault or negligence of the party seeking indemnity.

§ **10.3.4** The Owner shall not be responsible under this Section 10.3 for hazardous materials or substances the Contractor brings to the site unless such materials or substances are required by the Contract Documents. The Owner shall be responsible for hazardous materials or substances required by the Contract Documents, except to the extent of the Contractor ‘s fault or negligence in the use and handling of such materials or substances.

§ 10.3.5 Contractor shall reimburse the Owner for the cost and expense the Owner incurs (1) for remediation of hazardous materials or substances the contractor brings to the site and negligently handles, or (2) where the Contractor fails to perform its obligations under Section 10.3.1, except to the extent that the cost and expense are due to the Owner’s fault or negligence.

§ **10.3.6** If, without negligence on the part of the Contractor, the Contractor is held liable by a government agency for the cost of remediation of a hazardous material or substance solely by reason of performing Work as required by the Contract Documents, the Owner shall reimburse the Contractor for all cost and expense thereby incurred.

§ **10.4 Emergencies**
In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury , or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 15 and Article 7.

ARTICLE 11 INSURANCE AND BONDS

§ **11.1 Contractor's Insurance and Bonds**

§ **11.1.1** The Contractor shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Contractor shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located. The Owner, Architect, and Architect's consultants shall be named as additional insureds under the Contractor's commercial general liability policy or as otherwise described in the Contract Documents.

§ **11.1.2** The Contractor shall provide surety bonds of the types, for such penal sums, and subject to such terms and conditions as required by the Contract Documents. The Contractor shall purchase and maintain the required bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.

§ **11.1.3** Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds or shall authorize a copy to be furnished

§ **11.1.4 Notice of Cancellation or Expiration of Contractor's Required Insurance.** Within three (3) business days of the date the Contractor becomes aware of an impending or actual cancellation or expiration of any insurance required by the Contract Documents, the Contractor shall provide notice to the Owner of such impending or actual cancellation or expiration. Upon receipt of notice from the Contractor, the Owner shall, unless the lapse in coverage arises from an act or omission of the Owner, have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by the Contractor. The furnishing of notice by the Contractor shall not relieve the Contractor of any contractual obligation to provide any required coverage.

§ **11.2 Owner's Insurance**

§ **11.2.1** The Owner shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Owner shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located.

§ **11.2.2 Failure to Purchase Required Property Insurance.** If the Owner fails to purchase and maintain the required property insurance, with all of the coverages and in the amounts described in the Agreement or elsewhere in the Contract Documents, the Owner shall inform the Contractor in writing prior to commencement of the Work. Upon receipt of notice from the Owner, the Contractor may delay commencement of the Work and may obtain insurance that will protect the interests of the Contractor, Subcontractors, and Sub-Subcontractors in the Work. When the failure to provide coverage has been cured or resolved, the Contract Sum and Contract Time shall be equitably adjusted. In the event the Owner fails to procure coverage, the Owner waives all rights against the Contractor, Subcontractors, and Sub-subcontractors to the extent the loss to the Owner would have been covered by the insurance to have been procured by the Owner. The cost of the insurance shall be charged to the Owner by a Change Order. If the Owner does not provide written notice, and the Contractor is damaged by the failure or neglect of the Owner to purchase or maintain the required insurance, the Owner shall reimburse the contractor for all reasonable costs and damages attributable thereto.

§ **11.2.3 Notice of Cancellation or Expiration of Owner's Required Property Insurance.** Within three (3) business days of the date the Owner becomes aware of an impending or actual cancellation or expiration of any property insurance required by the Contract Documents, the Owner shall provide notice to the Contractor of such impending or actual cancellation or expiration. Unless the lapse in coverage arises from an act or omission of the Contractor: (1) the Contractor, upon receipt of notice from the Owner, shall have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by either the Owner or the Contractor; (2) the Contract Time and Contract Sum shall be equitably adjusted; and (3) the Owner waives all rights against the Contractor, Subcontractors, and Sub-subcontractors to the extent any loss to the Owner would have been covered by the insurance had it not expired or been cancelled. If the Contractor purchases replacement coverage, the cost of the insurance shall be charged to the Owner by

an appropriate Change Order. The furnishing of notice by the Owner shall not relieve the Owner of any contractual obligation to provide required insurance.

§ **11.3 Waivers of Subrogation**

§ **11.3.1** The Owner and Contractor waive all rights against (1) each other and any of their subcontractors, sub-subcontractors, agents, and employees, each of the other; (2) the Architect and Architect's consultants; and (3) Separate Contractors, if any, and any of their subcontractors, sub-subcontractors, agents, and employees, for damages caused by fire, or other causes of loss, to the extent those losses are covered by property insurance required by the Agreement or other property insurance applicable to the Project, except such rights as they have to proceeds of such insurance. The Owner or Contractor, as appropriate, shall require similar written waivers in favor of the individuals and entities identified above from the Architect, Architect's consultants, Separate Contractors, subcontractors, and sub-subcontractors. The policies of insurance purchased and maintained by each person or entity agreeing to waive claims pursuant to this section 11.3.1 shall not prohibit this waiver of subrogation. This waiver of subrogation shall be effective as to a person or entity (1) even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, (2) even though that person or entity did not pay the insurance premium directly or indirectly, or (3) whether or not the person or entity had an insurable interest in the damaged property.

§ **11.3.2** If during the Project construction period the Owner insures properties, real or personal or both, at or adjacent to the site by property insurance under policies separate from those insuring the Project, or if after final payment property insurance is to be provided on the completed Project through a policy or policies other than those insuring the Project during the construction period, to the extent permissible by such policies, the Owner waives all rights in accordance with the terms of Section 11.3.1 for damages caused by fire or other causes of loss covered by this separate property insurance.

§ **11.4 Loss of Use, Business Interruption, and Delay in Completion Insurance**

The Owner, at the Owner's option, may purchase and maintain insurance that will protect the Owner against loss of use of the Owner's property, or the inability to conduct normal operations, due to fire or other causes of loss. The Owner waives all rights of action against the Contractor and Architect for loss of use of the Owner's property, due to fire or other hazards however caused.

§11.5 Adjustment and Settlement of Insured Loss

§ **11.5.1** A loss insured under the property insurance required by the Agreement shall be adjusted by the Owner as fiduciary and made payable to the Owner as fiduciary for the insureds, as their interests may appear, subject to requirements of any applicable mortgagee clause and of Section 11.5.2. The Owner shall pay the Architect and Contractor their just shares of insurance proceeds received by the Owner, and by appropriate agreements the Architect and Contractor shall make payments to their consultants and Subcontractors in similar manner.

§ **11.5.2** Prior to settlement of an insured loss, the Owner shall notify the Contractor of the terms of the proposed settlement as well as the proposed allocation of the insurance proceeds. The Contractor shall have 14 days from receipt of notice to object to the proposed settlement or allocation of the proceeds. If the Contractor does not object, the Owner shall settle the loss and the Contractor shall be bound by the settlement and allocation. Upon receipt, the Owner shall deposit the insurance proceeds in a separate account and make the appropriate distributions. Thereafter, if no other agreement is made or the Owner does not terminate the Contract for convenience, the Owner and Contractor shall execute a Change Order for reconstruction of the damaged or destroyed Work in the amount allocated for that purpose. If the Contractor timely objects to either the terms of the proposed settlement or the allocation of the proceeds, the Owner may proceed to settle the insured loss, and any dispute between the Owner and Contractor arising out of the settlement or allocation of the proceeds shall be resolved pursuant to Article 15. Pending resolution of any dispute, the Owner may issue a Construction Change Directive for the reconstruction of the damaged or destroyed Work.

ARTICLE 12 UNCOVERING AND CORRECTION OF WORK

§ **12.1 Uncovering of Work**

§ **12.1.1** If a portion of the Work is covered contrary to the Architect's request or to requirements specifically expressed in the contract Documents, it must, if requested in writing by the Architect, be uncovered for the Architect's examination and be replaced at the contractor's expense without change in the Contract Time.

§ **12.1.2** If a portion of the Work has been covered that the Architect has not specifically requested to examine prior to its being covered, the Architect may request to see such Work and is shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, the Contractor shall be entitled to an equitable adjustment to the Contract

Sum and Contract Time as may be appropriate. If such Work is not in accordance with the Contract Documents, the costs of uncovering the Work, and the cost of correction, shall be at the Contractor's expense.

§ **12.2 Correction of Work**

§ **12.2.1 Before Substantial Completion**

The Contractor shall promptly correct Work rejected by the Architect or failing to conform to the requirements of the Contract Documents, discovered before Substantial Completion and whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including additional testing and inspections, the cost of uncovering and replacement, and compensation for the Architect's services and expenses made necessary thereby, shall be at the Contractor's expense.

§ **12.2.2 After Substantial Completion**

§ **12.2.2.1** In addition to the Contractor's obligations under Section 3.5, if, within one year after the date of Substantial Completion of the Work or designated portion thereof or after the date for commencement of warranties established under Section 9.9.1, or by terms of any applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt of notice from the Owner to do so, unless the Owner has previously given the Contractor a written acceptance of such condition. The Owner shall give such notice promptly after discovery of the condition. During the one-year period for correction of Work, if the Owner fails to notify the Contractor and give the Contractor an opportunity to make the correction, the Owner waives the rights to require correction by the Contractor and to make a claim for breach of warranty. If the Contractor fails to correct nonconforming Work within a reasonable time during thatperiod after receipt of notice from the Owner or Architect, the Owner may correct it in accordance with Section 2.5.

§ **12.2.2.2** The one-year period for correction of Work shall be extended with respect to portions of Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual completion of that portion of the Work.

§ **12.2.2.3** The one-year period for correction of Work shall not be extended by corrective Work performed by the Contractor pursuant to this Section 12.2.

§**12.2.3** The Contractor shall remove from the site portions of the Work that are in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

§ **12.2.4** The Contractor shall bear the cost of correcting destroyed or damaged construction of the Owner or Separate Contractors, whether completed or partially completed, caused by the Contractor's correction or removal of Work that is not in accordance with the requirements of the Contract Documents.

§ **12.2.5** Nothing contained in this Section 12.2 shall be construed to establish a period of limitation with respect to other obligations the Contractor has under the Contract Documents. Establishment of the one-year period for correction of Work as described in Section 12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and bas no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

§ **12.3 Acceptance of Nonconforming Work**

If the Owner prefers to accept Work that is not in accordance with the requirements of the Contract Documents, the Owner may do so instead of requiring its removal and correction, in which case the Contract Sum will be reduced as appropriate and equitable. Such adjustment shall be effected whether or not final payment has been made.

ARTICLE 13 MISCELLANEOUS PROVISIONS

§ **13.1 Governing Law**

The Contract shall be governed by the law of the place where the Project is located, excluding that jurisdiction's choice of law rules. If the parties have selected arbitration as the method of binding dispute resolution, the Federal Arbitration Act shall govern Section 15.4.

§ **13.2 Successors and Assigns**

§ **13.2.1** The Owner and Contractor respectively bind themselves, their partners, successors, assigns, and legal representatives to covenants, agreements, and obligations contained in the Contract Documents. Except as provided in

Section 13.2.2, neither party to the Contract shall assign the Contract as a whole without written consent of the other. If either party attempts to make an assignment without such consent, that party shall nevertheless remain legally responsible for all obligations under the Contract.

§ **13.2.2** The Owner may, without consent of the Contractor, assign the Contract to a lender providing construction financing for the Project, if the lender assumes the Owner's rights and obligations under the Contract Documents. The Contractor shall execute all consents reasonably required to facilitate the assignment.

§ **13.3 Rights and Remedies**

§ **13.3.1** Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights, and remedies otherwise imposed or available by law.

§ **13.3.2** No action or failure to act by the Owner, Architect, or contractor shall constitute a waiver of a right or duty afforded them under the Contract, nor shall such action or failure to act constitute approval of or acquiescence in a breach thereunder, except as may be specifically agreed upon in writing.

§ **Tests and Inspections**

§ **13.4.1** Tests, inspections, and approvals of portions of the Work shall be made as required by the Contract Documents and by applicable laws, statutes, ordinances, codes, rules, and regulations or lawful orders of public authorities. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections, and approvals with·an independent testing laboratory or entity acceptable to the Owner, or with the appropriate public authority, and shall bear all related costs of tests, inspections, and approvals. The Contractor shall give the Architect timely notice of when and where tests and inspections are to be made so that the Architect may present for such procedures. The Owner shall bear costs of tests, inspections, or approvals that do not become requirements until after bids are received or negotiations concluded. The Owner shall directly arrange and pay for tests, inspections, or approvals where building codes or applicable laws or regulations so require.

§ **13.4.2** If the Architect, Owner, or public authorities having jurisdiction determine that portions of the Work require additional testing, inspection, or approval not included under Section 13.4.1, the Architect will, upon written authorization from the Owner, instruct the Contractor to make arrangements for such additional testing, inspection, or approval, by an entity acceptable to the Owner, and the Contractor shall give timely notice to the Architect of when and where tests and inspections are to be made so that the Architect may be present for such procedures. Such costs, except as provided in Section 13.4.3, shall be at the Owner's expense.

§ **13.4.3** If procedures for testing, inspection, or approval under Sections 13.4.1 and 13.4.2 reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, all costs made necessary by such failure, including those of repeated procedures and compensation for the Architect 's services and expenses, shall be at the Contractor's expense.

§ **13.4.4** Required certificates of testing, inspection, or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor and promptly delivered to the Architect.

§ **13.4.5** If the Architect is to observe tests, inspections, or approvals required by the Contract Documents, the Architect will do so promptly and, where practicable, at the normal place of testing.

§ **13.4.6** Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

§ **13.5 Interest**

Payments due and unpaid under the Contract Document shall bear interest from the date payment is due at the rate the parties agree upon in writing or, in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located.

ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT

§ **14.1 Termination by the Contractor**

§ **14.1.1** The Contractor may terminate the Contract if the Work is stopped for a period of 30 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, for any of the following reasons:

.1 Issuance of an order of a court or other public authority having jurisdiction that requires all Work to be stopped;

.2 An act of government, such as a declaration of national emergency, that requires all Work to be stopped;

.3 Because the Architect has not issued a Certificate for Payment and has not notified the Contractor of the reason for withholding certification as provided in Section 9.4.1, or because the Owner has not made payment on a Certificate for Payment within the time stated in the Contract Documents; or

.4 The Owner has failed to furnish to the Contractor reasonable evidence as required by Section 2.2.

§ **14.1.2** The Contractor may terminate the Contract if, through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, repeated suspensions, delays, or interruptions of the entire Work by the Owner as described in Section 14.3, constitute in the aggregate more than 100 percent of the total number of days scheduled for completion, or 120 days in any 365-day period, whichever is less.

§ **14.1.3** If one of the reasons described in Section 14.1.1 or 14.1.2 exists, the Contractor may, upon seven days' notice to the Owner and Architect, terminate the Contract and recover from the Owner payment for Work executed, as well as reasonable overhead and profit on Work not executed, and costs incurred by reason of such termination.

§ **14.1.4** If the Work is stopped for a period of 60 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, or their agents or employees or any other persons or entities performing portions of the Work because the Owner has repeatedly failed to fulfill the Owner's obligations under the Contract Documents with respect to matters important to the progress of the Work, the Contractor may, upon seven additional days' notice to the Owner and the Architect, terminate the Contract and recover from the Owner as provided in Section 14.1.3.

§ **14.2 Termination by the Owner for Cause**

§ **14.2.1** The Owner may terminate the Contract if the Contractor

.1 repeatedly refuses or fails to supply properly skilled workers or proper materials;

.2 fails to make payment to Subcontractors or suppliers in accordance with the respective agreements between the Contractor and the Subcontractors or Suppliers;

.3 repeatedly disregards applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of a public authority; or

.4 otherwise is guilty of substantial breach of a provision of the Contract Documents.

§ **14.2.2** When any of the reasons described in Section 14.2.1 exist, and upon certification by the Architect that sufficient cause exists to justify such action, the Owner may, without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's surety, if any, seven days' notice, terminate employment of the Contractor and may, subject to any prior rights of the surety:

.1 Exclude the Contractor from the site and take possession of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;

.2 Accept assignment of subcontracts pursuant to Section 5.4; and

.3 Finish the Work by whatever reasonable method the Owner may deem expedient. Upon written request of the Contractor, the Owner shall furnish to the Contractor a detailed accounting of the costs incurred by the Owner in finishing the Work.

§ **14.2.3** When the Owner terminates the Contract for one of the reasons stated in Section 14.2.1, the Contractor shall not be entitled to receive further payment until the Work is finished.

§ **14.2.4** If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, including compensation for the Architect's services and expenses made necessary thereby, and other damages incurred by the Owner and not expressly waived, such excess shall be paid to the Contractor. If such costs and damages exceed the unpaid balance, the Contractor shall pay the difference to the Owner. The amount to be paid to the Contractor or Owner, as the case may be shall be certified by the Initial Decision Maker, upon application, and this obligation for payment shall survive termination of the Contract.

§ **14.3 Suspension by the Owner for Convenience**

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

§ **14.3.2** The Contract Sum and Contract Time shall be adjusted for increases in the cost and time caused by suspension, delay, or interruption under Section 14.3.1. Adjustment of the Contract Sum shall include profit. No adjustment shall be made to the extent

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

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

§ **14.4 Termination by the Owner for Convenience**

§ **14.4.1** The Owner may, at any time, terminate the Contract for the Owner's Convenience and without cause.

§ **14.4.2** Upon receipt of notice from the Owner of such termination for the Owner's convenience, the Contractor shall

.1 cease operations as directed by the Owner in:

.2 take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and

.3 except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders.

§ **14.4.3** In case of such termination for the Owner's convenience, the Owner shall pay the Contractor for Work properly executed; costs incurred by reason of the termination, including costs attributable to termination of Subcontracts; and the termination fee, if any, set forth in the Agreement.

ARTICLE 15 CLAIMS AND DISPUTES

§ **15.1 Claims**

§ **15.1.1 Definition**

A Claim is a demand or assertion by one of the parties seeking, as a matter of right, payment of money, a change in the Contract Time, or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. The responsibility to substantiate Claims shall rest with the party making the Claim. This Section 15.1.1 does not require the Owner to file a Claim in order to impose liquidated damages in accordance with the Contract Documents.

§ **15.1.2 Time Limits on Claims**

The Owner and Contractor shall commence all Claims and causes of action against the other and arising out of or related to the Contract, whether in contract, tort, breach of warranty or otherwise, in accordance with the requirements of the binding dispute resolution method selected in the Agreement and within the period specified by applicable law, but in any case not more than 10 years after the date of Substantial Completion of the Work. The Owner and Contractor waive all Claims and causes of action not commenced in accordance with this Section 15.1.2.

§ **15.1.3 Notice of Claims**

§ **15.1.3.1** Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered prior to expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party and to the Initial Decision Maker with a copy sent to the Architect, if the Architect is not serving as the Initial Decision Maker. Claims by either party under this Section 15 .1.3.1 shall be initiated within 21 days after occurrence of the event giving rise to such Claim or within 21 days after the claimant first recognizes the condition giving rise to the Claim, whichever is later.

§ **15.1.3.2** Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party. In such event, no decision by the Initial Decision Maker is required.

§ **15.1.4 Continuing Contract Performance**

§ **15.1.4.1** Pending final resolution of a Claim, except as otherwise agreed in writing or as provided in Section 9.7 and Article 14, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments in accordance with the Contract Documents.

§ **15.1.4.2** The Contract Sum and Contract Time shall be adjusted in accordance with the Initial Decision Maker's decision, subject to the right of either party to proceed in accordance with this Article 15. The Architect will issue Certificates for Payment in accordance with the decision of the Initial Decision Maker.

§ **15.1.5 Claims for Additional Cost**
If the Contractor wishes to make a Claim for an increase in the Contract Sum, notice as provided in Section 15.1.3 shall be given before proceeding to execute the portion of the Work that is the subject of the Claim. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Section 10.4.

§ **15.1.6 Claims for Additional Time**
§ **15.1.6.1** If the Contractor wishes to make a Claim for an increase in the Contract Time notice as provided in Section shall be given. The Contractor's Claim shall include an estimate of cost and of probable effect of delay on progress of the Work. In the case of a continuing delay, only one Claim is necessary.

§ **15.1.6.2** If adverse weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating that weather conditions were abnormal for the period of time, could not have been reasonably anticipated, and had an adverse effect on the scheduled construction.

§ **15.1.7 Waiver of Claims for Consequential Damages**
The Contractor and Owner waive Claims against each other for consequential damages arising out of or relating to this Contract. This mutual waiver includes

.1 damages incurred by the Owner for rental expenses, for losses of use, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and

.2 damages incurred by the Contractor for principal office expenses including the compensation of personnel stationed there, for losses of financing, business and reputation, and for loss of profit, except anticipated profit arising directly from the Work.

This mutual waiver is applicable, without limitation, to all consequential damages due to either party's termination in accordance with Article 14. Nothing contained in this Section 15.1.7 shall be deemed to preclude assessment of liquidated damages, when applicable, in accordance with the requirements of the Contract Documents.

§ **15.2 Initial Decision**
§ **15.2.1** Claims, excluding those where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2 or arising under Section 10.3, 10.4, and 11.5, shall be referred to the Initial Decision Maker for initial decision. The Architect will serve as the Initial Decision Maker, unless otherwise indicated in the Agreement. Except for those Claims excluded by this Section 15.2.1, an initial decision shall be required as a condition precedent to mediation of any Claim. If an initial decision has not been rendered within 30 days after the Claim has been referred to the Initial Decision Maker, the party asserting the Claim may demand mediation and binding dispute resolution without a decision having been rendered. Unless the Initial Decision Maker and all affected parties agree, the Initial Decision Maker will not decide disputes between the Contractor and persons or entities other than the Owner.

§ **15.2.2** The Initial Decision Maker will review Claims and within ten days of the receipt of a Claim take one or more of the following actions: (1) request additional supporting data from the claimant or a response with supporting data from the other party, (2) reject the Claim in whole or in part, (3) approve the Claim, (4) suggest a compromise, or (5) advise the parties that the Initial Decision Maker is unable to resolve the Claim if the Initial Decision Maker lacks sufficient information to evaluate the merits of the Claim or if the Initial Decision Maker concludes that, in the Initial Decision Maker's sole discretion , it would be inappropriate for the Initial Decision Maker to resolve the Claim.

§ **15.2.3** In evaluating Claims, the Initial Decision Maker, but shall not be obligated to, consult with or seek information from either patty or from persons with special knowledge or expertise who may assist the Initial Decision Maker in rendering a decision. The Initial Decision Maker may request the Owner to authorize retention of such persons at the Owner's expense.

§ **15.2.4** If the Initial Decision Maker requests a party to provide a response to a Claim or to burnish additional supporting data, such party shall respond, within ten days after receipt of the request, and shall either (1) provide a response on the requested supporting data, (2) advise the Initial Decision Maker when the response or supporting data will be furnished, or (3) advise the Initial Decision Maker that no supporting data will be furnished. Upon receipt of the response or supporting data, if any, the Initial Decision Maker will either reject or approve the Claim in whole or in part.

§ **15.2.5** The Initial Decision Maker will render an initial decision approving or rejecting the Claim, or indicating that the Initial Decision Maker is unable to resolve the Claim. This initial decision shall (1) be in writing; (2) state the reasons therefor; and (3) notify the parties and the Architect, if the Architect is not serving as the Initial Decision Maker, of any change in the Contract Sum or Contract Time or both. The initial decision shall be final and binding on the parties but subject to mediation and, if the parties fail to resolve their dispute through mediation, to binding dispute resolution.

§ **15.2.6** Either party may file for mediation of an initial decision at any time, subject of Section 15.2.6.1.

§ **15.2.6.1** Either party may, within 30 days from the date of receipt of an initial decision, demand in writing that the other party file for mediation. If such a demand is made and the party receiving the demand fails to file for mediation within 30 days after receipt thereof, then both parties waive their rights to mediate or pursue binding dispute resolution proceedings with respect to the initial decision.

§ **15.2.7** In the event of a Claim against the Contractor, the Owner may, but is not obligated to, notify the surety, if any, of the nature and amount of the Claim. If the Claim relates to a possibility of a Contractor's default, the Owner may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

§ **15.2.8** If a Claim relates to or is the subject of a mechanic's lien, the party asserting such Claim may proceed in accordance with applicable law to comply with the lien notice or filing deadlines.

§ **15.3 Mediation**

§ **15.3.1** Claims, disputes, or other matters in controversy arising out of or related to the Contract, except those waived as provided for in Sections 9.10.4, 9.10.5, and 15.1.7, shall be subject to mediation as a condition precedent to binding dispute resolution.

§ **15.3.2** The parties shall endeavor to resolve their Claims by mediation which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Mediation Procedures in effect on the date of the Agreement. A request for mediation shall be made in writing, delivered to the other party to the Contract and filed with the person or entity administering the mediation. The request may be made concurrently with the filing of binding dispute resolution proceedings but, in such event, mediation shall proceed in advance of binding dispute resolution proceedings, which shall be stayed pending mediation for a period of 60 days from the date of filing, unless stayed for a longer period by agreement of the parties or court order. If an arbitration is stayed pursuant to this Section 15.3.2, the parties may nonetheless proceed to the selection of the arbitrator(s) and agree upon a schedule for later proceedings.

§ **15.3.3** Either party may, within 30 days from the date that mediation has been concluded without resolution of the dispute or 60 days after mediation has been demanded without resolution of the dispute, demand in writing that the other party file for binding dispute resolution. If such a demand is made and the party receiving the demand fails to file for binding dispute resolution within 60 days after receipt thereof, then both parties waive their rights to binding dispute resolution proceedings with respect to the initial decision.

§ **15.3.4** The parties shall share the mediator's fee and any filing fees equally. The mediation shall be held in the place where the Project is located, unless another location is mutually agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

§ **15.4 Arbitration**

§ **15.4.1** If the parties have selected arbitration as the method for binding dispute resolution in the Agreement, any Claim subject to, but not resolved by, mediation shall be subject to arbitration which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Arbitration Rules in effect on the date of the Agreement. The Arbitration shall be conducted in the place where the Project is located, unless another location is mutually agreed upon. A demand for arbitration shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the arbitration. The party filing a notice of demand for arbitration must assert in the demand all Claims then known to that party on which arbitration is permitted to be demanded.

§ **15.4.1.1** A demand for arbitration shall be made no earlier than concurrently with the filing of a request for mediation, but in no event shall it be made after the date when the institution of legal or equitable proceedings based on the Claim would be barred by the applicable statute of limitations. For statute of limitations purposes, receipt of a written demand

for arbitration by the person or entity administering the arbitration shall constitute the institution of legal or equitable proceedings based on the Claim

§ **15.4.2** The award rendered by the arbitrator or arbitrators shall be final, and judgment may be entered upon it in accordance with applicable law in any court having jurisdiction thereof.

§ **15.4.3** The foregoing agreement to arbitrate and other agreements to arbitrate with an additional person or entity duly consented to by parties to the Agreement, shall be specifically enforceable under applicable law in any court having jurisdiction thereof.

§ **15.4.4 Consolidation or Joinder**

§ **15.4.4.1** Subject to the rules of the American Arbitration Association or other applicable arbitration rules, either party may consolidate an arbitration conducted under this Agreement with any other arbitration to which it is a party provided that (1) the arbitration agreement governing the other arbitration permits consolidation, (2) the arbitrations to be consolidated substantially involve common questions of law or fact, and (3) the arbitrations employ materially similar procedural rules and methods for selecting arbitrator(s).

§ **15.4.4.2** Subject to the rules of the American Arbitration Association or other applicable arbitration rules, either party may include by joinder persons or entities substantially involved in a common question of law or fact whose presence is required if complete relief is to be accorded in arbitration, provided that the party sought to be joined consents in writing to such joinder. Consent to arbitration involving an additional person or entity shall not constitute consent to arbitration of any claim, dispute or other matter in question not described in the written consent.

§ **15.4.4.3** The Owner and Contractor grant to any person or entity made a party to an arbitration conducted under this Section 15.4, whether by joinder or consolidation, the same rights of joinder and consolidation as those of the Owner and Contractor under this Agreement.

GENERAL CONDITIONS

SECTION 00 7200

PART 1 - GENERAL

1.01 DESCRIPTION

A. **SCOPE:** The **General Conditions of the Contract for Construction**, AIA Document A201, Seventeenth Edition, 2017, Articles 1 through 15 inclusive, is a part of this Contract and is incorporated herein.

B. **BIDDING COPY:** For the purpose of bidding, Contractors are presumed to be familiar with AIA Document A201, a copy of which may be obtained from the Professional, or examined in the Professional's office.

***** END OF SECTION *****

SUPPLEMENTARY CONDITIONS
SECTION 00 7300

PART 1 – GENERAL

1.01 **Description**

A. **Owner:** These supplements are necessary because the Owner is a political subdivision of the State of Mississippi and occupies a different position from that of the usual Owner.

B. **Document:** The following supplements modify, change, delete from, or add to the **General Conditions of the Contract**, AIA Document A201, Seventeenth Edition, 2017. When any Article of the **General Conditions** is modified, or deleted, by these Supplementary Conditions, the unaltered provisions of that Article, Paragraph, Subparagraph, or Clause will remain in effect.

Article 1
GENERAL PROVISIONS

1.1 **Basic Definitions**

1.1.1 **The Contract Documents**

Change this subparagraph to read as follows:

The Contract Documents are enumerated in the Agreement between the Owner and Contractor (hereinafter the Agreement) and consist of the Agreement, Conditions of the Contract (General, Supplementary and Special Conditions), Drawings, Specifications and Addenda issued prior to the execution of the Contract, other documents listed in the Agreement, and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a Construction Change Directive, or (4) a written order for minor changes in the Work issued by the Prime Professional. The Contract Documents also include the advertisement or invitation for bids or proposals, Instructions to Bidders, and the Contractor's bid or proposal.

1.1.2 **The Contract**

Change each instance of the word "Architect" to "Prime Professional" and each instance of the word "Architect's" to "Prime Professional's".

1.1.7 **Instruments of Service**

Change the word "Architect" to "Prime Professional" and change the word "Architect's" to "Prime Professional's".

1.1.8 Change this Subparagraph to read as follows:

Article 1.1.8 INITIAL RECOMMENDER

The Initial Recommender is the person identified in the Standard Form of Agreement between the Owner and the Contractor to render opinions and/or recommendations on Claims in accordance with Article 15.2. However, the Owner shall have final decision-making authority on all claims and matters.

1.2.1 Change this Subparagraph to read as follows:

The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by

the Contractor and unless otherwise provided in the Contract Documents, this shall include all labor, materials, equipment, tools, machinery, water, heat, utilities, transportation, and other facilities and services, whether temporary or permanent and whether or not incorporated in the Work. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; performance by the Contractor shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the indicated results. In case of any direct conflict among the Contract Documents, the specifications shall take precedence over the drawings, supplemental or special conditions shall take precedence over more general conditions or requirements, details shall take precedence over plans, and larger scale drawings shall take precedence over smaller scale drawings.

1.5 **Ownership and Use of Drawings, Specifications, and Other Instruments of Service**

1.5.1 Change each instance of the word "Architect" to "Prime Professional" and each instance of the word "Architect's" to "Prime Professional's" and add a new sentence at the end of this Subparagraph:

This Paragraph in no way supersedes the Owner's document rights set forth in the separate Agreement Between the Owner and the Professional.

1.6 **Notice**

1.6.1 Change this Subparagraph to read as follows:

Except as otherwise provided in Section 1.6.2, where the Contract Documents require one party to notify or give notice to the other party, such notice shall be provided in writing to the designated representative of the party to whom the notice is addressed and shall be deemed to have been duly served if delivered in person, by mail, by courier, or by electronic transmission if transmitted to the government or business issued e-mail address of the respective party.

1.7 **Digital Data Use and Transmission**

Delete the last sentence of this Paragraph.

1.8 **Building Information Models Use and Reliance**

Change this Paragraph to read as follows:

Any use of, or reliance on, all or a portion of a building information model without agreement to protocols governing the use of, and reliance on, the information contained in the model and without having those protocols set forth in written documents shall be at the using or relying party's sole risk and without liability to the other party and its contractors or consultants, the authors of, or contributors to, the building information model, and each of their agents and employees.

Article 2
OWNER

2.1 **General**

2.1.1 Change this Subparagraph to read as follows:

Wherever in these Documents the word "Owner" appears, it shall be understood to mean Jackson County, Mississippi, and its authorized representatives and is referred to throughout the Contract Documents as if singular in number. The Owner's representative is authorized to informally represent the Board and act as a liaison to Owner with respect to the project. Except as otherwise provided in Subparagraph 4.2.1, the Prime Professional does not have such authority. In all decisions, Jackson

County, Mississippi, can be bound only after written authorization and approval as reflected on its minutes.

2.1.2 Delete this Subparagraph in its entirety.

2.2 **Evidence of the Owner's Financial Arrangements**

2.2.1 Delete this Subparagraph in its entirety.

2.2.2 Delete this Subparagraph in its entirety.

2.2.3 Delete this Subparagraph in its entirety.

2.2.4 Delete this Subparagraph in its entirety.

2.3 **Information and Services Required of the Owner**

2.3.1 Delete this Subparagraph in its entirety.

2.3.2 Add the word "or Engineer" following each instance of the word "Architect" and add the words "or engineering respectively" following each instance of the word "architecture".

2.3.3 Add the words "or Engineer" following each instance of the word "Architect".

2.3.6 Change this Subparagraph to read as follows:

Unless otherwise provided in the Contract Documents, the Contractor will be furnished, free of charge, such copies of Drawings and Project Manuals as are reasonably necessary, but in no instance to exceed three (3) copies, for the execution of the Work.

2.4 **Owner's Right to Stop the Work**

Change this Subparagraph to read as follows:

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents as required by Section 12.2 or fails to carry out Work in accordance with the Contract Documents, the Owner may issue, or direct the Prime Professional to issue, a written order to the Contractor to stop the Work or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work shall not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity, except to the extent required by Section 6.1.3. The rights and remedies under this Subparagraph are in addition to and do not in any respect limit any other rights of the Owner, including the right to terminate in accordance with Article 14.

2.5 **Owner's Right to Carry Out the Work**

Change this Subparagraph read as follows:

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a ten-day period after receipt of notice from the Owner to commence and continue correction of such default or neglect with diligence and promptness, the Owner may, without prejudice to other remedies the Owner may have, correct such default or neglect. The Prime Professional may, pursuant to Section 9.5.1, withhold or nullify a Certificate for Payment in whole or in part, to the extent reasonably necessary to reimburse the Owner for the reasonable cost of correcting such deficiencies, including Owner's expenses and compensation for the Prime Professional's additional services made necessary by such default, neglect, or failure. If current and future payments are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner. If the Contractor disagrees with the actions of the Owner or the Prime Professional, or the amounts claimed as costs to the Owner, the Contractor

may file a Claim pursuant to Article 15.

Article 3
CONTRACTOR

3.1 **General**

3.1.1 Add the following sentence at the end of 3.1.1:

The relationship of Contractor to Owner shall be that of independent contractor, and nothing in the Contract Documents is intended to nor should it be construed as creating any other relationship, expressed or implied, between Owner and Contractor.

3.1.3 Change the word "Architect" to "Prime Professional" and change the word "Architect's" to "Prime Professional's".

3.2 **Review of Contract Documents and Field Conditions by Contractor**

3.2.2 Change each instance of the word "Architect" to "Prime Professional".

3.2.3 Change each instance of the word "Architect" to "Prime Professional".

3.2.4 Change the word "Architect" to "Prime Professional".

3.3 **Supervision and Construction Procedures**

3.3.1 Change each instance of the word "Architect" to "Prime Professional".

3.4 **Labor and Materials**

3.4.1 Add the following sentence to the end of Article 3.4.1:

No materials to be incorporated in the Work or otherwise used in the construction of the Project shall contain any material subject to EPA regulations or listed by it as carcinogenic or toxic.

3.4.2 Change each instance of the word "Architect" to "Prime Professional".

3.4.4 Add a new Subparagraph as follows:

Employee Status Verification System If applicable, the Contractor represents and warrants that it will ensure its compliance with the Mississippi Employment Protection Act, Section 71-11-1, et seq. of the Mississippi Code Annotated (Supp. 2008), and will register and participate in the status verification system for all newly hired employees. The term "employee" as used herein means any person that is hired to perform work within the State of Mississippi. As used herein, "status verification system" means the Illegal Immigration Reform and Immigration Responsibility Act of 1996 that is operated by the United States Department of Homeland Security, also known as the E-Verify Program, or any other successor electronic verification system replacing the E-Verify Program. The Contractor agrees to maintain records of such compliance and, upon request of the County or State and approval of the Social Security Administration or Department of Homeland Security, where required, to provide a copy of each such verification to the County and/or State. The Contractor further represents and warrants that any person assigned to perform services hereunder meets the employment eligibility requirements of all immigration laws of the State of Mississippi. The Contractor understands and agrees that any breach of these warranties may subject the Contractor to the following: (a) termination of this Agreement and ineligibility for any state or public contract in Mississippi for up to three (3) years, with notice of such cancellation/termination being made public, or (b) the loss of any license, permit, certification or

other document granted to the Contractor by an agency, department or governmental entity for the right to do business in Mississippi for up to one (1) year, or (c) both. In the event of such cancellation/termination, the Contractor would also be liable for any additional costs incurred by the County due to the contract cancellation or loss of license or permit.

3.4.5 Add a new Subparagraph as follows:

In providing labor for the proper execution and completion of the Work, the Contractor shall comply with the provisions of Section 31-5-19 of the Mississippi Code of 1972, Annotated.

3.4.6 Add a new Subparagraph as follows:

In providing materials for the proper execution and completion of the Work, the Contractor shall comply with the provisions of Section 31-5-23 of the Mississippi Code of 1972, Annotated.

3.4.7 Add a new Subparagraph as follows:

Contractor represents that it has independently investigated, considered and understands the labor conditions in the area surrounding the Project and acknowledges that such conditions may impact the Contractor's cost and/or time of performance of the Contract. Therefore, Contractor further represents that the Contract Price is based upon Contractor's independent investigations into such labor conditions and that the Contract time is reasonable and the date of Substantial Completion is obtainable. As a result, Contractor assumes the risk of increased costs, if any, incurred by it arising out of or related to such labor conditions and acknowledges that Contractor and its surety will reimburse Owner for any additional costs Owner incurs arising out of or related to such labor conditions.

3.5 **Warranty**

3.5.1 Change each instance of the word "Architect" to "Prime Professional".

3.7 **Permits, Fees, Notices and Compliance with Laws**

3.7.1 Change this Subparagraph to read as follows:

Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for any applicable permits, fees, licenses, and inspections by government agencies necessary for the proper execution and completion of the Work that are customarily secured after execution of the Contract and legally required at the time bids are received or negotiations concluded.

3.7.2 Change this Subparagraph to read as follows:

At no additional cost to the Owner, the Contractor shall comply with and give notices required by all laws, statutes, ordinances, codes, safety requirements, rules and regulations of whatever nature that apply to the Project, whether enacted or adopted before or after bid opening. If the Contractor observes that portions of the Contract Documents are in conflict therewith, the Contractor shall promptly notify the Owner and Prime Professional, in writing, and necessary changes shall be accomplished by appropriate modifications.

3.7.3 Delete the words "knowing it to be" from this Subparagraph.

3.7.4 Change each instance of the word "Architect" to "Prime Professional" and change the word "Architect's" to "Prime Professional's".

3.7.5 Change the word "Architect" to "Prime Professional".

3.8 **Allowances**

3.8.2.3 Replace the word "shall" with "may"

3.9 **Superintendent**

3.9.2 Change this Subparagraph to read as follows:

The Contractor, as soon as practicable after award of the Contract, and prior to commencement of any on-site Work, shall notify the Owner and Prime Professional of the name, qualifications and references of the proposed superintendent and any assistant superintendents where provided for in the Contract Documents. Within 14 days of receipt of the information, the Prime Professional shall notify the Contractor stating whether the Owner or the Prime Professional (1) has reasonable objection to the proposed superintendent based upon information provided or other requirements provided for in the Contract Documents or (2) requires additional information or time for review. Failure of the Prime Professional to respond within the 14-day period shall constitute notice of no reasonable objection.

3.9.3 Change the word "Architect" to "Prime Professional".

3.10 **Contractor's Construction and Submittal Schedules**

3.10.1 Change this Subparagraph to read as follows:

The Contractor, promptly after being awarded the Contract, and no later than fifteen days after the date established in the Notice to Proceed, shall submit, for the Owner's and Prime Professional's information, a Contractor's construction schedule for the Work. The schedule shall contain detail appropriate for the Project, including (1) the date of commencement of the Work, interim schedule milestone dates, and the date of Substantial Completion; (2) an apportionment of the Work by construction activity; and (3) the time required for completion of each portion of the Work. The schedule shall provide for the orderly progression of the Work to completion and shall not exceed the time limits current under the Contract Documents. Submission of a schedule that indicates or expresses an intent to complete Work prior to the time limits established by the Contract Documents shall not make the Owner liable to the Contractor for any failure to achieve early completion or obligate the Owner to take or prevent any actions to facilitate the Contractor's completion prior to the expiration of the Contract Time. The schedule shall be revised monthly or at more frequent intervals as required by the conditions of the Work and Project.

3.10.2 Change each instance of the word "Architect's" to "Prime Professional's" and change the word "Architect" to "Prime Professional".

3.10.3 Change the word "Architect" to "Prime Professional" and delete the word "general".

3.11 **Documents and Samples at the Site**

Change each instance of the word "Architect" to "Prime Professional".

3.12 **Shop Drawings, Product Data and Samples**

3.12.4 Change each instance of the word "Architect" to "Prime Professional".

3.12.5 Change each instance of the word "Architect" to "Prime Professional".

3.12.6 Change the word "Architect" to "Prime Professional".

3.12.7 Change the word "Architect" to "Prime Professional".

3.12.8 Change each instance of the word "Architect's" to "Prime Professional's" and change the word "Architect" to "Prime Professional".

3.12.9 Change the word "Architect" to "Prime Professional" and change the word "Architect's" to "Prime Professional's".

3.12.10.1 Change each instance of the word "Architect" to "Prime Professional".

3.12.10.2 Change each instance of the word "Architect" to "Prime Professional".

3.15 **Cleaning Up**

3.15.2 Change this Subparagraph to read as follows:

If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and the cost thereof shall be assessed to the Contractor.

3.16 **Access to Work**

Change this Paragraph to read as follows:

The Contractor shall provide the Owner, Prime Professional, Separate Contractors and their authorized representatives with access to the Work in preparation and progress wherever located. This shall include the provision of lifts, ladders, scaffolding and/or equivalent for access to elevated work.

3.17 **Royalties, Patents and Copyrights**

Change each instance of the word "Architect" to "Prime Professional".

3.18 **Indemnification**

3.18.1 Change this Subparagraph to read as follows:

To the fullest extent allowed by law, Contractor shall indemnify, defend, save and hold harmless, protect, and exonerate the Owner, Prime Professional, Prime Professional's consultants, as well as Jackson County, Mississippi, its Board Members, officers, employees, agents, and representatives, from and against all claims, demands, liabilities, suits, actions, damages, losses, and costs of every kind and nature whatsoever, including, without limitation, court costs, investigative fees and expenses, and attorneys' fees, arising out of or caused by Contractor's and/or its partners, principals, agents, employees, and/or subcontractors in the performance of or failure to perform this Agreement. In the County's sole discretion, Contractor may be allowed to control the defense of any such claim, suit, etc. In the event Contractor defends said claim, suit, etc., Contractor shall use legal counsel acceptable to the County; Contractor shall be solely liable for all reasonable costs and/or expenses associated with such defense and the County shall be entitled to participate in said defense. Contractor shall not settle any claim, suit, etc., without the County's concurrence, which the County shall not unreasonably withhold.

Article 4
ARCHITECT

Change the title of this article from "ARCHITECT" to "PRIME PROFESSIONAL".

4.1 **General**

4.1.1 Change this Subparagraph to read as follows:

The Prime Professional is the person identified as the Professional in the Agreement Between the Owner and the Contractor and retained by the Owner pursuant to Section 2.3.2.

4.1.2 Change the word "Architect" to "Prime Professional", and delete the following words: "Contractor and Architect. Consent shall not be reasonably withheld."

4.2 **Administration of the Contract**

4.2.1 Change the word "Architect" to "Prime Professional" and change the first line of this Subparagraph to read as follows:

The Prime Professional will provide administration of the Contract as described in the Contract Documents, and will be the Owner's representative during construction until the end of the period for correction of Work as described in Section 12.2.

4.2.2 Change each instance of the word "Architect" to "Prime Professional".

4.2.3 Change each instance of the word "Architect" to "Prime Professional".

4.2.4 Change each instance of the word "Architect" to "Prime Professional" and each instance of the word "Architect's" to "Prime Professional's".

4.2.5 Change the word "Architect's" to "Prime Professional's" and change the word "Architect" to "Prime Professional".

4.2.6 Change each instance of the word "Architect" to "Prime Professional".

4.2.7 Change each instance of the word "Architect" to "Prime Professional" and each instance of the word "Architect's" to "Prime Professional's".

4.2.8 Change each instance of the word "Architect" to "Prime Professional".

4.2.9 Change the word "Architect" to "Prime Professional".

4.2.10 Change each instance of the word "Architect" to "Prime Professional" and the word "Architect's" to "Prime Professional's".

4.2.11 Change the word "Architect" to "Prime Professional" and the word "Architect's" to "Prime Professional's" and change the word "decide" to "provide opinions on".

4.2.12 Change each instance of the word "Architect" to "Prime Professional" and change in each instance the word "decisions" to "opinions".

4.2.13 Delete this Subparagraph in its entirety.

4.2.14 Change each instance of the word "Architect" to "Prime Professional".

Article 5
SUBCONTRACTORS

5.2 **Award of Subcontracts and Other Contracts for Portions of the Work**

5.2.1 Change this Subparagraph to read as follows:

Unless otherwise stated in the Contract Documents or the bidding requirements, the Contractor, prior to award of the Contract by the Owner, shall furnish in writing to the Owner through the Prime Professional, the names, classifications, and COR #'s of Sub-

Contractors over Fifty Thousand Dollars ($50,000.00) (as well as entities who are to furnish materials or equipment fabricated to a special design) proposed for each principal portion of the Work. Such list shall also include any Mechanical, Plumbing, or Electrical Sub-Contractor as listed on Proposal Form regardless of amount. Within 7 days of receipt of the information, the Prime Professional shall notify the Contractor whether the Owner or the Prime Professional (1) has reasonable objection to any such proposed Sub-Contractor or entity based upon information provided or other requirements provided for in the Contract Documents or (2) requires additional information or time for review. Failure of the Prime Professional to respond within the 7-day period shall constitute notice of no reasonable objection. Where a Project involves a Mississippi Landmark or a building and/or site potentially eligible for such designation, the Contractor shall also furnish documentation that all Sub-Contractors, regardless of Sub-Contract amount, have at least the minimum number of years of successful experience specified by the Prime Professional in work on previous projects involving State or National Landmarks of similar type, scale and complexity and that all key personnel to be utilized to perform the Work are experienced craftsmen with not less than five (5) years of experience.

5.2.2 Change this Subparagraph to read as follows:

The Contractor shall not contract with a proposed Sub-Contractor or entity to whom the Owner or Prime Professional has made reasonable and timely objection. Other than the Mechanical, Plumbing, or Electrical Sub-Contractors as listed on the Proposal Form, the Contractor shall not be required to contract with anyone to whom the Contractor has made reasonable objection. Only where the listed Mechanical, Plumbing, or Electrical Sub-Contractor has (1) closed their business (2) entered into bankruptcy or (3) refuses to enter into a contract with the Contractor will substitution of such Sub-Contractor be permitted prior to the execution of the Agreement Between the Owner and Contractor. Substitution for refusal to enter into contract shall not be permitted if the reason for such refusal is due to unilateral reduction by Contractor of such Sub-Contractor's bid price.

5.2.3 Change this Subparagraph to read as follows:

If the Owner or Prime Professional has reasonable objection to a Sub-Contractor or entity proposed by the Contractor, other than the Mechanical, Plumbing, or Electrical Sub-Contractors as listed on the Proposal Form, the Contractor shall propose another to whom the Owner or Prime Professional has no reasonable objection. Neither the Contract Sum nor Contract Time may be increased or decreased due to any change in Sub-Contractor or entity. Failure of Contractor to identify Sub-Contractors or entities to whom the Owner and Prime Professional have no reasonable objections within 10 working days of initial submission shall result in the bid or proposal being deemed non-responsive at which time the Owner may elect to award to the next lowest responsive, responsible bidder or rebid the project.

5.2.4 Change this Subparagraph to read as follows:

Following the execution of the Agreement Between the Owner and Contractor, the Contractor shall not substitute a Sub-Contractor, person or entity previously selected without written consent of the Owner. The Contractor's unauthorized substitution of any Subcontractor, person or entity shall entitle the Owner to reject the work, materials or product furnished and require removal and replacement at no additional cost to the Owner. In no case shall substitution of Mechanical, Plumbing or Electrical Sub-Contractors be permitted except where such Sub-Contractor has (1) closed their business (2) entered into bankruptcy (3) becomes in arrears or (4) becomes involved in an ongoing dispute with the Contractor related to the Sub-Contractor's execution, workmanship, or timely performance of their potion of the Work.

5.4 **Contingent Assignment of Subcontracts**

5.4.1 Delete this Subparagraph in its entirety.

5.4.2 Delete this Subparagraph in its entirety.

5.4.3 Delete this Subparagraph in its entirety.

Article 6
CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

6.1 **Owner's Right to Perform Construction and to Award Separate Contracts**

6.1.1 Change this Subparagraph to read as follows:

The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and to award separate contracts in connection with other portions of the Project or other construction or operations on the site.

6.1.4 Delete this Subparagraph in its entirety.

6.2 Mutual Responsibility

6.2.2 Change each instance of the word "Architect" to "Prime Professional".

6.2.3 Delete Last Sentence.

6.2.5 Delete this Subparagraph in its entirety.

6.3 Change the word "Architect" to "Prime Professional".

Article 7
CHANGES IN THE WORK

7.1 **General**

Add the following to the end of 7.1.3:

Except as permitted in Article 7.3, a change in the Contract Sum or the Contract Time shall only be accomplished by written change order. Therefore, the Contractor acknowledges that it is not entitled to a change in the Contract Sum or the Contract Time in the absence of a written change order on the basis of the course of conduct or dealings between the parties and/or the Owner's express or implied acceptance of alterations or additions to the Work and/or the Owner has been unjustly enriched by the Contractor's Work or any other basis otherwise allowed by law or the facts and Contractor agrees that any such extra or changed work was performed by it as a volunteer.

7.2 **Change Orders**

7.2.1 Change each instance of the word "Architect" to "Prime Professional".

7.2.2 Add a new Subparagraph as follows:

The maximum mark-up included in a Change Order for profit and overhead is limited to ten percent (10%) of the total of the actual cost for materials, labor and subcontracts. Profit and overhead include: all taxes, fees, permits, insurance, bond, job superintendent, job and home office expense. All Sub-Contractors and Sub-Sub-Contractors shall acquiesce to the same requirements when participating in a Change Order.

7.2.3 Add a new Subparagraph as follows:

In order to facilitate consideration of change order requests, all such requests, except those involving an amount less than $500 must be accompanied by a complete itemization of costs, including labor, materials and subcontractor costs which shall likewise be itemized. Changes for more than $500 may not be approved without such itemization.

7.2.4 Add a new Subparagraph as follows:

Contractor's execution of a change order constitutes a final settlement to the Contract Sum, construction schedule and the Contract Time for all matters relating to or arising out of the change in the Work that is the subject of the change order.

7.3 **Construction Change Directives**

7.3.4 Change the word "Architect" to "Prime Professional".

7.3.4.1 Change the word "Architect" to "Prime Professional".

7.3.6 Change this Subparagraph to read as follows:

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

7.3.7 Change this Subparagraph to read as follows:

A Construction Change Directive signed by the Contractor indicates the Contractor's agreement therewith, including adjustment in Contract Sum and Contract Time or the method for determining them. Such agreement shall become effective once signed by the Prime Professional and the Owner and will subsequently be incorporated into a Change Order.

7.3.8 Change the word "Architect" to "Prime Professional".

7.3.9 Change this Subparagraph to read as follows:

Until such time that a Construction Change Directive is recorded as a Change Order, the Contractor may not request payment for Work completed under the Construction Change Directive in Applications for Payment.

7.3.10 Change each instance of the word "Architect" to "Prime Professional".

7.4 Change each instance of the word "Architect" to "Prime Professional" and the word "Architect's" to "Prime Professional's".

Article 8
TIME

8.1 **Definitions**

8.1.2 Change this Subparagraph to read as follows:

The date of commencement of the Work is the date established in the Notice to Proceed.

8.1.3 Change the word "Architect" to "Prime Professional".

8.2 **Progress and Completion**

8.2.1 Change this Subparagraph to read as follows:

Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement, the Contractor confirms that the Contract Time is a reasonable period for performing the Work, that the Contractor is fully capable of properly

completing the Work within the Contract Time, and acknowledges that such period includes time for all applicable submittals, selections, reviews, approvals, inspections, meetings, as well as discovery and investigation of any latent conditions.

8.2.2 Change this Subparagraph to read as follows:

The Contractor shall not knowingly commence the Work prior to the date established in the Notice to Proceed or the effective dates of bond and insurance required to be furnished by the Contractor.

8.3 **Delays and Extensions of Time**

8.3.1 Change this Subparagraph to read as follows:

No delay, interference, hindrance or disruption, from whatever source or cause, in the commencement or progress of the Contractor's Work shall be a basis for an extension of time and/or additional compensation, unless the delay, interference, hindrance or disruption (1) is without the fault and not the responsibility of the Contractor, its Sub-Contractors and/or suppliers and (2) directly affects the overall completion of the Work as reflected on the critical path of the Contractor's updated and accepted construction schedules. If the Owner, in consultation with the Prime Professional determines a delay is justified, then the Contract Time shall be extended for such reasonable time as the Owner, in consultation with the Prime Professional, may determine. Such determination shall take into consideration the critical path of the Work and will be reduced by any float in the Contractor's Construction Schedule that does not affect the overall completion of the Work. Except where such delay is due to suspension by the Owner in accordance with Article 14 or such delay has the effect of stopping all progress of the Work for 14 calendar days or more, the Contract Sum will not be increased for additional general overhead expenses. Any claim for loss or any delay occasioned by any Sub-Contractor or entity under contract with the Contractor, shall be settled between the Contractor and such other Sub-Contractor or entity.

8.3.2 Change this Subparagraph to read as follows:

All claims by the Contractor for or relating to a change in Contract Time must follow the procedures set forth in Articles 15.1.2 and 15.1.5, including the requirement that the Contractor give written notice of any Claim within twenty-one (21) days after occurrence of the event giving rise to such a Claim or within twenty-one (21) days after the Contractor first recognizes the condition giving rise to the Claim, whichever is later.

8.3.4 Add a new Subparagraph as follows:

The Contractor expressly agrees that the Owner shall have the benefit of any float in the construction schedule and that delays to construction activities, which do not affect the overall completion of the Work, do not entitle the Contractor to any extension in the Contract Time and/or increase in Contract Sum.

Article 9
PAYMENTS AND COMPLETION

9.2 **Schedule of Values**

Change this Paragraph to read as follows:

Where the Contract is based on a stipulated sum, the Contractor shall submit to the Prime Professional, at least 10 working days before the first Application for Payment, a schedule of values allocating the entire Sum to the various portions of the Work. The schedule of values shall be prepared in the form, and supported by the data to substantiate its accuracy, required by the Prime Professional. This schedule, unless objected to by the Prime Professional or Owner, shall be used as a basis for reviewing the Contractor's Applications for Payment. Any subsequent changes to the schedule of values shall be submitted to the Prime Professional and supported by such data to substantiate its accuracy as the Prime Professional may require, and unless objected to by the Prime Professional or Owner, shall be used as a basis for reviewing the Contractor's subsequent Applications for Payment.

9.3 **Applications for Payment**

9.3.1 Add a new sentence to the end of this Subparagraph:

The form of Application for Payment will be AIA Document G702, Application and Certification for Payment, supported by AIA Document G703, Continuation Sheet, or a computer generated form containing similar data.

9.3.1.1 Delete this Subparagraph in its entirety.

9.3.1.3 Add a new Clause to Subparagraph 9.3.1 as follows:

On any contract as described herein, of which the total amount is Two Hundred Fifty Thousand Dollars ($250,000.00) or greater, or on any contract with a subcontractor, regardless of amount, five percent (5%) shall be retained until the Work is at least fifty percent (50%) complete, on schedule and satisfactory in the Prime Professional's opinion, at which time fifty percent (50%) of the retainage held to date shall be returned, subject to consent of surety, to the prime contractor for distribution to the appropriate subcontractors and suppliers; provided, however, that future retainage shall be withheld at the rate of two and one-half percent (2 1/2%). When submitting request for reduction in retainage, the Contractor will include, with the application, a Consent of Surety to Reduction which is AIA Form G707A, and a Power of Attorney. (Code 31-5-33)

9.3.1.4 Add a new Clause to Subparagraph 9.3.1 as follows:

The Contractor must submit each month with this Application for Payment a separate letter stating that he is requesting an extension of time or that he had no need for an extension for that period of time. No payment on a monthly application will be considered due and payable until the letter is received. Complete justification such as weather reports or other pertinent correspondence must be included for each day's request for extension. A Contractor's letter, or statement, will not be considered as adequate justification. The receipt of this request and data by the Owner will not be considered as approval of the Owner or Prime Professional in any way.

9.3.2.1 Add a new Clause to Subparagraph 9.3.2 as follows:

Payment in an amount not greater than the documented cost paid by the Contractor for materials stored at some location other than the Project site, may be approved by the Prime Professional and the Owner after the Contractor has submitted the following items:

.1 An acceptable Lease Agreement between the General Contractor and the owner of the land, or building, where the materials are stored covering the specific area where the materials are located.
.2 Consent of Surety, or other acceptable Bond, to cover the materials stored off-site.
.3 All Perils Insurance coverage for the full value of the materials stored off-site.
.4 A Bill of Sale from the Manufacturer to the General Contractor for the stored materials.
.5 A complete list and inventory of materials manufactured, stored and delivered to the storage site and of materials removed from the storage site and delivered to the job site.
.6 A review by the Prime Professional of the materials stored off-site prior to release of payment. Where the storage location is greater than 50 miles of the building site, the Contractor shall pay or reimburse reasonable travel costs of the Prime Professional and/or his Consultants for such review.
.7 Proof of payment of stored materials verified by the supplier must be submitted to the Prime Professional within thirty (30) days of the Application for Payment on which payment for said materials was made. If proof of payment is not submitted within thirty (30) days, then payment for said materials will be deducted from the next application for payment and withheld until proof of payment is received.
.8 Guarantee no storage costs, additional delivery fees, or subsequent costs to the Owner.

9.4 **Applications for Payment**

9.4.1 Change each instance of the word "Architect" to "Prime Professional" and the word "Architect's" to "Prime Professional's".

9.4.2 Change each instance of the word "Architect" to "Prime Professional" and each instance of the word "Architect's" to "Prime Professional's".

9.5 **Decisions to Withhold Certification**

9.5.1 Change each instance of the word "Architect" to "Prime Professional" and the word "Architect's" to "Prime Professional's".

9.5.1.7 Delete the word "repeated" from this Clause.

9.5.1.8 Add the following as Article 9.5.1.8:

.8 The letter from the Contractor which is required by Article 9.3.1.4 has not been received.

9.5.2 Change the word "Architect" to "Prime Professional".

9.5.3 Delete this Subparagraph in its entirety.

9.5.4 Change each instance of the word "Architect" to "Prime Professional".

9.6 **Progress Payments**

9.6.1 Change this Subparagraph to read as follows:

The Owner agrees to make payment in accordance with Mississippi law. Subject to the conditions of the contract, the Owner shall place the Certificate for Payment, following receipt of same from the Prime Professional, on its next regular monthly claims docket for approval and make all undisputed payments to the Contractor in the amount certified.

9.6.2 Change the first line of this Subparagraph to read as follows:

The Contractor shall pay each Sub-Contractor and material supplier, in accordance with Section 31-5-27 of the Mississippi Code 1972, Annotated, in proportion to the percentage of work completed by each less applicable retainage.

9.6.3 Change each instance of the word "Architect" to "Prime Professional".

9.6.4 Change the word "Architect" to "Prime Professional".

9.6.7 Change the word "Unless" in the First Sentence to the phrase "Whether or not".

9.6.9 Add a new Subparagraph as follows:

The amount retained by the Contractor from each payment to each Sub-Contractor and material supplier shall not exceed the percentage retained by the Owner from the Contractor.

9.6.9.1 Add a new Clause to Subparagraph 9.6.9 as follows:

The Contractors shall submit monthly certification, in accordance with Section 31-5-25 of the Mississippi Code 1972, Annotated, on Owner's "Affidavit Certifying Payment to All Subcontractors" form, to the Prime Professional indicating payments to subcontractors on prior payment request.

9.6.10 Add a new Subparagraph as follows:

Contractor understands and agrees that the Owner, as a political subdivision of the State of Mississippi, is exempt from the payment of taxes. All payments shall be in United States currency**.** No payment, including final payment, shall be construed as acceptance of defective or incomplete work, and the Contractor shall remain responsible and liable for full performance.

9.7 **Failure of Payment**

Change this Paragraph to read as follows:

The Contractor and the Owner shall be subject to the remedies as prescribed in Section 31-5-25 of the Mississippi Code 1972, Annotated.

9.8 **Substantial Completion**

9.8.1 Add the following sentence to the end this Subparagraph to read as follows:

In order to be considered occupiable or utilizable by the Owner, all life safety systems must be operable and tested and the commissioning requirements for the Work or designated portion thereof must be complete.

9.8.3 Change this Subparagraph to read as follows:

Upon receipt of the Contractor's list, the Prime Professional will promptly visit the site to determine whether the Work or designated portion thereof is substantially complete. If, in the opinion of the Prime Professional, the Work or designated portion thereof is not substantially complete, the Prime Professional will not proceed with inspection and the Prime Professional will report the reasons for such determination to the Contractor. In such case, the Contractor shall then submit a revised list and request for inspection when these reasons have been resolved.

9.8.4 Change this Subparagraph to read as follows:

When the Work or designated portion thereof is substantially complete and affirmed by the Owner, the Prime Professional will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion, shall establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance, and shall fix the time within which the Contractor shall finish all items on the punch list accompanying the Certificate. Unless otherwise provided in the Contract Documents, warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.

9.8.5 Add the following to the end of Article 9.8.5:

Contractor's execution of the Certificate of Substantial Completion constitutes Contractor's representation that the items on the list accompanying the Certificate can and will be completed by Contractor and his subcontractors within thirty (30) days of Contractor's execution of the Certificate. Based upon this representation by Contractor and upon the acknowledgment of the Prime Professional that the listed items remaining can be completed within thirty (30) days, the Owner agrees to execute the Certificate of Substantial Completion. If Contractor fails to complete the items on the list within thirty (30) days of Contractor's execution of the Certificate, then the Owner, at its option and without prejudice to any other rights or remedies it may have under this Contract or otherwise and without notice to Contractor or Surety, may proceed to have same completed and to deduct the reasonable costs thereof from the amounts then due or thereafter to become due to Contractor.

9.8.6 Add a new Subparagraph as follows:

The costs of inspections made by the Prime Professional which are not required by Articles 4, 9.8 or 9.10 or 12 of the General Conditions and any other inspection required by Article 12 other than the year-end inspection itself, will be the responsibility

of the Contractor and will be deducted by the Owner from the Application for Payment submitted after the Owner's receipt of the Prime Professional's statement for its costs of additional inspections. These costs are not the result of Contractor's failure to timely complete the Contract within the specified time and, therefore, such costs are in addition to and not a part of any liquidated damages calculation, if any.

9.9 **Partial Occupancy or Use**

9.9.1 Change each instance of the word "Architect" to "Prime Professional".

9.9.1.1 Add a new Subparagraph as follows:

The Owner's occupancy or use of any completed or partially completed portions of the Work shall not affect Contractor's obligation to complete incomplete items on the list attached to the Certificate of Substantial Completion within the time fixed in the Certificate and does not waive Owner's right to obtain completion of incomplete items at Contractor's expense upon Contractor's failure to timely complete same.

9.9.2 Change the word "Architect" to "Prime Professional".

9.10 **Final Completion and Final Payment**

9.10.1 Change this Subparagraph and add the associated Clauses to read as follows:

When, in the opinion of the Contractor, the Work is ready for final inspection and acceptance by the Owner, the Contractor shall make such notice to the Prime Professional.

1. Upon receipt of the Contractor's notice that the Work is ready for final inspection and acceptance by the Owner, the Prime Professional will promptly visit the site and assess the state of the Work to determine if it is ready for final inspection by the Owner. If, in the Prime Professional's judgment, the Work is not ready for final inspection, the Prime Professional will report the reasons for such determination to the Contractor. In such case, the Contractor shall then submit a revised request for final inspection when these reasons have been resolved.

2. Once the Prime Professional determines the Work is ready for final inspection, the Prime Professional will call for final inspection of the Project with the Owner for the purpose of determining whether the Work is acceptable under the Contract Documents.

3. The final inspection shall be conducted in the presence of the Owner and a list of defects or discrepancies, if any, will be compiled into a final punch list furnished to all parties.

4. Once corrections of all final punch list items have been confirmed by the Prime Professional, the Prime Professional will provide a letter recommending final acceptance of the Work to the Owner.

9.10.2 Change this Subparagraph to read as follows:

Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Prime Professional (1) final application for payment, (2) consent of surety to final payment, (3) power of attorney, (4) Contractor's affidavit of release of liens, (5) Contractor's affidavit of payment of debts and claims, (6) Contractor's guarantee of work, (7) Project Record Documents and (8) certificates, warranties, guarantees, bonds or documents as called for in the individual sections of the Project Manual. The final payment will be reduced by the value of any amounts assessed to the Contractor per Section 2.5 Owner's Right to Carry Out the Work, Section 6.3 Owners Right to Clean Up, or Section 9.11 Liquidated Damages where such amounts have not been reconciled by a Change Order per Section 7.2 prior to final acceptance unless such amounts have been resolved via separate agreement(s) between the Owner and the Contractor.

9.10.4 Delete this Subparagraph in its entirety.

9.11 **Liquidated Damages**

9.11.1 Add a new Paragraph as follows:

Time being of the essence and a matter of material consideration thereof, a reasonable estimate in advance is established to cover losses incurred by the Owner if the Project is not substantially complete on the date set forth in the Contract Documents. The Contractor and his Surety will be liable for and will be assessed by the Owner the sums as indicated in the Standard Form of Agreement between the Owner and Contractor stipulated in Paragraph 2.2 of the Standard Form of Agreement Between the Owner and the Contractor as fixed and agreed as liquidated damages for each calendar day of delay until the Work is substantially complete unless circumstances dictate otherwise in the discretion of the Owner. The Contractor and his Surety acknowledge that losses to the Owner caused by the delay of the Contractor are not readily ascertainable and that the amount estimated per day and established as liquidated damages is reasonable and not a penalty.

Article 10
PROTECTION OF PERSONS AND PROPERTY

10.2 **Safety of Persons and Property**

10.2.5 Change this Subparagraph to read as follows:

The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Clauses 10.2.1.2 and 10.2.1.3 caused in whole or in part by the Contractor, a Sub-Contractor, a Sub-Sub-Contractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible under Clauses 10.2.1.2 and 10.2.1.3. The Contractor may make a Claim for the cost to remedy the damage or loss attributable to acts or omissions of the Owner or Prime Professional and not attributable to the fault or negligence of the Contractor. Where damage or loss is insured under property insurance required by the Contract Documents, the Contractor shall promptly report, file and facilitate the claim process so as to minimize any impacts on the timely completion of the Work. The foregoing obligations of the Contractor are in addition to the Contractor's obligations under Paragraph 3.18.

10.2.9 Add new Subparagraph as follows:

10.2.9 The Contractor shall be responsible for the adequate strength and safety of all scaffolding, staging and hoisting equipment and for temporary shoring, bracing and tying.

10.3 **HAZARDOUS MATERIALS**

10.3.2 Delete this Subparagraph in its entirety.

10.3.3 Delete this Subparagraph in its entirety.

10.3.4 Delete this Subparagraph in its entirety.

10.3.5 Change this Subparagraph to read as follows:

The Contractor shall indemnify and hold harmless the Owner for any and all claims, damages, losses, expenses, attorney's fees, including but not limited to the cost and expense the Owner incurs (1) for remediation of a material or substance the Contractor brings to the site and negligently handles, or (2) where the Contractor fails to perform its obligations under Section 10.3.1.

10.3.6 Delete this Subparagraph in its entirety.

Article 11
INSURANCE AND BONDS

11.1 **Contractor's Insurance and Bonds**

11.1.1 Change this Subparagraph to read as follows:

The Contractor shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Contractor shall purchase and maintain the required insurance from an insurance company or companies licensed to do business in Mississippi and against which the Owner has no reasonable objections. The Owner, Prime Professional and Prime Professional's consultants shall be named as additional insureds under the Contractor's commercial general liability policy or as otherwise described in the Contract Documents.

Insurance shall be purchased to protect the Contractor for not less than the limits of liability specified by Article 11 or required by law, whichever coverage is greater, which may arise out of or result from the Contractor's operations and completed operations under the Contract and for which the Contractor may be legally liable, whether such operations be by the Contractor or by a Sub-Contractor or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable.

The Contractor's certificate of insurance must state that the Owner and Prime Professional are additional insureds under the referenced CGL policy and that all of Contractor's contractual liabilities, including but not limited to its indemnity obligations, are covered by such CGL policy. Any language contained on the certificate of insurance form or elsewhere to the contrary is deemed stricken. The certificate of insurance must also state that all of Contractor's contractual liabilities, including but not limited to its indemnity obligations, are covered. Any terms and conditions contained in the certificate of insurance which are contrary to the Contractor's contractual obligations are hereby stricken from the certificate.

Certificates of insurance acceptable to the Owner shall be filed with the Owner prior to final execution of the Contract. Furnish one copy of the Certificate herein required for each copy of the Agreement, specifically setting forth evidence of all coverage required by Article 11. Furnish to the Owner copies of any endorsements that are subsequently issued amending limits of coverage.

Copies of all Policies, including Policy Jackets, must accompany Certificates of Insurance. The Owner may also require that a true copy of all policies specified be filed with it. Each and every policy and certificate must contain an endorsement stating that the insurance company will not, prior to the completion of the project or any policy expiration date shown on the policy and certificate, whichever occurs first, terminate the policy or change any coverage therein without first mailing to the Owner, by registered mail, written notice of such action at least thirty (30) days prior to the termination or change.

11.1.2: Change this Subparagraph to read:

The Contractor shall furnish and pay for a Performance Bond and Labor and Material Payment Bond of a company qualified to do business in the State of Mississippi, and which is acceptable to the Owner, in an amount equal to 100% of the Contract Sum, as security for the true and faithful performance of the Contract and payment in full of all subcontractors and persons performing labor, services, materials, machinery and fixtures in connection with the Work.

The executed bonds, together with the bonding agent's power of attorney, shall be furnished to the Owner along with the executed Contract and number of copies reasonably required. The bonds shall provide that the surety waives the requirements of notice of any change in the Work which does not exceed 20% of the Contract Sum and of any extension of time granted to the Contractor. The Contractor shall deliver the required bonds to the Owner not later than the date of execution of the Contract.

11.1.5: Add a new subparagraph to read:

Contractor's limits of liability shall be written for amounts not less than the following, or greater amounts if required by law or if deemed necessary by the Contractor to protect his interests:

.1	**General Liability**		
	Commercial General Liability (including XCU)		
	General Aggregate	$1,000,000.00	Aggregate
	Products & Completed Operations	$1,000,000.00	Aggregate
	Personal & Advertising Injury	$ 500,000.00	Per Occurrence
	Bodily Injury & Property Damage	$1,000,000.00	Per Occurrence
	Fire Damage Liability	$ 50,000.00	Per Occurrence
	Medical Expense	$ 5,000.00	Per Person
.2	**Owners and Contractors Protective Liability:**		
	Bodily Injury & Property Damage	$1,000,000.00	Aggregate
	Bodily Injury & Property Damage	$ 500,000.00	Each Occurrence
.3	**Automobile Liability** (Owned, Non-owned & Hired Vehicles)		
	Bodily Injury	$1,000,000.00	Per Person
		$2,000,000.00	Per Accident
	Property Damage	$1,000,000.00	Per Accident
.4	**Excess or Umbrella Liability**	$1,000,000.00	General Aggregate
.5	**Workers' Compensation**	As required by statute	
	EMPLOYERS' LIABILITY		
	Accident	$100,000.00	Per Occurrence
	Disease	$500,000.00	Policy Limit
	Disease	$100,000.00	Per Employee
.6	**Property Insurance**		
	Builder's Risk	Equal to Value of Work	
	OR		
	Installation Floater	Equal to Value of Work	

Property Damage Liability insurance will provide Explosion, Collapses and Underground Coverages where applicable.

11.1.6 Add a new Subparagraph to read as follows:

Insurance shall be maintained without interruption from the date of commencement of the Work until the date of final payment unless otherwise noted on the Certificate of Substantial Completion.

11.1.7 Add a new Subparagraph to read as follows:

If the Contractor fails to purchase and maintain such insurance and the Owner is damaged by such failure, then the Contractor shall be liable to the Owner for all such damages incurred by the Owner.

11.1.8 Add a new Subparagraph as follows:

If the coverages are provided on a claims-made basis, the policy date or retroactive date shall predate the Contract; the termination date, or the policy, or applicable extended reporting period shall be no earlier than the termination date of coverages required to be maintained after final payment.

11.1.9 Add a new Subparagraph as follows:

If any insurance requires deductibles, the Contractor shall pay costs not covered because of such deductibles.

11.1.10 Add a new Subparagraph as follows:

The Owner as fiduciary shall have power to adjust and settle a loss with Insurers unless one of the parties in interest shall object in writing within five (5) days after occurrence of loss.

11.2 **Owner's Insurance**

Delete this Paragraph in its entirety and substitute the following:

The Contractor shall purchase and maintain such insurance as will protect the Owner and Prime Professional from their contingent liability to others for damages because of bodily injury, including death, and property damage, which may arise from operations under this Contract and other liability for damages which the Contractor is required to insure under any provision of this Contract. Certificate of this insurance will be filed with the Owner and will be the same limits set forth in 11.1.5.

11.2.1 Delete this Subparagraph in its entirety.

11.2.2 Delete this Subparagraph in its entirety.

11.2.3 Delete this Subparagraph in its entirety.

11.3 **Waivers of Subrogation**

11.3.1 Delete this Subparagraph in its entirety.

11.3.2 Delete this Subparagraph in its entirety.

11.4 **Loss of Use, Business Interruption, and Delay in Completion Insurance**

Delete this Paragraph in its entirety.

11.5 **Adjustment and Settlement of Insured Loss**

11.5.1 Delete this Subparagraph in its entirety.

11.5.2 Delete this Subparagraph in its entirety.

Article 12
UNCOVERING AND CORRECTION OF WORK

12.1 **Uncovering of Work**

12.1.1 Change each instance of the word "Architect's" to "Prime Professional's", change the word "Architect" to "Prime Professional",

and add the words "or Contract Sum" at the end of this sentence.

12.1.2 Change each instance of the word "Architect" to "Prime Professional".

12.2 **Correction of Work**

12.2.1 Change the word "Architect" to "Prime Professional" and the word "Architect's" to "Prime Professional's".

12.2.2.1 Change the word "Architect" to "Prime Professional".

12.2.6 Add a new Subparagraph to read:

Upon request by the Owner and prior to the expiration of one year from the date of Substantial Completion, the Prime Professional will conduct, and the Contractor and all major subcontractors shall attend, a meeting with the Owner to review the facility, operations and performance.

Article 13
MISCELLANEOUS PROVISIONS

13.1 **Governing Law**

Change this Paragraph to read as follows:

The Contract shall be governed by the laws of the State of Mississippi.

13.2 **Successors and Assigns**

13.2.1 Change this Subparagraph to read as follows:

The Contractor binds itself, its partners, successors, assigns and legal representatives to covenants, agreements and obligations contained in the Contract Documents. Except as provided in Section 13.2.2, neither party to the Contract shall assign the Contract as a whole without written consent of the other. If either party attempts to make an assignment without such consent, that party shall nevertheless remain legally responsible for all obligations under the Contract.

13.3 **Rights and Remedies**

13.3.2 Change the word "Architect" to "Prime Professional".

13.4 **Tests and Inspections**

13.4.1 Change each instance of the word "Architect" to "Prime Professional".

13.4.2 Change each instance of the word "Architect" to "Prime Professional".

13.4.3 Change the word "Architect" to "Prime Professional's".

13.4.4 Change the word "Architect" to "Prime Professional".

13.4.5 Change each instance of the word "Architect" to "Prime Professional".

13.5 Delete this Paragraph in its entirety.

Article 14
TERMINATION OR SUSPENSION OF THE CONTRACT

14.1 **Termination by the Contractor**

14.1.1.3 Change the word "Architect" to "Prime Professional".

14.1.1.4 Delete this Clause in its entirety.

14.1.3 Change the word "Architect" to "Prime Professional" and delete "as well as reasonable overhead and profit on Work not executed, and costs incurred by reason of such termination".

14.1.4 Change the word "Architect" to "Prime Professional".

14.2 **Termination by the Owner for Cause**

14.2.1.1 Delete the word "repeatedly" from this Clause.

14.2.1.3 Delete the word "repeatedly" from this Clause and delete the word "or" from this Clause.

14.2.1.4 Change the period to a semi-colon.

14.2.1.5 Add a new Clause as follows:

fails to achieve Substantial Completion of the Project within the time limits established by the Contract Documents and/or fails to complete the list of items attached to the Certificate of Substantial Completion; or

14.2.1.6 Add a new Clause as follows:

fails to meet any deadline required by the Contract. Contractor acknowledges that time is of the essence of this Contract and that all deadlines required by the Contract are critical to timely completion of the Contract. Therefore, Contractor agrees that its failure to meet any deadline constitutes a substantial and material breach of this Contract, entitling the Owner to terminate the Contract.

14.2.2 Change the word "Architect" to "Prime Professional" and change the words "certification by" to "advice of".

14.2.4 Delete the First Sentence and change the words "Decision Maker" to "Recommender".

14.2.5 Add a new Subparagraph as follows:

If the Owner terminates the Contract for cause, and it is determined for any reason that the Contractor was not actually in default under the Contract at the time of termination, the Contractor shall be entitled to recover from the Owner the same amount as the Contractor would be entitled to receive under a termination for convenience as provided by Article 14.4. The foregoing shall constitute the Contractor's sole and exclusive remedy for termination of the Contract. In no event shall the Contractor be entitled to special, consequential, or exemplary damages, nor shall the Contractor be entitled to anticipated profits resulting from termination of this Contract.

14.4 Termination by the Owner for Convenience

14.4.3 Delete from the last line of Article 14.4.3 the phrase "along with reasonable overhead and profit on the Work not executed" and add after the end of that sentence: "The Contractor shall not be entitled to receive any payment for either overhead or profit on work not performed."

Article 15
CLAIMS AND DISPUTES

15.1 **Claims**

15.1.2 Change this Subparagraph to read as follows:

Commencement of Statutory Limitation Period

The Owner and Contractor shall commence all claims and causes of action within the time period specified by applicable state law.

15.1.3.1 Change each instance of the word "Architect" to "Prime Professional".

15.1.3.2 Change the word "Decision Maker" to "Recommender"

15.1.4.2 Change this Subparagraph to read as follows:

Where both the Owner and the Contractor concur with the Initial Recommender's recommendation, the Contract Sum and Contract Time shall be adjusted in accordance with Article 7 and the Prime Professional will issue Certificates for Payment in accordance with the recommendation of the Initial Recommender.

15.1.7 Delete this Subparagraph in its entirety.

15.2 Change this Title to read "Initial Recommendation"

15.2.1 Change this Subparagraph to read as follows:

Claims, excluding those where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2 or arising under Sections 10.3 and 10.4, shall be referred to the Initial Recommender for initial recommendation. The Prime Professional will serve as the Initial Recommender. An initial recommendation by the Initial Recommender shall be required as a condition precedent to litigation of all Claims between the Contractor and Owner arising prior to the date final payment is due, unless 30 days have passed after the Claim has been referred to the Initial Recommender with no recommendation having been rendered by the Initial Recommender. The Initial Recommender will not decide disputes between the Contractor and persons or entities other than the Owner.

15.2.2 Change the words "Decision Maker" to "Recommender" and change the words "approve the Claim" to "recommend approval of the Claim to the Owner".

15.2.3 Change the words "Decision Maker" to "Recommender" and change the word "decision" to "recommendation".

15.2.4 Change the words "Decision Maker" to "Recommender" and change the last sentence to read "Upon receipt of the response or supporting data, if any, the Initial Recommender will either recommend to the Owner rejection or approval of the Claim in whole or in part within thirty (30) days."

15.2.5 Change the Subparagraph to read as follows:

The Initial Recommender will render an initial recommendation to approve the Claim, or indicate that the Initial Recommender is unable to resolve the Claim. This initial recommendation shall (1) be in writing; (2) state the reasons therefor; and (3) notify the parties and the Prime Professional, if the Prime Professional is not serving as the Initial Recommender, of any recommended change in the Contract Sum or Contract Time or both. Where the Owner concurs with the recommendation it is binding on the parties but subject to litigation.

15.2.6 Delete this Subparagraph in its entirety.

15.2.6.1 Delete this Clause in its entirety.

15.3 **Mediation**

15.3.1 Change this Subparagraph to read as follows:

Claims, disputes, or other matters in controversy arising out of or related to the Contract except those waived as provided for in Section 9.10.5 may be subject to mediation upon mutual agreement of the Owner and Contractor. A request for mediation shall be made in writing and delivered to the other party to the Contract.

15.3.2 Delete this Subparagraph in its entirety.

15.3.3 Delete this Subparagraph in its entirety.

15.4 **Arbitration**

15.4.1 Delete this Subparagraph in its entirety.

15.4.1.1 Delete this Clause in its entirety.

15.4.2 Delete this Subparagraph in its entirety.

15.4.3 Delete this Subparagraph in its entirety.

15.4.4 Delete this Subparagraph in its entirety.

15.4.4.1 Delete this Clause in its entirety.

15.4.4.2 Delete this Clause in its entirety.

15.4.4.3 Delete this Clause in its entirety.

AIA Document A101™ 2017

Standard Form of Agreement Between Owner and Contractor where the basis of payment is a Stipulated Sum

AGREEMENT made as of the day of
in the year
(In words, indicate day, month and year.)

BETWEEN the Owner:
(Name, legal status, address and other information)
Jackson County Board of Supervisors
PO Box 998
Pascagoula, MS 39568

and the Contractor:
(Name, legal status, address and other information)

for the following Project:
(Name, location and detailed description)

Pascagoula Public Library
Repairs and Renovations

The Architect:
(Name, legal status, address and other information)

Allred Stolarski Architects, PA
711 Church Street
Ocean Springs, MS 39564

The Owner and Contractor agree as follows.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

The parties should complete A101™- 2017, Exhibit A, Insurance and Bonds, contemporaneously with this Agreement.

AIA Document A201™- 2017, General Conditions of the Contract for Construction, is adopted in this document by reference. Do not use with other general conditions unless this document is modified.

TABLE OF ARTICLES

ARTICLE 1 THE CONTRACT DOCUMENTS

The Contract Documents consist of this Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to execution of this Agreement, other documents listed in this Agreement, and Modifications issued after execution of this Agreement, all of which form the Contract, and are as fully a part of the Contract as if attached to this Agreement or repeated herein. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations, or agreements, either written or oral. An enumeration of the Contract Documents, other than a Modification, appears in Article 9.

ARTICLE 2 THE WORK OF THIS CONTRACT

The Contractor shall fully execute the Work described in the Contract Documents, except as specifically indicated in the Contract Documents to be the responsibility of others.

ARTICLE 3 DATE OF COMMENCEMENT AND SUBSTANTIAL COMPLETION

§ **3.1** The date of commencement of the Work shall be:
(Check one of the following boxes.)

☐ The date of this Agreement.

☐ A date set forth in a notice to proceed issued by the Owner.

☐ Established as follows:
(Insert a date or a means to determine the date of commencement of the Work.)

If a date of commencement of the Work is not selected, then the date of commencement shall-be the date of this Agreement.

§ **3.2** The Contract Time shall be measured from the date of commencement of the Work.

§ 3.3 Substantial Completion

§ 3.3.1 Subject to adjustments of the Contract Time as provided in the Contract Documents, the Contractor shall achieve Substantial Completion of the entire Work:

(Check one of the following boxes and complete the necessary information.)

[X] Not later than Two Hundred Forty Days (240) calendar days from the date of commencement of the Work.

[ ] By the following date:

§ 3.3.2 Subject to adjustments of the Contract Time as provided in the Contract Documents, if portions of the Work are to be completed prior to Substantial Completion of the entire Work, the Contractor shall achieve Substantial Completion of such portions by the following dates:

Portion of Work	Substantial Completion Date

§ 3.3.3 If the Contractor fails to achieve Substantial Completion as provided in this Section 3.3, liquidated damages, if any, shall be assessed as set forth in Section 4.5.

ARTICLE 4 CONTRACT SUM

§ 4.1 The Owner shall pay the Contractor the Contract Sum in current funds for the Contractor's performance of the Contract. The Contract Sum shall be ($), subject to additions and deductions as provided in the Contract Documents.

§ 4.2 Alternates

§ 4.2.1 Alternates, if any, included in the Contract Sum:

Item	Price

§ 4.2.2 Subject to the conditions noted below, the following alternates may be accepted by the Owner following execution of this Agreement. Upon acceptance, the Owner shall issue a Modification to this Agreement.

(Insert below each alternate and the conditions that must be met for the Owner to accept the alternate.)

Item	Price	Conditions for Acceptance

§ **4.3** Allowances, if any, included in the Contract Sum:
(Identify each allowance.)

Item	Price
N/A	

§ **4.4** Unit prices, if any:
(Identify the item and state the unit price and quantity limitations, if any, to which the unit price will be applicable.)

Item	Units and Limitations	Price per Unit ($0.00)
N/A		

§ **4.5** Liquidated damages, if any:
(Insert terms and conditions for liquidated damages, if any.)

Contractor shall pay to Owner, as liquidated damages, a sum of Five Hundred and 00/100 Cents ($500.00), per day, for each calendar day of delay for the Project and or until the actual date of Substantial Completion of the Project.

§ **4.6** Other:
(Insert provisions for bonus or other incentives, if any, that might result in a change to the Contract Sum.)

ARTICLE 5 PAYMENTS

§ 5.1 Progress Payments

§ **5.1.1** Based upon Applications for Payment submitted to the Architect by the Contractor and Certificates for Payment issued by the Architect, the Owner shall make progress payments on account of the Contract Sum to the Contractor as provided below and elsewhere in the Contract Documents,

§ **5.1.2** The period covered by each Application for Payment shall be one calendar month ending on the last day of the month, or as follows:

§ **5.1.3** Provided that an Application for Payment is received by the Architect not later than the day of a month, the Owner shall make payment of the amount certified to the Contractor not later than the day of the month. If an Application for Payment is received by the Architect after the application date fixed above, payment of the amount certified shall be made by the Owner not later than ( ) days after the Architect receives the Application for Payment.
(Federal, state or local laws may require payment within a certain period of time.)

§ **5.1.4** Each Application for Payment shall be based on the most recent schedule of values submitted by the Contractor in accordance with the Contract Documents. The schedule of values shall allocate the entire Contract Sum among the various portions of the Work. The schedule of values shall be prepared in such form, and supported by such data to substantiate its accuracy, as the Architect may require. This schedule of values shall be used as a basis for reviewing the Contractor's Applications for Payment.

§ **5.1.5** Applications for Payment shall show the percentage of completion of each portion of the Work as of the end of the period covered by the Application for Payment.

§ **5.1.6** In accordance with AIA Document A201™-2017, General Conditions of the Contract for Construction, and subject to other provisions of the Contract Documents, the amount of each progress payment shall be computed as follows:

§ **5.1.6.1** The amount of each progress payment shall first include:

- **.1** That portion of the Contract Sum properly allocable to completed Work;
- **.2** That portion of the Contract Sum properly allocable to materials and equipment delivered and suitably stored at the site for subsequent incorporation in the completed construction, or, if approved in advance by the Owner, suitably stored off the site at a location agreed upon in writing; and
- **.3** That portion of Construction Change Directives that the Architect determines, in the Architect's professional judgment, to be reasonably justified.

§ **5.1.6.2** The amount of each progress payment shall then be reduced by:

- **.1** The aggregate of any amounts previously paid by the Owner;
- **.2** The amount, if any, for Work that remains uncorrected and for which the Architect has previously withheld a Certificate for Payment as provided in Article 9 of AIA Document A201-2017;
- **.3** Any amount for which the Contractor does not intend to pay a Subcontractor or material supplier, unless the Work has been performed by others the Contractor intends to pay;
- **.4** For Work performed or defects discovered since the last payment application, any amount for which the Architect may withhold payment, or nullify a Certificate of Payment in whole or in part, as provided in Article 9 of AIA Document A201-2017; and
- **.5** Retainage withheld pursuant to Section 5.1.7.

§ **5. 1.7 Retainage**

§ **5.1.7.1** For each progress payment made prior to Substantial Completion of the Work, the Owner may withhold the following amount, as retainage, from the payment otherwise due:

(Insert a percentage or amount to be withheld as retainage from each Application for Payment. The amount of retainage may be limited by governing law.)

§ **5.1.7.1.1** The following items are not subject to retainage:

(Insert any items not subject to the withholding of retainage, such as general conditions, insurance, etc.)

§ **5.1.7.2** Reduction or limitation of retainage, if any, shall be as follows:
(If the retainage established in Section 5.1.7.1 is to be modified prior to Substantial Completion of the entire Work, including modifications for Substantial Completion of portions of the Work as provided in Section 3.3.2, insert provisions for such modifications.)
Reduction on any contract described herein, of which the total amount is Two Hundred Fifty Thousand Dollars ($250,000.00) or greater, or on any contract with a subcontractor, regardless of amount, five percent (5%) shall be retained until the work is at least fifty percent (50%) complete, on schedule and satisfactory in the architect's and /or engineer's opinion, at which time fifty percent (50%) of the retainage held to date shall be returned to the prime contractor for distribution to the appropriate subcontractors and suppliers. Provided, however, that future retainage shall be held at the rate of two and one-half percent (2-1/2%)

§ **5.1.7.3** Except as set forth in this Section 5.1.7.3, upon Substantial Completion of the Work, the Contractor may submit an Application for Payment that includes the retainage withheld from prior Applications for Payment pursuant to this Section 5.1.7. The Application for Payment submitted at Substantial Completion shall not include retainage as follows:
(Insert any other conditions for release of retainage upon Substantial Completion.)

§ **5.1.8** If final completion of the Work is materially delayed through no fault of the Contractor, the Owner shall pay the Contractor any additional amounts in accordance with Article 9 of AIA Document A201-2017.

§ **5.1.9** Except with the Owner's prior approval, the Contractor shall not make advance payments to suppliers formaterials or equipment which have not been delivered and stored at the site.

§ 5.2 Final Payment

§ **5.2.1** Final payment, constituting the entire unpaid balance of the Contract Sum, shall be made by the Owner to the Contractor when

.1 the Contractor has fully performed the Contract except for the Contractor's responsibility to correct Work as provided in Article 12 of AlA Document A201- 2017, and to satisfy other requirements, if any, which extend beyond final payment; and

.2 a final Certificate for Payment has been issued by the Architect.

§ **5.2.2** The Owner's final payment to the Contractor shall be made no later than 30 days after the issuance of the Architect's final Certificate for Payment, or as follows:

Payments are due and payable in accordance with Mississippi law, and undisputed amounts shall be paid following approval by the Owner on the next regular claims docket following receipt of a properly submitted invoice.

§ 5.3 Interest

Payments due and unpaid under the Contract shall bear interest from the date payment is due at the rate stated below, or in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located.
(Insert rate of interest agreed upon, if any.)
%

ARTICLE 6 DISPUTE RESOLUTION

§ 6.1 Initial Decision Maker

The Architect will serve as the Initial Decision Maker pursuant to Article 15 of AIA Document A201-2017, unless the parties appoint below another individual, not a party to this Agreement, to serve as the Initial Decision Maker.
(If the parties mutually agree, insert the name, address and other contact information of the Initial Decision Maker, if other than the Architect.)

§ 6.2 Binding Dispute Resolution
For any Claim subject to, but not resolved by, mediation pursuant to Article 15 of AIA Document A201- 2017, the method of binding dispute resolution shall be as follows:
(Check the appropriate box.)

- ☐ Arbitration pursuant to Section 15.4 of AIA Document A201- 2017
- ☒ Litigation in a court of competent jurisdiction
- ☐ Other *(Specify)*

If the Owner and Contractor do not select a method of binding dispute resolution, or do not subsequently agree in writing to a binding dispute resolution method other than litigation, Claims will be resolved by litigation in a court of competent jurisdiction.

ARTICLE 7 TERMINATION OR SUSPENSION
§ 7.1 The Contract may be terminated by the Owner or the Contractor as provided in Article 14 of AIA Document A201- 2017.

§ 7.1.1 If the Contract is terminated for the Owner's convenience in accordance with Article 14 of AIA Document A201-2017, then the Owner shall pay the Contractor a termination fee as follows:
(Insert the amount of, or method for determining, the fee, if any, payable to the Contractor following a termination for the Owner's convenience.)

§ 7.2 The Work may be suspended by the Owner as provided in Article 14 of AIA Document A201- 2017.

ARTICLE 8 MISCELLANEOUS PROVISIONS
§ 8.1 Where reference is made in this Agreement to a provision of AIA Document A201- 2017 or another Contract Document, the reference refers to that provision as amended or supplemented by other provisions of the Contract Documents.

§ 8.2 The Owner's representative:
(Name, address, email address, and other information)

W. Brian Fulton-County Administrator
Jackson County Board of Supervisors
Jackson County Board of Supervisors
PO Box 998
Pascagoula, MS 39568-0998

§ **8.3** The Contractor's representative:
(Name, address, email address, and other information)

§ **8.4** Neither the Owner's nor the Contractor's representative shall be changed without ten days' prior notice to the other party.

§ **8.5 Insurance and Bonds**

§ **8.5.1** The Owner and the Contractor shall purchase and maintain insurance as set forth in AIA Document A101™-2017, Standard Form of Agreement Between Owner and Contractor where the basis of payment is a Stipulated Sum, Exhibit A, Insurance and Bonds, and elsewhere in the Contract Documents.

§ **8.5.2** The Contractor shall provide bonds as set forth in AIA Document A101™-2017 Exhibit A, and elsewhere in the Contract Documents.

§ **8.6** Notice in electronic format, pursuant to Article 1 of AIA Document A201- 2017, may be given in accordance with AIA Document E203™-2013, Building Information Modeling and Digital Data Exhibit, if completed, or as otherwise set forth below:
(If other than in accordance with AJA Document E203-2013, insert requirements for delivering notice in electronic format such as name, title, and email address of the recipient and whether and how the system will be required to generate a read receipt for the transmission.)

§ **8.7** Other provisions:

ARTICLE 9 ENUMERATION OF CONTRACT DOCUMENTS

§ **9.1** This Agreement is comprised of the following documents:

- **.1** AIA Document A101™-2017, Standard Form of Agreement Between Owner and Contractor
- **.2** AIA Document A101™-2017, Exhibit A, Insurance and Bonds
- **.3** AIA Document A201™-2017, General Conditions of the Contract for Construction
- **.4** AIA Document E203™-2013, Building Information Modeling and Digital Data Exhibit, dated as indicated below:
  (Insert the date of the E203-2013 incorporated into this Agreement.)

.5 Drawings

Number	Title	Date

.6 Specifications

Section	Title	Date	Pages

.7 Addenda, if any:

Number	Pages

Portions of Addenda relating to bidding or proposal requirements are not part of the Contract Documents unless the bidding or proposal requirements are also enumerated in this Article 9.

.8 Other Exhibits:
(Check all boxes that apply and include appropriate information identifying the exhibit where required.)

☐ AIA Document E204™-2017, Sustainable Projects Exhibit, dated as indicated below:
(Insert the date of the E204-2017 incorporated into this Agreement.)

☐ The Sustainability Plan:

Title	Date	Pages

☐ Supplementary and other Conditions of the Contract:

Document	Title	Date	Pages

.9 Other documents, if any, listed below:
(List here any additional documents that are intended to form part of the Contract Documents. AJA Document A201™-2017 provides that the advertisement or invitation to bid, Instructions to Bidders,sample forms, the Contractor's bid or proposal, portions of Addenda relating to bidding or proposal requirements, and other information famished by the Owner in anticipation of receiving bids or proposals, are not part of the Contract Documents unless enumerated in this Agreement. Any such documents should be listed here only if intended to be part of the Contract Documents.)

This Agreement entered into as of the day and year first written above.

OWNER *(Signature)*	**CONTRACTOR** *(Signature)*
(Printed name and title)	*(Printed name and title)*

CAUTION: You should sign an original AIA Contract Document, on which this text appears in RED. An original assures that changes will not be obscured.

AIA® Document A312™ – 2010

Performance Bond

CONTRACTOR:
(Name, legal status and address)

SURETY:
(Name, legal status and principal place of business)

OWNER:
(Name, legal status and address)

CONSTRUCTION CONTRACT
Date:
Amount: $
Description:
(Name and location)

BOND
Date:
(Not earlier than Construction Contract Date)

Amount: $
Modifications to this Bond: ☐ None ☐ See Section 16

CONTRACTOR AS PRINCIPAL		**SURETY**	
Company:	*(Corporate Seal)*	Company:	*(Corporate Seal)*
Signature:		Signature:	
Name and Title:		Name and Title:	

(Any additional signatures appear on the last page of this Performance Bond.)

(FOR INFORMATION ONLY — Name, address and telephone)

AGENT or **BROKER:**

OWNER'S REPRESENTATIVE:
(Architect, Engineer or other party:)

ADDITIONS AND DELETIONS:
The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed. A vertical line in the left margin of this document indicates where the author has added necessary information and where the author has added to or deleted from the original AIA text.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

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 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 Section 3.

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

.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 Section 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;

.2 the Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and

.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 Section 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 Section 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 Owner's 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 Section 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:

.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

.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 Section 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 Section 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 Section 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

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

.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 Section 5; and

.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 Section 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 period of limitation 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 to the Contractor of 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:

(Space is provided below for additional signatures of added parties, other than those appearing on the cover page.)

CONTRACTOR AS PRINCIPAL		**SURETY**	
Company:	*(Corporate Seal)*	Company:	*(Corporate Seal)*
Signature:		Signature:	
Name and Title:		Name and Title:	
Address:		Address:	

AIA® Document A312™ – 2010

Payment Bond

CONTRACTOR:
(Name, legal status and address)

SURETY:
(Name, legal status and principal place of business)

OWNER:
(Name, legal status and address)

CONSTRUCTION CONTRACT
Date:
Amount: $
Description:
(Name and location)

BOND
Date:
(Not earlier than Construction Contract Date)

Amount: $
Modifications to this Bond: ☐ None ☐ See Section 18

CONTRACTOR AS PRINCIPAL		**SURETY**	
Company:	*(Corporate Seal)*	Company:	*(Corporate Seal)*
Signature:		Signature:	
Name and Title:		Name and Title:	

(Any additional signatures appear on the last page of this Payment Bond.)

(FOR INFORMATION ONLY — Name, address and telephone)

AGENT or **BROKER:**

OWNER'S REPRESENTATIVE:
(Architect, Engineer or other party:)

ADDITIONS AND DELETIONS:
The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed. A vertical line in the left margin of this document indicates where the author has added necessary information and where the author has added to or deleted from the original AIA text.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

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 defends, indemnifies and holds harmless the Owner from claims, demands, liens or suits by any person or entity seeking payment for labor, materials or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.

§ 3 If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond shall arise after the Owner has promptly notified the Contractor and the Surety (at the address described in Section 13) of claims, demands, liens or suits against the Owner or the Owner's property by any person or entity seeking payment for labor, materials or equipment furnished for use in the performance of the Construction Contract and tendered defense of such claims, demands, liens or suits to the Contractor and the Surety.

§ 4 When the Owner has satisfied the conditions in Section 3, the Surety shall promptly and at the Surety's expense defend, indemnify and hold harmless the Owner against a duly tendered claim, demand, lien or suit.

§ 5 The Surety's obligations to a Claimant under this Bond shall arise after the following:

§ 5.1 Claimants, who do not have a direct contract with the Contractor,

.1 have furnished a written notice of non-payment to the Contractor, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and

.2 have sent a Claim to the Surety (at the address described in Section 13).

§ 5.2 Claimants, who are employed by or have a direct contract with the Contractor, have sent a Claim to the Surety (at the address described in Section 13).

§ 6 If a notice of non-payment required by Section 5.1.1 is given by the Owner to the Contractor, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Section 5.1.1.

§ 7 When a Claimant has satisfied the conditions of Sections 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:

§ 7.1 Send an answer to the Claimant, with a copy to the Owner, within sixty (60) days after receipt of the Claim, stating the amounts that are 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 Section 7.1 or Section 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 Section 7.1 or Section 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 Section 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 Section 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 request 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 "labor, materials or equipment" that part of 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:

(Space is provided below for additional signatures of added parties, other than those appearing on the cover page.)

CONTRACTOR AS PRINCIPAL		**SURETY**	
Company:	*(Corporate Seal)*	Company:	*(Corporate Seal)*
Signature:		Signature:	
Name and Title:		Name and Title:	
Address:		Address:	

AIA® Document A310™ – 2010

Bid Bond

CONTRACTOR:
(Name, legal status and address)

SURETY:
(Name, legal status and principal place of business)

OWNER:
(Name, legal status and address)

BOND AMOUNT: $

PROJECT:
(Name, location or address, and Project number, if any)

ADDITIONS AND DELETIONS:
The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed. A vertical line in the left margin of this document indicates where the author has added necessary information and where the author has added to or deleted from the original AIA text.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

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

The Contractor and Surety are bound to the Owner in the amount set forth above, for the payment of which the Contractor and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, as provided herein. The conditions of this Bond are such that if the Owner accepts the bid of the Contractor within the time specified in the bid documents, or within such time period as may be agreed to by the Owner and Contractor, and the Contractor either (1) enters into a contract with the Owner in accordance with the terms of such bid, and gives such bond or bonds as may be specified in the bidding or Contract Documents, with a surety admitted in the jurisdiction of the Project and otherwise acceptable to the Owner, for the faithful performance of such Contract and for the prompt payment of labor and material furnished in the prosecution thereof; or (2) pays to the Owner the difference, not to exceed the amount of this Bond, between the amount specified in said bid and such larger amount for which the Owner may in good faith contract with another party to perform the work covered by said bid, then this obligation shall be null and void, otherwise to remain in full force and effect. The Surety hereby waives any notice of an agreement between the Owner and Contractor to extend the time in which the Owner may accept the bid. Waiver of notice by the Surety shall not apply to any extension exceeding sixty (60) days in the aggregate beyond the time for acceptance of bids specified in the bid documents, and the Owner and Contractor shall obtain the Surety's consent for an extension beyond sixty (60) days.

If this Bond is issued in connection with a subcontractor's bid to a Contractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

When this Bond has been furnished to comply with a statutory or other legal requirement in the location of the Project, 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.

Signed and sealed this day of ,

	(Contractor as Principal) *(Seal)*
(Witness)	*(Title)*
	(Surety) *(Seal)*
(Witness)	*(Title)*

DIVISION 1 GENERAL REQUIREMENTS

01.000 REQUIREMENTS

.001 EXTENT

A. Requirements of GENERAL CONDITIONS, DIVISION 0, BIDDING REQUIREMENTS AND MODIFICATIONS TO GENERAL CONDITIONS, and ADDENDA, if issued, shall apply to work under all Divisions of the Contract.
B. Separation of these Specifications into Divisions and Sections is for convenience only and is not intended to establish limits of work.
C. Contractor shall inform himself fully of the conditions relating to the construction of the project. Failure to do so will not relieve the Contractor of his obligation to furnish all material and labor necessary to carry out the provisions of this contract, as indicated by these Specifications and Drawings.

01.020 SUMMARY OF THE WORK

.011 WORK UNDER THIS CONTRACT

A. Description of Project - Work consists of Pascagoula Public Library, Repairs and Renovations, Jackson County Board of Supervisors, Pascagoula, Mississippi, as shown on the Drawings and in accordance with these Specifications.
B. Work shall include all General, Architectural, Structural, Civil, Mechanical, and Electrical Construction, as shown on the Plans and described in the Specifications.
C. The sequence of work is to be as follows (Contingent upon the award of alternates):
    1. Roof and Elevator (Complete this work while Mechanical Equipment is on order);
    2. Mechanical and Associated Electrical and Ceilings (1st Floor, except Law Library);
    3. Mechanical and Associated Electrical and Ceilings (2nd Floor);
    4. Restroom Upgrades (1st and 2nd Floors);
    5. Mechanical, Associated Electrical, Ceilings and Aluminum Windows (Law Library);
    6. Exterior ADA Upgrades.

.012 ACCESS

A. All Contractors and sub-contractors shall use the ingress and egress roads designated for movement of materials, workmen, etc.

.013 WORK BY OTHERS

A. Work or Equipment indicated on Plans as N.I.C. (Not In Contract) shall be furnished and installed by others.

B. The Owner reserves the right for his own forces to perform (or to further contract) additional work during the course of this Project. This Work shall be coordinated with the General Contractor.

.020 OWNER

A. Wherever the term "Owner" is used in the Specifications, it refers to Jackson County Board of Supervisors, Pascagoula, Mississippi.
B. All papers required to be delivered to the Owner shall, unless otherwise directed in writing, be delivered to the Architect.
C. All verbal and written communications shall be delivered thru the Architect.

.030 COMMENCEMENT

A. The Contractor is required to begin work under this Contract within 10 days after date of written Notice to Proceed issued by the Architect, and to complete work within the time stipulated in the proposal form. Beginning of work shall mean actual physical work on the site.

.040 BENEFICIAL OCCUPANCY BY OWNER

A. If the Owner finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion thereof, such occupancy shall be considered beneficial occupancy and shall not constitute Substantial Completion. Consent of the Contractor to such occupancy or use shall not be unreasonably withheld. Note that the building will be occupied throughout the duration of the project.

01.200 PROJECT MEETINGS

.201 EXTENT

A. Preconstruction Conference - Contractor shall arrange for a Conference on the job site, between representatives of the Owner, the Architect, the Sub-Contractors, the Superintendent for the project and himself prior to any construction work. Purpose of conference shall be to establish the Construction sequence, time schedule, and the limits of use of the areas surrounding the project.

01.300 SUBMITTALS

01.310 CONSTRUCTION SCHEDULE

.311 GENERAL

A. Submit All Shop Drawings, Product Data and Samples required by the Contract Documents, within eight weeks after "Notice to Proceed."

B. Related Requirements in Other Parts of the Project Manual:
   1. Definitions, and Additional Responsibilities of Parties: Conditions of the Contract.
C. Contractor shall submit for approval a shop drawing submittal log listing all items to be submitted including Section No. and Item No. This must be provided prior to the approval of any shop drawings.
D. Contractor shall submit a written phasing plan prior to beginning construction. This phasing plan must be approved by the Owner/Architect prior to start of work. Any necessary amendments must be presented in written form and approved prior to work in areas affected by the amendment.
E. See “Summary of Work” for sequence of work.

.312 SHOP DRAWINGS

A. Drawings shall be presented in a clear and thorough manner.
   1. Details shall be identified by reference to sheet and detail, schedule or room numbers shown on Contract Drawings.
   2. Any material which is not fully distinguishable because of poor quality reproduction will be discarded and the Contractor shall resubmit this material at his expense.
B. Minimum sheet sizes: 8-1/2" x 11"
C. No shop drawings shall be accepted by the architect until same has been field checked and coordinated by the Contractor to ensure that the item or items covered can be installed as detailed on the shop drawings, and that said item or items fully meets the requirements of the plans and specifications. All such shop drawings shall bear the stamp of approval of the Contractor before submission to the Architect. Where shop drawings are approved as noted by the Contractor, such notes shall be prominently displayed on each copy, in a uniform and legible manner. If such notes require extensive revision to the shop drawings, same shall not be submitted to the Architect until they fully display the item or items detailed and meeting the requirements of the plans and the specifications.
D. Reproductions of the contract documents will not be accepted as shop drawings. All shop drawings must be drawings developed by the supplier and shall show all details, sections, anchorage, etc., which may be needed to give a clear indication of that material's relation to the project.
E. It shall be the responsibility of the Contractor to check all dimensions to ensure that the item or items covered can be installed as detailed and are the quality, etc., called for in the specification or on the drawings.

.313 PRODUCT DATA

A. Preparation
   1. Clearly mark each copy to identify pertinent products or models.
   2. Show performance characteristics and capacities.

3. Show dimensions and clearances required.
4. Show wiring or piping diagrams and controls.

B. Manufacturer's standard schematic drawings and diagrams:
   1. Modify drawings and diagrams to delete information which is not applicable to the Work.
   2. Supplement standard information to provide information specifically applicable to the Work.

.314 SAMPLES

A. Office samples shall be of sufficient size and quantity to clearly illustrate:
   1. Functional characteristics of the product, with integrally related parted and attachment devices.
   2. Full range of color, texture and pattern.

B. Field samples and mock-ups:
   1. Contractor shall erect, at the Project Site, at a location acceptable to the Architect/Engineer.
   2. Size or area: That specified in the respective specification section.
   3. Fabricate each sample and mock-up complete and finished.
   4. Remove mock-ups at conclusion of Work or when acceptable to the Architect/Engineer.

.315 CONTRACTOR RESPONSIBILITIES

A. Review shop drawings, product data and samples prior to submission.

B. Determine and verify:
   1. Field measurements.
   2. Field construction criteria.
   3. Catalog numbers and similar data.
   4. Conformance with Specifications.

C. Coordinate each submittal with requirements of the Work and of the Contract Documents.

D. Notify the Architect/Engineer in writing, at time of submission, of any deviations in the submittals from requirements of the Contract Documents.

E. Begin no fabrication or work which requires submittals until return of submittals with Architect/Engineer approval.

.316 SUBMISSION REQUIREMENTS

A. Make submittals promptly, and in such sequence as to cause no delay in the Work or in the work of any other Contractor.
   1. Contractor shall notify material and equipment manufacturer or supplier of this project's timetable for construction and of the importance to make submittals at the earliest possible time during the project to avoid delays.

B. Number of submittals required:
   1. Shop Drawings and Product Data: Submit eight copies for the following parties:
      1 Architect
      1 Engineer
      1 Owner
      1 Supplier
      1 Sub Contractor
      1 General Contractor
      2 Closeout Documents
   2. Samples: Submit the number stated in each specification section.

C. Submittals shall contain:
   1. The date of submission and the dates of any previous submissions.
   2. The Project title and number.
   3. Contract identification.
   4. The names of:
      a. Contractor
      b. Supplier
      c. Manufacturer
   5. Identification of the product, with the specification section number.
   6. Field dimensions, clearly identified as such.
   7. Relation to adjacent or critical features of the Work or materials.
   8. Applicable standards, such as ASTM or Federal Specifications numbers.
   9. Identification of divisions from Contract Documents.
   10. Identification of revisions on re-submittals.
   11. An 8" x 3" blank space for Contractor and Architect/Engineer stamps.
   12. Contractor's stamp, initialed or signed, certifying to review of submittal, verification of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the Work and of Contract Documents.
   13. If submittal is a substitution, provide in accordance with requirements of Section 01600 Product Requirements.

.317 RE-SUBMISSION REQUIREMENTS

A. Make any corrections or changes in the submittals required by the Architect/Engineer and resubmit until approved.

B. Shop Drawings and Product Data:
   1. Revise initial drawings or data, and resubmit as specified for the initial submittal.
   2. Indicate any changes which have been made other than those requested by the Architect/Engineer.

C. Samples: Submit new samples as required for initial submittal.
D. If submittal is stamped "APPROVED AS NOTED" with the Contractor's review, fabrication on order may proceed in order to expedite work. Once corrections are made on submittal by manufacturer or supplier, provide corrected copy to Architect and Engineer.

.318 DISTRIBUTION

A. Distribute reproductions of Shop Drawings and copies of Product Data which carry the Architect/Engineer stamp of approval to:
   1. Job site file.
   2. Record Documents file.
   3. Other affected contractors.
   4. Subcontractors.
   5. Supplier or Fabricator.
B. Distribute samples which carry the Architect/Engineer stamp of approval as directed by the Architect/Engineer.
C. Retain two copies for Contract Closeout.

.319 ARCHITECT/ENGINEER DUTIES

A. Review submittals with reasonable promptness and in accord with schedule. The Architect/Engineer will review shop drawings for conformance with the information given and the design concept expressed in the Contract Drawings only and will not bear the responsibility of any phase of the Contractor's liability in relation to shop drawings and their approval and/or corrections. The Architect's review of the Contractor's submittals/shop drawings shall not relieve the Contractor of his obligations and entire responsibility for the performance of the work in full accordance with the requirements of the contract.
B. Affix stamp and initials or signature, and indicate requirements for resubmittal, approval of submittal, or review of submittal for design.
C. Return submittals to Contractor for distribution or for re-submission.

01.350 <u>LAYOUT</u>

.351 EXTENT

A. Before commencing any work, the Contractor shall verify all grades, levels, and dimensions as indicated on the Drawings. He shall report errors or inconsistencies in them to the Architect before commencing work.
B. All lines, grades, levels and bench marks shall be established and maintained by the Contractor, who shall be responsible for them.

01.360 SCHEDULE OF VALUES

.361 EXTENT

A. Before beginning work, the Contractor shall submit a Breakdown of Cost covering in detail all phases of the work.

01.400 QUALITY CONTROL

.401 EXTENT

A. Manufacturer's Directions
   1. All manufactured articles, materials and equipment shall be applied, installed, connected, erected, used cleaned and conditioned as directed by the manufacturer, unless herein specified to the contrary.
   2. Furnish copies of all printed directions to the Architect.

.402 TESTING LABORATORY SERVICES

A. The Contractor shall employ and pay for the services of an independent laboratory to perform specified services. Employment of a testing laboratory shall in no way relieve the contractor of his obligation to perform the work in accordance with the Contract.
B. The Architect must approve the testing agency.
C. Refer to each individual specification section for specific inspection, sampling and testing requirements.
D. All test reports, in addition to those sent to the Contractor, shall be sent directly to the Architect and applicable Engineer from the testing laboratory.

01.500 TEMPORARY FACILITIES AND CONTROLS

.510 TEMPORARY TOILETS

A. The General Contractor shall provide and maintain sanitary temporary toilets for all employees, subject to any and all Sanitary Codes having jurisdiction. The temporary toilets shall be enclosed and weatherproof and kept in sanitary condition at all times. They must be located at points approved by the Owner.

.512 TEMPORARY UTILITIES

A. The Contractor must make arrangements to provide his own water and power. Temporary services shall be removed at completion of the project. Permanent utilities shall not be used during this Project except with the written permission of the Owner.

.513 DRINKING WATER

A. The General Contractor shall furnish and provide drinking water facilities for all workmen on the job. This shall include icing when required, paper cups, etc., all maintained in a sanitary condition.

.514 SPECIAL CONTROLS

A. Workmen who may, because of improper conduct, become objectionable, will be promptly removed by the Contractor at the request of the Owner or the Architect.
B. Dress of workmen shall at all times be complete with shirts and pants while on job.
C. No burning of trash or rubbish shall be allowed on site.

.515 BARRIERS AND SECURITY

A. Protective devices such as signs, lights and signals shall be utilized night and day for safety of public and workmen. Partition along the canal area.
B. The Owner will not be responsible for the protection and/or safety of the Contractor's work, materials and/or equipment.
C. Contractor may provide security guards at his own discretion.

.516 CONSTRUCTION AIDS

A. Scaffolding shall be provided by Contractor for the work, both interior and exterior, for construction of walls, ceilings, etc. Build or furnish and maintain scaffolding in accordance with all laws and regulations in effect.

.517 TEMPORARY FIELD OFFICES

A. Field office for use of Contractor, Sub-Contractors, Architect and Owner shall be provided by Contractor. Office shall be weatherproof, contain adequate ventilation, telephone, heat and racks for drawings. Locate office where directed by Architect and remove when directed by Architect.

01.600 <u>MATERIAL AND EQUIPMENT</u>

.601 EXTENT

A. Where a specific material is specified by name. The materials mentioned by name shall form the basis of the Contract. No substitutions under such clauses shall be made without authority in writing from the Architect.

.602 ASBESTOS CONTAINING MATERIALS

A. There shall be NO asbestos containing materials used in the construction of this Project. In the event a material which is specified contains asbestos, the Contractor shall recommend a non-asbestos substitute to the Architect for approval. Substitution of material shall be at no additional cost to the Owner.
B. The Contractor shall provide written certification to the Owner that no asbestos containing material was used during the construction of this Project.

01.700 PROJECT CLOSEOUT

.710 CLEANING UP

A. Clean up shall be performed continuously during working days to keep building and premises free from accumulation of waste materials and rubbish.
B. At completion of the work, remove all waste, rubbish and unused surplus materials from and about the building and site, as well as tools, construction equipment and leave building broom clean.
C. Also see specific cleaning requirements hereinafter required in these Specifications.
D. Just prior to final inspection, remove all dust, dirt and stains from finished surfaces and leave the work ready for occupancy.

.715 GUARANTEES, BONDS AND AFFIDAVITS

A. Submitted by the Contractor to the Architect for transmittal to the Owner and shall be, but not limited to, the following:
    1. Certification that all work, including that of sub-contractors, has been completed in accordance with requirements of the Contract Documents.
    2. Copies of warranties, guarantees and bonds required by these Specifications.
    3. Contractor’s one-year guarantee that all defects in materials and workmanship will be remedied by Contractor without additional cost to Owner.
    4. Written certification that no asbestos containing material was used during the Construction of this Project.
    5. Consent for Final Payment from the Contractor's Surety Company.

.730 PROJECT RECORD DRAWINGS

A. Contractor shall furnish two complete sets of final project record drawings to Architect prior to final payment. Architect shall furnish two copies of blue line prints to contractor for indicating in red pencil all changes made in actual construction. The actual final location of all piping, drains, cleanouts, appurtenances and equipment shall be indicated thereon by Contractor.

.740 FINAL INSPECTION

A. After receipt of written notice that the work is ready for final inspection and acceptance and receipt of the final application for payment, the Architect will make such inspection and furnish the Contractor with a check list of any items found incomplete or not in conformance with the Contract Documents. The Contractor shall remedy such defects within 30 days of his receipt of the list and the Architect will make (1) subsequent inspection of the work. Should correction not be made within the allotted 30 days, and should additional inspections of the work be required due to failure of the Contractor to remedy defects listed, the Contractor shall pay to the Owner the sum of $250.00 for each subsequent trip. When the Architect finds the work acceptable under the Contract Documents and the Contract fully performed, he will issue the final Certificate for Payment stating that to the best of his knowledge, information and belief, and on the basis of his observations, the work has been completed in accordance with the terms and conditions of the Contract Documents, and that the entire balance found to be due to the Contractor, and noted in said final Certificate, is due and payable.

01.800 <u>TIME FOR SUBSTANTIAL COMPLETION AND LIQUIDATED DAMAGES</u>

.801 TIME FOR SUBSTANTIAL COMPLETION

A. The Contractor shall complete all work under the contract agreement, including all alternate proposals which are made a part of the contract agreement within the Contract Time indicated on the Form of Proposal.

.802 LIQUIDATED DAMAGES

A. The Contractor shall substantially complete all work under the Contract Agreement, including all Alternate Proposals which are made a part of the Contract Agreement, on or before the date so stipulated on the Form of Bid Proposal. If all work required by this contract agreement is not substantially completed within this specified time for substantial completion, the Contractor shall pay to the Owner, or shall agree to the Owner's withholding from monies due him, liquidated damages in the amount of Two Hundred and Fifty 00/100 ($250.00) Dollars per day per building, for each consecutive calendar day following the contract substantial completion date that the work remains incomplete, Saturdays, Sundays, and holidays included.

B. The intent of this requirement is not to penalize the Contractor, but it is to offset damages which the Owner will experience if the project is not completed on the specified date.

.803 ALLOWANCES: All Allowances are to be included in each Base Bid package (and Combined Packages) as scheduled below.

A. General:
   1. Purchase products under allowance as directed by Architect or as specified herein.
   2. The amount of all specified allowances shall include:
      a. Net cost of product
      b. Delivery to site
      c. Installation
      d. Labor
      e. Equipment Rental
   3. At close-out of Contract, funds remaining in Allowance will be credited to owner by Change Order. In addition to the balance of the allowance all applicable costs for overhead, profit, bond, insurance and taxes will be added to the allowance change order credit. Overhead amounts that can be clearly documented as being expended over the course of the project will be excluded from this added amount to the allowance credit.

B. Contingency Allowance:
   1. In addition to the work shown on the contract documents, include in the Base Bid contract amount the following lump sum contingency allowance amount: Fifty Thousand Dollars ($50,000).
   2. Contractor shall solicit a minimum of three (3) quotes for additional material or work to be performed under the Contingency Allowance."

01.900 ALTERNATIVES

.901 ALTERNATE #1 (ADDITIVE)

A. An Additive Alternate proposal for all material, equipment and labor is required to provide and install the following scope complete as indicated on the drawings and in the specifications: Roof Replacement, Elevator Upgrades, and Restroom Upgrades.

ALTERNATE #2 (ADDITIVE)

A. An Additive Alternate proposal for all material, equipment and labor is required to provide and install Interior Finishes complete as indicated on the drawings and in the specifications: Interior Flooring and Interior Painting.

END OF DIVISION

SECTION 02.110 SELECTIVE BUILDING DEMOLITION

PART 1 GENERAL

1.01 EXISTING CONDITIONS AND SCOPE

A. All contractors shall visit the building to determine the existing conditions and review the items of work required to be removed for the planned and specified new construction work.
B. The Contractor shall coordinate demolition work with designated officials to insure total safety.
C. Contractor shall remove existing construction as indicated or required, and execute all demolition in such a manner as to not damage the existing adjacent structures or materials which are to remain.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 PROTECTION OF EXISTING FACILITIES

A. All structures, materials, or equipment of any kind now on the site that do not interfere with the performance of new work hereunder shall be left in place (except as indicated on the Drawings), shall remain the property of the Owner, and shall be protected against injury as directed.

3.02 INTENT

A. It is the intent of this specification that all required building demolition work be fully and completely performed and all work be accomplished in a neat and workmanlike manner.

3.03 EXISTING CONDITIONS

A. Contractor shall protect all active utility lines. Any damage during this contract, to existing utility lines serving the existing building to remain, shall be properly repaired and reactivated at no expense to the Owner.

3.04 SALVAGED MATERIALS AND EQUIPMENT

A. All existing equipment and materials shall remain the property of the Owner. Care must be taken to avoid damage to existing equipment and materials being relocated or stored. Items that are damaged during demolition shall be repaired and brought back to their original state.

3.05 PREVENTION OF NOXIOUS CONDITIONS

A. Demolition and construction methods shall be as dust-free and noise-free as is possible. Damage to the Owner's operations or equipment can impose liquidated damages on the Contractor, based on expense in loss of production and repair or replacement of equipment.

B. In certain areas the contractor will be required to install dust partitions. partitions shall be wood stud and plywood construction with 6 mil polyethylene sandwiched between the studs and the plywood. Dust partitions shall extend from the floor slab to the concrete floor deck above.
C. Wet down materials during removal to prevent dust from rising. All rubbish, debris and expendable items resulting from demolition work shall be removed from the premises as it accumulates and disposed of at an off-site location by the Contractor.

3.06 SAFETY CODES AND STANDARDS

A. The Contractors shall conduct all operations in such a manner as not to jeopardize life or property. He shall brace, shore, barricade or protect all areas where he is working, and shall provide all necessary railing, dust curtains, baffle walls, or other devices as needed for construction and protection of life and property.

END OF SECTION

SECTION 02.411 SITEWORK DEMOLITION

PART 1 GENERAL

1.01 DESCRIPTION

Scope: CONTRACTOR shall furnish all labor, materials, equipment and incidentals required for demolitions, removal and disposal of work shown and specified.

A. Included, but not limited to, are demolition and removals of existing facilities, materials, equipment, or work necessary to install the new work as shown and specified and to connect same with existing work in an approved manner. Demolition includes structural concrete, foundations, equipment pads, walls, doors, windows, structural steel, equipment supports, metals, roofs, masonry, attachments, appurtenances, piping, electrical and mechanical equipment, paving, curbs, walks, fencing, and similar existing facilities.
B. Demolitions and removals which may be specified under other Sections shall conform to requirements of this Section.
C. CONTRACTOR will be responsible for all costs associated for any permits, licenses, and bonds required for demolition or removal items herein.

1.02 SUBMITTALS

Schedule: Submit for approval proposed methods, equipment, and operations sequence. Include coordination for shut-off, capping, temporary services, continuation of utility services, and other applicable items to ensure no interruption of OWNER'S operations.

1.03 JOB CONDITIONS

A. PROTECTION
    1. CONTRACTOR shall execute the demolition and removal work to prevent damage or injury to structures, occupants thereof and adjacent features which might result from falling debris or other causes, and so as not to interfere with the use, and free and safe passage to and from, adjacent structures.
    2. Closing or obstructing of roadways, sidewalks, and passageways adjacent to the work by the placement or storage of materials will not be permitted, and all operations shall be conducted without interference to traffic on these ways.
    3. CONTRACTOR shall repair damage done to facilities to remain, or to any property belonging to the OWNER.
B. Notification: At least 48 hours prior to commencement of a demolition or removal, CONTRACTOR shall notify the ENGINEER and OWNER in writing of his proposed schedule therefore. OWNER shall inspect the existing equipment to identify and mark those items which are to

remain the property of the OWNER. No removals shall be started without the permission of the ENGINEER.

C. Explosives: Do not bring explosives on site nor use explosive for demolition.

D. Any work performed within public rights-of-way or on adjacent properties shall be done in strict accordance with the requirements of the governmental agencies or the owning entities having jurisdiction and shall not begin until authorized by those parties.

1.04 RELATED SECTIONS

A. Construction Drawings

B. Architectural Plans and Specifications as they relate specifically to the earthwork beneath the buildings where the architectural requirements are more stringent than the civil requirements.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.01 GENERAL

A. All materials and equipment removed from existing work shall become the property of the CONTRACTOR, except for those which the OWNER has identified and marked to remain the property of the OWNER. All materials and equipment, marked by the OWNER to remain its property, shall be carefully removed by the CONTRACTOR so as not to be damaged, and then cleaned and stored on or adjacent to the site in a protected place specified by the ENGINEER or delivered to the OWNER.

B. CONTRACTOR shall dispose of all demolition materials, equipment, debris, and all other items, not marked by the ENGINEER to remain the OWNER'S property, off the site and in conformance with all existing applicable laws and regulations.

C. Pollution Control: Use water sprinkling, temporary enclosures, and other suitable methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level. Comply with governing regulations pertaining to environmental protection.

1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.
2. Clean adjacent structures, facilities, and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to conditions existing prior to the start of the work.

D. Concrete Demolition: Unless otherwise approved by the ENGINEER, proceed with demolition from the top of the structure to the ground.

1. Demolish concrete and masonry in small sections.
2. Remove structural framing members and lower to ground by means of hoists, derricks, or other suitable methods.

3. Break up and remove foundations and slabs-on-grade, unless otherwise shown or specified to remain.
4. Remove structures down to at least two feet below finished grade unless otherwise show or specified.

E. Utilities: It is the CONTRACTOR'S responsibility to contact all pertinent utility companies or owning entities to verify that all utilities shown to be removed are in fact inoperative, and if not, shall provide a temporary means of operation until permanent utilities are in-place. The CONTRACTOR is cautioned by the ENGINEER to use extreme caution when removing items below grade which might disturb existing utilities to remain.

F. Storm Water Utilities: The CONTRACTOR shall not remove any drainage structures until positive drainage has been provided during the construction of new items. No existing storm drainpipe shall be plugged until a positive drainage route has been provided for the adjacent pipe.

G. Items to be demolished and/or removed have been identified on the plans to the maximum extent possible. It is the CONTRACTOR'S responsibility to visit the site prior to initiating any work to identify any deviations from the construction plans. If any deviations are identified, the CONTRACTOR shall notify the ENGINEER and OWNER in writing immediately. If said deviations are found by the ENGINEER to adversely affect the progress and/or the scope of the project, a resolution shall be made for such deviations in a timely manner by the ENGINEER and the CONTRACTOR.

H. All surrounding site features which are shown to remain on the drawings shall be protected from injury during construction by the CONTRACTOR. Any damage done to such items shall be fully restored to their original conditions at the CONTRACTOR'S expense. Any adjacent streets, drainage facilities, and/or utilities shall be repaired, if damaged, at the CONTRACTOR'S expense in a manner acceptable to the ENGINEER and the Owning Entity.

END OF SECTION

SECTION 02.522 SIDEWALKS, ADA RAMPS AND DRIVEWAYS

PART 1 SCOPE OF WORK

1.01 This work shall consist of constructing portland cement concrete sidewalk, ADA ramps or driveway on a prepared subgrade in accordance with the plans and specifications. Lines and grades shall be as shown on the plans. "Subgrade" in this section shall mean the prepared foundation on which the sidewalk or driveway is constructed.

1.02 All pedestrian traffic areas and accessible routes including sidewalks and ramps shall conform to the requirements of ADAAG.

1.03 SPECIFIED ELSEWHERE.

PART 2 MATERIALS

2.01 CONCRETE. Class B, MDOT Specifications.

2.02 REINFORCEMENT. Driveways - 6 x 6 No. 6 WWF or Fiber additive as approved by Engineer. Sidewalks and Ramps - if required, will be specified on the plans.

2.03 PRE-MOLDED EXPANSION JOINT FILLER. Bituminous, 1/2 inch thick, per AASHTO M-213.

2.04 CURING COMPOUND. ASTM C-309.

2.05 DETECTABLE / TACTILE WARNING SURFACES

A. Both cast-in-place and surface applied detectable / tactile warning surface tile shall be produced of a vitrified polymer composite (VPC) such as Armor-Tile as manufactured by Engineered Plastics, Inc. (800-682-2525). If not indicated otherwise on the plans, the color of the product shall be yellow conforming to Federal Color No. 33538.
   1. For surface applied detectable / tactile warning surface tiles, the following or an approved equivalent shall be used:
      a) Fasteners: Color matched, corrosion resistant, flat head drive anchor: 1/4" diameter x 1 -1/2" long as supplied by Engineered Plastics, Inc.
      b) Adhesive: Armor-Bond as supplied by Engineered Plastics, Inc.
      c) Sealant: Armor-Seal as supplied by Engineered Plastics, Inc.

PART 3 CONSTRUCTION REQUIREMENTS

3.01 EXCAVATION AND IN-GRADE PREPARATION. Excavation shall be made to the required depth and to a width that will permit the installation and bracing of forms. The foundation shall be shaped and compacted at the proper moisture content to a firm, even surface conforming to the lines, grades and sections shown on the plans. All soft, spongy, or other unsuitable materials encountered shall be removed and replaced with acceptable material. The foundation shall be shaped and compacted to 90% Standard Proctor at the proper moisture.

3.02 SETTING FORMS. Forms shall be set to the required line and grade and rigidly held in place by stakes or braces. Ends of adjoining form sections shall be flush. Forms and division plates shall be cleaned and oiled before placing concrete against them.

3.03 PLACING CONCRETE

A. A template resting upon the side forms and having its lower edge at the elevation of the subgrade shall be drawn along the forms to shape and grade the subgrade before concrete is deposited. The subgrade shall be moist and free of debris and foreign material before concrete is deposited upon it. The concrete mixture shall be placed on the prepared subgrade to the depth required to complete the sidewalk or driveway in one course. It shall then be vibrated and/or tamped and struck off with an approved straight-edge resting upon the side forms and drawn forward with a sawing motion. The surface shall be given a float finish.
B. The edges of the sidewalk shall be rounded with an edging tool having a radius of 1/2 inch. Expansion joints shall be edged with an edger having a radius of 1/4 inch.
C. The edges of driveways at expansion joints shall be edged with an edger having a radius of 1/2 inch.

3.04 JOINTS

A. Expansion joints shall be of the dimensions specified and shall be filled with the type of premolded expansion joint filler specified. Sidewalks shall be divided into sections by dummy joints formed by a jointing tool or other acceptable means. These dummy joints shall extend into the concrete for at least one-inch and shall be approximately 1/8 inch wide. Joints shall match as nearly as possible adjacent joints in curb or pavements. Dummy joints may be sawed in lieu of forming with a joint tool.
B. Construction joints shall be formed around all appurtenances such as manholes, utility poles, etc., extending into and through the sidewalk. Premolded expansion joint filler 1/4-inch thick shall be installed in these joints. Expansion joint filler of the thickness

indicated shall be installed between concrete sidewalks and fixed structure, such as a building or bridge. This expansion joint material shall extend for the full length of the walk.

3.05 PROTECTION AND CURING

A. After finishing and texturing operations have been completed and immediately after free water has evaporated, the surface of the slab and any exposed edges shall be uniformly coated with the membrane-curing compound. It can be applied by a pressure sprayer, with a maximum coverage of 200 ft2/gal. Two applications at 90° offset may be required on windy days.

B. Contractor shall have materials available at all times for the protection of unhardened concrete against rain. During the curing period, all traffic, both pedestrian and vehicular, shall be kept off the concrete. Vehicular traffic shall be kept off for such additional time as Engineer may direct. Contractor shall protect the work from damage until final acceptance. All sections which are damaged before final acceptance shall be removed and reconstructed by Contractor without additional compensation.

3.06 DETECTABLE / TACTILE WARNING SURFACES. Detectable / Tactile Warning surface tiles shall be either cast-in-place for new construction or surface applied to existing improvements. Installation will not be allowed on asphalt surfaces.

A. CAST-IN-PLACE INSTALLATION

1. The specifications of the structural embedment flange system and related materials shall be in strict accordance with the contract documents and the guidelines set by their manufacturers.
2. The physical characteristics of the concrete shall be consistent with the contract specifications while maintaining a slump range of 4 - 7 to permit solid placement of the Cast-In-Place Tile system. An overly wet mix will cause the tile to float. Under these conditions, suitable weights such as 2 concrete blocks or sandbags (25 lb) shall be placed on each tile.
3. The concrete pouring and finishing operations require typical mason's tools, however, a four (4) inch long level with electronic slope readout, 25 lb. Weights, and a large non-marring rubber mallet are specific to the installation of the Cast- In-Place Tile system. A vibrating mechanism such as that manufactured by Vibco can be employed, if desired. The vibrating unit should be fixed to a soft base such as wood, at least one (1) foot square.
4. The factory-installed plastic sheeting shall remain in place during the entire installation process to prevent the splashing of concrete onto the finished surface of the tile.

5. The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to the tile placement. Immediately after finishing concrete, a level should be used to check that the required slope is achieved. The tile shall be placed true and square to the curb edge in accordance with the drawings. The Cast-In-Place tiles shall be tamped (or vibrated) into the fresh concrete to ensure that the field level of the tile is flush to the adjacent concrete surface. The embedment process shall not be accomplished by stepping on the surface. The contract drawings indicate that the tile field level (base of truncated dome) is flush to adjacent surfaces to permit proper water drainage and eliminate tripping hazards between adjacent finishes.
6. Immediately after placement, the tile elevation is to be checked to adjacent concrete. The elevations and slope should be set consistent with contract drawings to permit water drainage to curb as the design dictates. Ensure that the field surface of the tile is flush with the surrounding concrete and back of curb so that no ponding is possible on the tile at the back side of curb.
7. While concrete is workable, a 3/8" radius edging tool shall be used to create a finished edge of concrete, then a steel trowel shall be used to finish the concrete around the tile's perimeter, flush to the field level of the tile.
8. Following tile placement, review installation tolerances to contract drawings and adjust tile before the concrete sets. Two (2) suitable weights of 25 lbs. each may be required to be placed on each tile as necessary to ensure solid contact of the underside of tile to concrete.
9. Following the concrete curing stage, protective plastic wrap is to be removed from the tile surface by curing the plastic with a sharp knife, tight to the concrete/tile interface. If concrete bled under the plastic, a soft brass wire brush will clean the residue without damage to the tile surface.
10. Individual tiles can be bolted together using 1/4 inch or equivalent hardware. This can help to ensure that adjacent tiles are flush to each other during the installation process. Tape or caulking can be placed on the underside of the bolted butt joint to ensure that concrete does not rise up between the tiles during installation. Any protective plastic wrap which was peeled back to facilitate bolting or cutting, should be replaced and taped to ensure that the tile surface remains free of concrete during the installation process.

3.07 BACKFILLING AND CLEANING UP

A. When the concrete has set sufficiently, all forms, bracing, etc., shall be removed and the sides of the walk or driveway shall be backfilled

and compacted to the required elevation with suitable material. All surplus material shall be disposed of as directed, and the completed work and the site shall be left in a neat and presentable condition.

1. Set the tile true and square to the curb ramp area as detailed in the design drawings, so that its location can be marked on the concrete surface.
2. The surface to receive the tile shall be mechanically cleaned with a diamond cup grinder or shot blaster to remove any dirt or foreign material. This cleaning and roughening of the concrete surface should include at least four (4) inches around the perimeter of the area to receive the tile, and also along the cross pattern established by the corresponding areas on the backside of the tile. Those same areas should then be cleaned with a clean rag soaked in Acetone.
3. Immediately prior to installing the tile, the concrete surfaces shall be inspected to ensure that they are clean, dry, free of voids, curing compounds, projections, loose material, dust, oil, grease, sealers and determined to be structurally sound and cured for a minimum of thirty (30) days.
4. Using Acetone, wipe the backside of the tile around the perimeter and along the internal cross pattern, to remove any dirt or dust particles from the area to receive the adhesive.
5. Apply adhesive to the backside of the tile, following the perimeter and internal cross pattern established by the tile manufacturer. Sufficient adhesive must be placed on the prescribed areas to have full coverage across the two (2) inch width of the adhesive locator and shall be applied to within 1/4" continuously around the perimeter edge of the tile. The entire tube of adhesive shall be applied to the back of each tile, sizes 24" x 36" and greater.
6. Set the tile true and square to the curb ramp area as detailed in the design drawings.
7. Working from the center of the tile outwards, proceed to drill and install all fasteners in the tile's molded recesses.
8. Standing with both feet, applying pressure around the molded recess provided in the tile, drill a hole true and straight to a depth of 3-1/2" using a 1/4" masonry drill bit. Drill through the tile without hammer option (on the drill) until the tile has been successfully penetrated, then with the hammer option (on the drill) to drill into the concrete.
9. Immediately after drilling each hole, before moving on to the next, and while still applying foot pressure, mechanically fasten tiles to the concrete substrate using a leather bound or hard plastic mallet to set the fasteners. Ensure the fastener has been placed to full depth in the dome, straight, and flush to the top of dome.

10. Following the installation of the fasteners, the concrete dust should be vacuumed, brushed or blown away from the tile's surface and adjacent concrete. Using Acetone on a rag, wipe the concrete around the tile's perimeter to ensure a clean, dry surface to receive perimeter sealant.
11. Perimeter caulking sealant shall be applied following the sealant manufacturer's recommendations. Tape all perimeter edges of the tile back 1/16" from the tile's perimeter edge and tape the adjacent concrete back 1/2" from the tile's perimeter edge to maintain a straight and even caulking line. Apply sealant around the perimeter using care to work sealant into any void between the tile and concrete interface. Tool the perimeter caulking with a rounded plastic applicator or spatula to create a cove profile between the tile and adjacent concrete. Remove tape immediately after tooling perimeter caulking sealant.
12. Do not allow foot traffic on installed tiles until the perimeter caulking sealant has cured sufficiently to avoid tracking. Adhesive or caulking on the surface of the tile can be removed with Acetone.
13. If installing adjacent tiles, note the orientation of each tile. Careful attention will reveal that one of the long edges of the tile is different than the other in regard to the tiny dotted texture. You may also note a larger perimeter margin before the tiny dotted texture pattern begins. Consistent orientation of each Armor-tile is required in order that the truncated domes on adjacent tiles line up with each other.
14. In order to maintain proper spacing between truncated domes on adjacent tiles, the tapered edge should be trimmed off using a continuous rim diamond blade in a circular saw or mini-grinder. The use of a straightedge to guide the cut is required. All cuts should be made prior to installation of the tiles. If installing adjacent tiles, care should be taken to leave a 1/8 inch gap between each tile to allow for expansion and contraction.

PART 4 METHOD OF MEASUREMENT - NOT USED

PART 5 PAYMENT - NOT USED

END OF SECTION

SECTION 02.820 ALUMINUM LOUVER FENCES AND GATES

PART 1 GENERAL

1.01 SUMMARY

A. Ornamental fixed louver modular fencing panels fabricated with extruded aluminum louvers and flat aluminum bars, including extruded aluminum fence posts and aluminum louver gates.

B. Related sections:
   1. Section 03.300 Cast-in-Place Concrete
   2. Division 15 Mechanical

1.02 REFERENCES

A. ASTM International (ASTM):
   1. ASTM B117 - Operating Salt Spray (Fog) Apparatus.
   2. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
   3. ASTM B221 - Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   4. ASTM D822 - Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
   5. ASTM D2794 - Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   6. ASTM D3363 - Test Method for Film Hardness by Pencil Test.

1.03 SUBMITTALS

A. Provide in accordance with Section 01300 - Submittal Procedures:
   1. Product data for components and accessories.
   2. Shop drawings showing layout, dimensions, spacing of components, and anchorage and installation details.
   3. Sample: 8 by 10 inches minimum size sample of fence panel illustrating design, fabrication workmanship, and selected color coating.
   4. Copy of warranty specified in Paragraph 1.4 for review by Architect.

1.04 WARRANTY

A. Provide in accordance with Division 1 Section - Closeout Procedures:
   1. 10-year warranty for factory finish against cracking, peeling, and blistering under normal use.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Basis of Design Manufacturer: Ametco Manufacturing Corporation, 4326 Hamann Parkway, P.O. Box 1210, Willoughby, Ohio 44096; 800-362-1360. For convenience, all product names in this section

refer to products by the Basis of Design manufacturer. Provided all other project requirements are met, products by the following manufacturers shall be considered equal:
1. As approved by the Architect.

2.02 MATERIALS

A. Extruded aluminum: ASTM B221, Alloy 6063, Temper T-6.
B. Sheet aluminum: ASTM B209, Alloy 6063, Temper T-6.
C. Grout: Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, and water-reducing and plasticizing additives.

2.03 FENCE SYSTEM

A. Type: Ornamental fencing system consisting of horizontal, fixed louver, modular fence panels fabricated with extruded aluminum framing bars and supported by extruded aluminum fence posts
   1. Total Eclipse Aluminum Fixed Louver Fencing
B. Fence panel
   1. Fixed louver bars: Extruded aluminum louver bars, 1-31/32 inches wide, spaced at 1-13/16 inches. Extend louver flange to allow 100 percent direct visual screening.
   2. Cross bars: 1/2 by 1/8 inch flat bars welded perpendicular to back side of louver bars and spaced at 18 inches.
   3. Panel height: As indicated on Drawings.
   4. Panel width: 64-21/32 max, or as required for enclosure drawn.
C. Posts
   1. Type: 4 x 43 inch extruded tubular aluminum sections with solid aluminum caps.
   2. Length: As indicated on Drawings.

2.04 GATES

A. Provide gates of type and size indicated on Drawings. Equip gates with manufacturer's standard hardware as required for complete functional operation.
B. Type: Hinged swinging double gate.
   1. Construction: Welded frame fabricated from 4” by 4” extruded aluminum tubing with aluminum fixed louver panels to match fencing material.
   2. Nominal size: 6’ wide by 8’ high.
   3. Hardware:
      a. Hinges: Size and type as determined by manufacturer. Provide 2 hinges for each leaf up to 6 feet high and 1 additional hinge for each additional 24 inches in height or fraction thereof.
      b. Latch: 3/4 inch diameter slide bolt to accommodate padlock.

c. For double gates provide padlockable, 5/8 inch diameter center cane bolt assembly and strike.

2.05 ACCESSORIES

A. Fasteners: Stainless steel bolts of type, size, and spacing as recommended by fence manufacturer for specific condition.

2.06 FACTORY FINISH

A. Aluminum fence panels and posts shall receive polyester powder coating.
B. Polyester powder coating: Electrostatically applied colored polyester powder coating heat cured to chemically bond finish to metal substrate.
   1. Minimum hardness measured in accordance with ASTM D3363: 2H.
   2. Direct impact resistance tested in accordance with ASTM D2794. Withstand 160 inch-pounds.
   3. Salt spray resistance tested in accordance with ASTM B117: No undercutting, rusting, or blistering after 500 hours in 5 percent salt spray at 95 degrees F and 95 percent relative humidity and after 1000 hours less than [3/16 inch] [5 mm] undercutting.
   4. Weatherability tested in accordance with ASTM D822: No film failure and 88 percent gloss retention after 1 year exposure in South Florida with test panels tilted at 45 degrees.
C. Color: Selected by Architect from manufacturer's standard range.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to fabrication, field verify required dimensions.
B. Cast concrete footings in accordance with Section 03.300 - Cast-in-Place Concrete as detailed on Drawings and approved shop drawings.
   1. Minimum footing diameter:
      a. Terminal and gate posts: 24 inches
      b. Intermediate line posts: 24 inches
   2. Allow 48 inch minimum embedment of posts.
   3. Allow 12 inches minimum concrete beneath post bottom.
C. Provide setting holes for embedment of fence posts. Hole shall be 2 inches minimum greater than post width.

3.02 INSTALLATION

A. Install fencing in accordance with manufacturer's installation instructions and approved shop drawings.

B. Install fence posts plumb and level by embedding post directly in concrete footing. Temporarily brace fence posts with 2 by 4 wood supports until concrete is set.
C. Do not install bent, bowed, or otherwise damaged panels. Remove damaged components from site and replace.
D. Secure fence panels with standard stainless steel bolts to fence posts after posts have been set in footings.
E. Gates
    1. Install gates and adjust hardware for smooth operation.
    2. Provide concrete center foundation depth and drop rod retainers at center of double swinging gate openings.
    3. After installation, test gate. Open and close a minimum of five times. Correct deficiencies and adjust.
F. Touch-up damaged finish with paint supplied by manufacturer and matching original coating.

END OF SECTION

SECTION 02840 - PARKING BUMPERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes wheel stops.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: For each type of exposed finish requiring color selection.

C. Samples for Verification: For wheel stops, 6 inches long, showing color and cross section; with fasteners.

PART 2 - PRODUCTS

2.1 PARKING BUMPERS

A. Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete, 4000-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, transverse drainage slots on underside, and a minimum of three factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Surface Appearance: Free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.

2. Mounting Hardware: Galvanized-steel hardware as standard with wheel-stop manufacturer.

B. Resilient Wheel Stops: Solid, integrally colored, 96 percent postconsumer or commingled postconsumer and preconsumer recycled rubber or plastic; UV stabilized; 4 inches high by 6 inches wide by 72 inches long. Provide chamfered corners and a minimum of three factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Color: Yellow.

2. Mounting Hardware: Galvanized-steel hardware as standard with wheel-stop manufacturer.

3. Adhesive: As recommended by wheel-stop manufacturer for adhesion to pavement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install wheel stops according to manufacturer's written instructions unless otherwise indicated.

B. Install wheel stops in bed of adhesive before anchoring.

C. Securely anchor wheel stops to pavement with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheel stop.

END OF SECTION

SECTION 02.842 PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Install painted pavement markings as indicated on the construction drawings.

1.02 PROJECT CONDITIONS:

A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize flagmen, barricades, warning signs and warning lights as required.

PART 2 PRODUCTS

2.01 MATERIALS

A. The paint shall be a non-bleeding, quick-drying, alkyd petroleum base paint suitable for traffic-bearing surface and shall meet FS TTP-85E and mixed in accordance with manufacturer's instructions before application.

PART 3 EXECUTION

3.01 PREPARATION

A. Apply two coats of paint at manufacturer recommended rate without the addition of thinner, with a maximum of 100 square feet per gallon. Apply with mechanical equipment to produce uniform straight edges. At sidewalk curbs and crosswalks, use a straightedge to ensure a uniform, clean, straight stripe at the front of the store.

B. The following items are to be painted with the colors noted below:
   1. Pedestrian Crosswalks: White
   2. Fire Lanes: Red or per local code
   3. Lane Striping: As noted on plans
   4. Handicap Symbols: Blue
   5. Parking Stall Striping: White, unless otherwise noted on plans.

END OF SECTION

SECTION 03.300 CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The work includes the provision of cast in place concrete. In the ACI publications referred to herein, the advisory provisions shall be considered to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears; reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" shall be interpreted to mean the Architect.

1.02 SUBMITTALS

A. Shop Drawings: Reproductions of contract drawings are unacceptable. Submit prior to fabrication.
   1. Shop Drawings for Reinforcing Steel: ACI 315. Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing rods. Submit to the Architect.
   2. Shop Drawings for Reinforcing Steel Placement: The contract drawings and electronic data files shall not be used to prepare placement drawings. Prepare sections, details, elevations and other drawings for field personnel to properly place reinforcing. Indicate spacings, clearances, cover, bolsters and any other information for correct placing of the reinforcement. Submit to the Architect with reinforcing steel shop drawings.

B. Contractor Mix Design: Thirty (30) days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Proportioning of mix and submittal of mix design shall conform to ACI 318 Section 5.3. Cylinder break data used shall be submitted with the mix design submittal. Mix designs submitted without supporting cylinder break data will be rejected without review. If required cylinder break data is not available as required by ACI and the International Building Code, then increase design strength shown on the drawings by 1200 psi. Furnish complete list of materials including type, brand, source and amount of cement, fly ash, pozzolan, ground slag, and admixtures, and applicable reference specifications. Provide fly ash and pozzolan test results performed within 6 months of submittal date. Architect review is required before concrete placement. Submit additional data regarding concrete aggregates if the source of aggregate changes.

C. Certificates of Compliance
   1. Aggregates
   2. Admixtures
   3. Reinforcement - Mill reports and recycled material content

4. Cement
5. Fly ash
6. Pozzolan
7. Ground slag

D. Catalog Data
1. Materials for curing concrete
2. Joint sealant
3. Joint filler
4. Vapor barrier
5. Reinforcing bolsters
6. Epoxy

E. Post-Installed Anchors
ICC ES Evaluation Reports
1. Manufacturer's Installation Instructions
2. Installer Qualifications

1.03 DELIVERY

A. Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement, and required inspections by the appropriate authorities have been completed.

1.04 STORAGE

A. ACI 301 for job site storage of concrete aggregates. Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Provide for accurate identification after bundles are broken and tags removed.

1.05 FORMWORK

A. The Contractor shall be solely responsible for the ability of formwork to produce members of the size, shape, alignment and finish required for structure adequacy. Contractor shall provide forms that carry construction loads safely and without excessive deflection. The Contractor shall be solely responsible for any injury or damage arising from inadequate forms or from premature removal of formwork.

B. Formwork design, engineering, construction and removal shall conform to ACI 318, Building Code Requirements for Reinforced Concrete, and ACI 347, Guide to Formwork for Concrete.

C. Where formwork will provide support for fresh elevated concrete or where formwork will be used to support shoring or re-shoring, provide sealed design calculations indicating arrangement of forms, size and grades of supports, panels and related components. Calculations must indicate concrete pressure with both live and dead loads, along with concrete strength requirements before removal of forms and shoring.

1.06 CONTROL SUBMITTALS

A. Concrete Curing Plan: Submit proposed materials, methods and duration for curing concrete elements in accordance with ACI 308.1.
B. Pumping Concrete: Submit proposed materials and methods for pumping concrete. Submittal must include mix designs, pumping equipment, including type of pump and size and material for pipe, and maximum length and height concrete is to be pumped.
C. Finishing Plan: Submit proposed material and procedures to be used in obtaining the finish for the floors. Include qualification of person to be used for obtaining floor tolerance measurement, description of measuring equipment to be used, and a sketch showing lines and locations the measuring equipment will follow.

PART 2 PRODUCTS

2.01 CONCRETE

A. Contractor Furnished Mix Design: ACI 211.1 and ACI 301 and ACI 211.2. Concrete shall have a 28 day compressive strength of indicated or specified below.

Location	Strength	Ratio	Max W/C Entr.	Air Slump*
All work	3000 psi	.6	4-6%	4"

*Slump requirement is before the addition of High Range Water Reducer admixture (HRWR). Maximum slump after addition of HRWR is 8-inches. Slump shall be checked before and after the addition of HRWR.

2.02 MATERIALS

A. Cement: ASTM C150, Type I or II or ASTM C595, Type IP blended cement, except as modified herein. The blended cement shall consist of a mixture of ASTM C150 cement and one of the following materials: ASTM C618 pozzolan or fly ash, or ASTM C989 ground iron blast furnace slag. The pozzolan/fly ash content shall not exceed 25 percent by weight of the total cementitious material and the ground iron blast furnace slag shall not exceed 50 percent by weight of total cementitious material. For exposed concrete, use one manufacturer for each type of cement, ground slag, fly ash, and pozzolan.
   1. Fly Ash and Pozzolan: ASTM C618, Class F, except that the maximum allowable loss on ignition shall be 6 percent for Type F. Add with cement.
   2. Ground Iron Blast Furnace slag: ASTM C989, Grade 120.
B. Water: Water shall be fresh, clean, and potable.
C. Aggregates: ASTM C33, except as modified herein. Obtain aggregates for exposed concrete surfaces from one source. Aggregates shall not

contain any substance which may be deleteriously reactive with the alkalies in the cement.

D. Nonshrink Grout: ASTM C1107.

E. Admixtures:
   1. Air Entraining: ASTM C260.
   2. Accelerating: ASTM C494, Type C.
   3. Retarding: ASTM C494, Type B, D, or G.
   4. Water Reducing: ASTM C494, Type A, E, or F.

F. Materials for Forms: Provide wood, plywood, or steel. Use plywood or steel forms where a smooth form finish is required. Lumber shall be square edged or tongue and groove boards, free of raised grain, knotholes, or other surface defects. Plywood: PS 1, B B concrete form panels or better. Steel form surfaces shall not contain irregularities, dents, or sags.

G. Reinforcement:
   1. Reinforcing Bars: ACI 301 unless otherwise specified. ASTM A615 or A706 for welded applications. ASTM A615 rebar shall not be welded.
   2. Welded Wire Fabric: ASTM A185 or ASTM A497. Provide flat sheets only of welded wire fabric for slabs.
   3. Wire: ASTM A82 or ASTM A496.
   4. Dowels: Plain steel; ASTM A675, Grade 80 or ASTM A499.
   5. Zinc coated (galvanized) bars shall comply with ASTM A767, Class II coating, galvanized after fabrication.
   6. Epoxy-coated bars shall comply with ASTM A934.

H. Vapor Barrier: See section 07.260 Vapor Barrier

I. Materials for Curing Concrete
   1. Impervious Sheeting: ASTM C171; waterproof paper, clear or white polyethylene sheeting, or polyethylene coated burlap.
   2. Pervious Sheeting: AASHTO M182.
   3. Liquid Membrane Forming Compound: ASTM C309, Type 2, Class B.
   4. Liquid Chemical Sealer Hardener Compound: Shall be a magnesium fluosilicate compound which when mixed with water penetrates the concrete and seals and hardens the surface of the concrete. Do not use on exterior slabs exposed to freezing conditions. Compound shall not reduce the adhesion of resilient flooring, tile, paint, roofing, waterproofing, or other material applied to concrete.

J. Expansion/Contraction Joint Filler: ASTM D1751 or ASTM D1752, 1/2 inch thick, unless otherwise indicated.

K. Joint Sealants:
   1. Horizontal Surfaces (3 percent slope, maximum):
      a. Outside Buildings: ASTM D1190.
      b. Inside Buildings: ASTM D1190 or ASTM D1850.

2. Vertical Surfaces (greater than 3 percent slope): ASTM C920, Type M, Grade NS, Class 25,Use T.

L. Release Agent for Fiberglass Forms: Nox-Crete.

M. Waterstops: As indicated.

N. Post-Installed Anchors:

1. Fasteners and Anchors:
   a. Bolts and Studs: ASTM A307; ASTM A449 where "high strength" is indicated on the Drawings.
   b. Carbon and Alloy Steel Nuts: ASTM A563.
   c. Carbon Steel Washers: ASTM F436.
   d. Carbon Steel Threaded Rod: ASTM A36; or ASTM A193 Grade B7; or ISO 898 Class 5.8.
   e. Wedge Anchors: ASTM A510; or ASTM A108.
   f. Stainless Steel Bolts, Hex Cap Screws, and Studs: ASTM F593.
   g. Stainless Steel Nuts: ASTM F594.
   h. Zinc Plating: ASTM B633.
   i. Hot-Dip Galvanizing: ASTM A153.
   j. Reinforcing Dowels: ASTM A615
2. CAST-IN-PLACE BOLTS
   a. Anchors, Bolts, Nuts, and Washers: Bolts and studs, nuts, and washers shall conform to ASTM A307, Grade A, and ASTM A449, ASTM A563, and ASTM F436, as applicable. Hot-dip galvanized bolts and studs including associated nuts and washers in accordance with ASTM A153.
3. DRILLED-IN ANCHORS
   a. Wedge Anchors: Wedge type, torque-controlled, with impact section to prevent thread damage complete with required nuts and washers. Provide anchors with length identification markings conforming to ICC ES AC01 or ICC ES AC193. Type and size as indicated on Drawings.
      1) Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).
      2) Exterior Use: As indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. Stainless steel nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
   b. Screw Anchors: Screw type. Pre-drilling of the hole requires a standard ANSI drill bit with the same diameter as the anchor

and installing the anchor will be done with an impact wrench. Provide anchors with a diameter and anchor length marking on the head. Type and size as indicated on Drawings.

1) Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating equivalent to DIN EN ISO 4042 (8 m min.).

c. Cartridge Injection Adhesive Anchors: Threaded steel rod, inserts or reinforcing dowels, complete with nuts, washers, polymer or hybrid mortar adhesive injection system, and manufacturer's installation instructions. Type and size as indicated on Drawings.

1) Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel threaded rods conforming to ASTM A36, ASTM A193 Type B7 or ISO 898 Class 5.8 with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1) [or carbon steel HIT TZ rods conforming to ASTM A510 with chemical composition of AISI 1038].

2) Exterior Use: As indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. All nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.

a. Reinforcing dowels shall be A615 Grade 60.

b. Capsule Anchors: Threaded steel rod, inserts and reinforcing dowels with 45 degree chisel point, complete with nuts, washers, glass or foil capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, and manufacturer's installation instructions. Type and size as indicated on Drawings.

1) Interior Use: Unless otherwise indicated on the Drawings, provide chisel-pointed carbon steel rods conforming to ASTM A36, ASTM A193 Type B7 or ISO 898 Class 5.8 with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).

2) Exterior Use: As indicated on the Drawings, provide chisel-pointed stainless steel anchors. Stainless steel anchors shall be AISI Type 304 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the

externally threaded fastener. All nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.

c. Reinforcing dowels shall be A615 Grade 60, with 45-degree chisel-points at embedded end.
d. Epoxy Bonding Agent: Sikadur 32 HI-MOD, Simpson FX-752, or approved equal.

PART 3 EXECUTION

3.01 FORMS

A. ACI 301. Provide forms, shoring, and scaffolding for concrete placement unless indicated or specified otherwise. Concrete for footings may be placed in excavations without forms upon observation and approval by the Architect. Excavation width shall be a minimum of 4-inches greater than indicated. Set forms mortar tight and true to line and grade. Chamfer above grade exposed joints, edges, and external corners of concrete 0.75 inch unless otherwise indicated. Provide formwork with clean out openings to permit inspection and removal of debris. Forms submerged in water shall be watertight.

B. Coating: Before concrete placement, coat the contact surfaces of forms with a nonstaining mineral oil, nonstaining form coating compound, or two coats of nitrocellulose lacquer. Do not use mineral oil on forms for surfaces to which adhesive, paint, or other finish material is to be applied.

C. Removal of Forms: Prevent concrete damage during form removal. After placing concrete, forms shall remain in place for the following minimum time periods. The minimum time period for removal of forms shall govern where it exceeds the minimum specified curing period. Where the formwork for one element supports the formwork for another element, the greater time period shall apply to both elements. Where concrete supports other work in progress, forms and shores shall not be removed until concrete reaches 75% of its design compressive strength.

Element	Time Period (Days Minimum)
All Work	3

3.02 PLACING REINFORCEMENT & MISCELLANEOUS MATERIALS

A. Fabricate and place reinforcing steel as specified, as shown on shop drawings, and in accordance with ACI 301. Provide bars, wire fabric, wire ties, supports, and other devices necessary to install and secure reinforcement. Reinforcement shall not contain rust, scale, oil, grease,

clay, and foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross sectional area or the nominal weight per foot of the reinforcement has been reduced to less than specified in paragraph entitled "Reinforcing Bars." Remove loose rust prior to placing steel. Tack welding is prohibited, unless ASTM A706 rebar is provided.

B. Vapor Barrier: Provide beneath the on grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 12-inches. Remove torn, punctured, or damaged vapor barrier material and provide with new vapor barrier prior to placing concrete. Concrete placement shall not damage vapor barrier material.

C. Support: Place reinforcement and secure with galvanized or noncorrodible chairs, spacers, or metal hangers. Use 4000 psi concrete blocks or other noncorrodible material for supporting reinforcement on the ground within footings or grade beams. Use steel chairs with sand plates to support reinforcement in grade slabs. Use steel bolsters with rubber tips to support reinforcement in forms above grade.

D. Splicing: ACI 301, except as otherwise indicated or specified. Splices shall be approved prior to use. Do not splice at points of maximum stress. Overlap welded wire fabric the spacing of the cross wires, plus 2- inches.

E. Cover: ACI 301 for minimum coverage, unless otherwise indicated.

F. Setting Miscellaneous Material: Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

G. Construction Joints: Locate joints to least impair strength. Continue reinforcement across joints unless otherwise indicated.

H. Sawed Joints: Saw joints early enough to prevent uncontrolled cracking in the slab, but late enough that this can be accomplished without appreciable spalling. Start cutting as soon as the concrete has hardened sufficiently to prevent raveling of the edges of the saw cut. Complete cutting before shrinkage stresses become sufficient to produce cracking. Use concrete sawing machines that are adequate in number and power, and with sufficient replacement blades to complete the sawing at the required rate. Cut joints to true alignment and in sequence of concrete placement continue joints to edge of slab. Remove sludge and cutting debris. Make joints 1/8 inch to 3/16 inch wide and extend into the slab one-fourth the slab thickness, minimum.

I. Tooled Joints: Joints may be tooled to same pattern and depth as indicated for sawn joints. Tool joints when concrete is sufficiently hard enough to support foot traffic.

J. Expansion Joints: Use preformed expansion joint filler in expansion and isolation joints in slabs around columns and between slabs on grade

and vertical surfaces where indicated. Extend the filler to the full slab depth, unless otherwise indicated. Neatly finish the edges of the joint with an edging tool of 1/8 inch radius, except where a resilient floor surface will be applied. Where the joint is to receive a sealant, install the filler strips at the proper level below the finished floor with a slightly tapered, dressed and oiled wood strip temporarily secured to the top to form a recess to the size shown on the drawings. Remove the wood strip after concrete has set. Contractor may opt to use a removable expansion filler cap designed and fabricated for this purpose in lieu of the wood strip. Thoroughly clean the groove of laitance, curing compound, foreign materials, protrusions of hardened concrete, and any dust. If blowing out the groove, use oil-free compressed air.

K. Form Ties and Accessories: The use of wire alone is prohibited. Form ties and accessories shall not reduce the effective cover of the reinforcement. Bend or cut ends of wires to provide minimum 1" cover.

L. Waterstop: Install in strict accordance with manufacturer's recommendations and as indicated.

M. Welded-Wire Reinforcement Placement:
   1. Place welded-wire reinforcement in slabs as indicated. Reinforcement placed in slabs on grade must be continuous between expansion, construction, and contraction joints. Reinforcement placement at joints must be as indicated.
   2. Lap splices in such a way that the overlapped area equals the distance between the outermost crosswires plus 2 inches. Stagger laps to avoid continuous laps in either direction. Wire or clip together reinforcement at laps at intervals not to exceed 4 feet. Position reinforcement by the use of supports.

N. Dowel Installation: Install dowels in slabs on grade at locations indicated and at right angles to joint being doweled. Accurately position and align dowels parallel to the finished concrete surface before concrete placement. Rigidly support dowels during concrete placement. Coat one end of dowels with a bond breaker.

O. Drilled-In Anchors:
   1. Drill holes with rotary impact hammer drills. Drill bits shall be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes shall be drilled perpendicular to the concrete surface.
      a. Cored Holes: Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer's instructions.
      b. Embedded Items: Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Notify the Engineer if reinforcing steel or other embedded items are encountered

during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines.

c. Base Material Strength: Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

2. Perform anchor installation in accordance with manufacturer instructions.

P. Wedge Anchors, Heavy-Duty Sleeve Anchors, and Undercut Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in part to be fastened. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10% of the specified torque, 100% of the specified torque shall be reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor shall be removed and replaced unless otherwise directed by the Engineer.

Q. Cartridge Injection Adhesive Anchors: Clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive shall be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed.

R. Capsule Anchors: Perform drilling and setting operations in accordance with manufacturer instructions. Clean all holes to remove loose material and drilling dust prior to installation of adhesive. Remove water from drilled holes in such a manner as to achieve a surface dry condition. Capsule anchors shall be installed with equipment conforming to manufacturer recommendations. Do not disturb or load anchors before manufacturer specified cure time has elapsed.

3.03 MEASURING, MIXING, TRANSPORTING AND PLACING CONCRETE

A. ASTM C 94, ACI 301, ACI 302.1R, and ACI 304, except as modified herein. Provide mandatory batch ticket information for each load of ready mix concrete. Batch tickets must include maximum amount of water that can be added in the field.

B. Measuring: Make moisture, weight, and air determinations at intervals as specified in paragraph entitled "Sampling and Testing." Allowable tolerances for measuring cement and water shall be 1 percent; for aggregates, 2 percent; and for admixtures, 3 percent.

C. Mixing: ASTM C94. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 85 degrees F. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 85 degrees F. Additional water may be added, provided that both the specified maximum slump and water cement ratio are not exceeded. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch. No admixtures may be added on site unless manufacturer's requirements are strictly followed and concrete supplier provides direct jobsite supervision.

D. Transporting: Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as required.

E. Placing: Place concrete as soon as practicable after the forms and the reinforcement have been inspected by the appropriate authorities. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 3 feet from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other.

    1. Vibration: ACI 301. Furnish a spare vibrator on the job site whenever concrete is placed. Consolidate concrete slabs greater than 4-inches in depth with high frequency, internal, mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 4-inches or less in depth by wood tampers, spading, and settling with a heavy leveling straight edge. Operate vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 6000 impulses per minute when submerged. Do not use vibrators to transport the concrete in the forms. Insert and withdraw vibrators approximately 18- inches apart. Penetrate the previously placed lift with the vibrator when more than one lift is required. Place concrete in 18 inch maximum vertical lifts. External vibrators shall be used on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete.

F. Cold Weather: ACI 306R. Provide 50 degrees F minimum concrete temperature. Obtain approval prior to placing concrete when the ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover

concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 5 degrees F in any one hour and 50 degrees F per 24 hours after heat application.

G. Hot Weather: ACI 305R. Provide and maintain required concrete temperature using Figure 2.1.5 in ACI 305R to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment. and water hauling equipment (where work site is remote to water source) to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.04 SURFACE FINISHES (EXCEPT FLOOR & SLAB FINISHES)

A. Defects: Repair formed surfaces by removing minor honeycombs, pits greater than one square inch surface area or 0.25-inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with nonshrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb (including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects) which affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain proposed concurrence of Architect for corrective action prior to repair. The surface of the concrete shall not vary by more than the allowable tolerances of ACI 347. Exposed surfaces shall be uniform in appearance and finished to a smooth form finish unless otherwise specified.

B. Not Against Forms (Top of Walls): Surfaces not otherwise specified shall be finished with wood floats to even surfaces. Finish shall match adjacent finishes.

C. Formed Surfaces

1. As Cast Rough Form (for Surfaces Not Exposed to Public View): Remove fins and other projections exceeding 0.25- inch in height; level abrupt irregularities.
2. As Cast Smooth Form (for Surfaces Exposed to Public View): Form facing material shall produce a smooth, hard, uniform texture on the concrete. Remove fins and other projections. Provide light sandblast where indicated on the drawings.

3. Sandblast and provide light sandblast finish where indicated on the drawings.

D. Rubbed Finish: Provide concrete with a smooth form finish. Finish as follows:
   1. Smooth Rubbed: Provide on newly hardened concrete within 24 hours following form removal. Wet surfaces and rub with an abrasive tool to produce uniform color and texture. Use only the cement paste drawn from the concrete rubbing process.

3.05 FLOOR, SLAB & MISCELLANEOUS CONSTRUCTION

A. Before construction of slabs on ground, have underground work on pipes and conduits completed, tested as required, inspected by appropriate authorities and observed by Architect. Underground pipes and conduits shall be located as indicated.

B. ACI 302.1R, unless otherwise specified. Slope floors uniformly to drains where drains are provided. Depress the concrete base slab where indicated on Structural or Architectural plans. Provide interior floor slabs with a steel troweled finish. After troweling is completed, apply a liquid chemical sealer hardener compound on interior floor slabs that do not receive floor covering or floor polishing.

C. Flatness/Levelness Requirements
   1. All Areas: FF = 35 overall with a minimum value of 24, FL = 25 overall with a minimum value of 18. Contractor is required to repair and retest any floors not meeting specified tolerances. Prior to repair, Contractor must submit and receive approval for the proposed repair, including product data from any materials proposed. Repairs must not result in damage to the structural integrity of the floor. For floors exposed to public view, repairs must prevent any uneven or unusual coloring of the surface.

D. Finish: Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.
   1. Floated: Provide for machinery pads and other exterior slabs where not otherwise specified. Float the surface by hand with a wood or magnesium float, or use a power driven float.
   2. Steel Troweled: First, provide a floated finish. When slab attains a proper set, trowel to a smooth, hard, dense finish. Finished surfaces shall be free of troweled marks, uniform in texture, and a true plane, level and flat within specified tolerance; hand finish portions of the slab not accessible to power finishing equipment (e.g., edges, corners) to match the remainder of the slab. Power trowel once and finally hand trowel where a finished floor covering

(e.g., tile, carpet) is specified. Power trowel twice and finally hand trowel for exposed concrete floors.

3. Broomed: Provide for exterior walks, platforms, patios, and ramps, unless otherwise indicated. Provide a floated finish, then finish with a flexible bristle broom. Permit surface to harden sufficiently to retain the scoring or ridges. Broom transverse to traffic or at right angles to the slope of the slab.

E. Concrete Walks: Provide 4-inches thick minimum. Provide contraction joints spaced every 5 linear feet unless otherwise indicated. Cut contraction joints 3/4 inch deep with a jointing tool after the surface has been finished. Provide 0.5-inch thick transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every 20 feet maximum apart. Provide walks with a broomed finish. Provide a transverse slope of 1/4-inch per foot, unless noted otherwise. Llimit variation in cross section to 1/4-inch in 5 feet. Maintain ADA slope requirements for all walks and paved areas.

F. Pits and Trenches: Place bottoms and walls monolithically or provide waterstops and keys.

G. Curbs: Reinforce as indicated. Provide contraction joints spaced every 10 feet maximum unless otherwise indicated. Align joints in curbs with joints in pavement. Cut contraction joints 3/4 inch deep with a jointing tool after the surface has been finished. Provide expansion joints 1/2 inch thick and spaced as indicated. Provide a pavement finish.

3.06 CURING AND PROTECTION

A. ACI 301 unless otherwise specified. Begin curing immediately after placement and as recommended by compound manufacturer. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period.

B. Moist Curing: Provide for the removal of water without erosion or damage to the structure.

1. Ponding or Immersion: Continually immerse the concrete throughout the curing period. Water shall not be more than 20 degrees F less than the temperature of the concrete. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

2. Fog Spraying or Sprinkling: Provide uniform and continuous application of water throughout the curing period. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.
3. Pervious Sheeting: Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 6-inches over adjacent sheeting. Sheeting shall be at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.
4. Impervious Sheeting: Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12-inches minimum. Provide sheeting not less than 18-inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting, overlap and continuously tape sheeting joints, and introduce sufficient water to soak the entire surface prior to completely enclosing.

C. Liquid Membrane Forming Compound Curing: Seal or cover joint openings prior to application of curing compound. Prevent curing compound from entering the joint. Provide and maintain compound on the concrete surface throughout the curing period. Do not use this method of curing where the use of Figure 2.1.5 in ACI 305R indicates that hot weather conditions will cause an evaporation rate exceeding 0.2 pound of water per square foot per hour.
   1. Application: Unless the manufacturer recommends otherwise, apply compound immediately after the surface loses its water sheen and has a dull appearance, and before joints are sawed. Mechanically agitate curing compound thoroughly during use. Use approved power spraying equipment to uniformly apply two coats of compound in a continuous operation. The total coverage for the two coats shall be 200 square feet maximum per gallon of undiluted compound unless otherwise recommended by the manufacturer's written instructions. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel. Immediately apply an additional coat of compound to areas where the film is defective. Respray concrete surfaces subjected to rainfall within 3 hours after the curing compound application.
   2. Protection of Treated Surfaces: Prohibit foot and vehicular traffic and other sources of abrasion for not less than 72 hours after

compound application. Maintain continuity of the coating for the entire curing period and immediately repair any damage.

D. Liquid Chemical Sealer Hardener Curing: Apply to interior floors that do not receive a floorcovering. Apply the sealer hardener in accordance with manufacturer's recommendations. Seal or cover joints and openings in which joint sealant is to be applied as required by the joint sealant manufacturer. The sealer hardener shall not be applied until the concrete has cured for a minimum of 30 days. Apply a minimum of two coats of sealer hardener.

E. Curing Periods and Minimum Temperatures: After placing concrete, maintain air temperature adjacent to the concrete at 50 degrees F minimum for the specified time period, or 70 degrees F minimum for a period of 3 days after placing, and 40 degrees F minimum for the remainder of the specified time period.

Time Period (Days Minimum)	Concrete Structure or Cement Type
7	ASTM C150, Type I or II, either with or without fly ash, pozzolan, or ground slag; and ASTM C595 cement for concrete not specified otherwise.

1. Additional Curing: Double the required curing period if either one or the average of both 7 day test cylinders indicate less than 75 percent of the strength specified (f'c).

3.07 SAMPLING AND TESTING

A. Sampling: ASTM C172. Collect samples of fresh concrete to perform tests specified. ASTM C31 for making test specimens.

B. Testing

1. Slump Tests: ASTM C143. Take concrete samples during concrete placement. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water cement ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 10 cubic yards (maximum) of concrete. Perform slump test before and after addition of superplasticizer.
2. Temperature Tests: Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 10 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

3. Compressive Strength Tests: ASTM C39. Make five test cylinders for each set of tests in accordance with ASTM C31. Test two cylinders at 7 days, two cylinders at 28 days, and hold one cylinder in reserve. Samples for strength tests of each mix design of concrete placed each day shall be taken not less than once a day, nor less than once for each 100 cubic yards of concrete, nor less than once for each 5000 square feet of surface area for slabs or walls. For the entire project, there shall be no less than five sets of samples taken and strength tests performed for each mix design of concrete placed. Each strength test result shall be the average of two cylinders from the same concrete sample tested at 28 days. If the average of any three consecutive strength test results is less than f'c or if any strength test result falls below f'c by more than 500 psi, take a minimum of three ASTM C42 core samples from the in-place work represented by the low test cylinder results and test. Concrete represented by core tests shall be considered structurally adequate if the average of three cores is equal to at least 85 percent of f'c and if no single core is less than 75 percent of f'c. Locations represented by erratic core strengths shall be retested. Remove concrete not meeting strength criteria and provide new acceptable concrete. Repair core holes with nonshrink grout. Match color and finish of adjacent concrete.
4. Air Content: ASTM C173 or ASTM C231. Test air entrained concrete for air content at the same frequency as specified for slump tests.
5. Post-Installed Anchors
    a. Testing: 25 of each type and size of drilled-in anchor shall be proof loaded by the independent testing laboratory. Adhesive anchors and capsule anchors shall not be torque tested. If more than 10% of the tested anchors fail to achieve the specified torque or proof load within the limits as defined on the Drawings, all anchors of the same diameter and type as the failed anchor shall be tested.
        1) Tension testing should be performed in accordance with ASTM E488.
        2) Torque shall be applied with a calibrated torque wrench.
        3) Proof loads shall be applied with a calibrated hydraulic ram. Displacement of adhesive and capsule anchors at proof load shall not exceed D/10, where D is the nominal anchor diameter.
    b. Minimum anchor embedments, proof loads and torques shall be as shown on the Drawings.

3.08 REPAIR, REHABILITATION AND REMOVAL

A. Prior to final acceptance, inspect the structure for cracks, damage and substandard concrete placements that may adversely affect the service

life of the structure. Submit a report documenting these defects, which includes recommendations for repair, removal and/or remediation to the Architect for concurrence before any corrective work is accomplished. Perform corrective measures required.

1. Crack Repair: Prior to final acceptance, document and repair all cracks in excess of 0.02 inches wide. Submit the proposed method and materials to repair the cracks to the Architect for concurrence. Address the amount of movement expected in the crack due to temperature changes and loading. Perform corrective measures required.

B. Post-Installed Anchors: Remove and replace misplaced or malfunctioning anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout. Anchors that fail to meet proof load or installation torque requirements shall be regarded as malfunctioning.

END OF SECTION

SECTION 04.200 UNIT MASONRY

PART 1 GENERAL

1.01 SUMMARY

A. Extent of each type of masonry work is indicated on Drawings and Schedules. To be used for replacing existing damaged masonry.
   1. Face Brick, in standard size units, and custom shapes, or custom units as indicated.
   3. Brick mortar
   4. Anchors, ties, reinforcing, insulation, masonry accessories, and concealed flashings.
   5. Other items as specified herein or indicated on the Drawings.

B. Related Sections include the following:
   1. Section 05.500 Metal Fabrications
   2. Section 07.950 Sealants and Caulking

1.02 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Material Certificates: For each type and size of product indicated. For masonry units include data on material properties.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
   2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

D. Shop Drawings
   1. For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
   2. Flashing: show layout of flashing, including preformed corners and end dam locations.

E. Samples: For verification purposes submit the following:
   1. Manufacturer’s complete and current product data for each different masonry unit, accessory, and other manufactured product indicated, including certifications that each item and type complies with specified requirements.
      a. Include instructions for handling, storage, installation, and protection.
   2. Provide samples for initial selection purposes of the following:
      a. Exposed masonry, showing full extent of colors and variations anticipated, for each standard and special shape unit.

1.03 QUALITY ASSURANCE

A. All work shall comply with the 2018 International Building Code (IBC 2018) and ACI 530.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver masonry materials to project in undamaged condition.
B. Store and handle masonry units palleted, off the ground, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not place until units are in an air-dried condition.
C. Store cementitious materials and insulation off the ground, under cover, and in dry location.
D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
E. Store masonry accessories including metal items to prevent corrosion and accumulation of dirt and oil.

1.05 PROJECT CONDITIONS

A. Protection of Masonry
    1. During erection, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
    2. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
    3. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after constructing masonry walls or columns.
C. Stain Prevention:
    1. Prevent grout or mortar from staining the face of masonry to be left exposed. Remove immediately grout or mortar in contact with such masonry.
    2. Protect installed face brick at ground level from clay staining by maintaining a perimeter **3'-0" wide of sod as specified**, until final landscaping or other improvements indicated adjacent to completed masonry work are in place.
    3. Protect sills, ledges and projections from droppings of mortar.
    4. Protect surfaces of window and door frames as well as similar products with painted and integral finished from mortar droppings, and other damage.
D. Clean Air Space: Prevent grout and mortar from occurring in, bridging, forming ledges, and/or filling air space between masonry and back up walls.

E. Cold-Weather Construction: When the ambient temperature falls below 40 degrees (4 degrees Celsius) comply with provisions of ACI 530, Specification for Masonry, for cold-weather construction and the following:
   1. Do not lay masonry units that are wet or frozen.
   2. Remove masonry damaged by freezing conditions.
F. Hot-Weather Construction: When the ambient temperature exceeds 90 degrees (32 degrees Celsius) comply with provisions of ACI 530, Specification for Masonry, for hot-weather construction.
G. Protect plastic insulation from exposure to sunlight and against ignition. Schedule delivery so that installation and concealment may be performed as rapidly as possible.

PART 2 PRODUCTS

2.01 BRICK MATERIALS

A. Face Brick General
   1. Obtain masonry units of each type from one manufacturer, of uniform texture and color.
   2. Size
      a. Standard Modular: 3-5/8 inches x 2-1/4 inches x 7-5/8 inches unless otherwise indicated.
      b. Provide modular and as follows:
         (1) For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
         (2) Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
   3. Provide solid, uncored brick for all brick reveal areas, brick screen walls, and other areas indicated to receive “solid” brick.
B. Face Brick Schedule
   1. Brick Type 1
      a. Assurance: Comply with ASTM C216, Grade SW, Type FBS.
      b. Provide brick to match existing vertical exterior masonry.
         (1) Approved comparable products by:
            (a) Columbia Block & Brick,
            (b) Cherokee Brick & Tile Company
            (c) Approved Equal
   2. Brick Type 2
      a. Assurance: Comply with ASTM C216, Grade SW, Type FBS.
      b. Provide brick to match existing horizontal exterior masonry (brick curbs).
         (1) Approved comparable products by:
            (a) Columbia Block & Brick,

(b) Cherokee Brick & Tile Company
(c) Approved Equal

2.03 MASONRY LINTELS

A. Provide and install loose lintels of steel and other materials where indicated.
   1. Steel lintels are specified in Division 5 Section “Metal Fabrications”.

2.04 MORTAR MATERIALS

A. Portland Cement: ASTM C 150, Type I, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
B. Hydrated Lime: ASTM C207, Type S.
C. Masonry Cement: ASTM C 91.
D. Aggregate for Mortar: ASTM C 144.
E. Aggregate for Grout: ASTM C 404.
F. Water: Potable.

2.05 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.
   2. Use portland cement-lime or masonry cement mortar unless otherwise indicated.
B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
C. Grout for Unit Masonry: Comply with ASTM C 476.
   1. Use grout of type indicated or, in not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
   2. Proportion grout in accordance with ASTM C 476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 3000 psi.
   3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143.
D. Mortar for Brick: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.
   1. For all face brick, use **Type N**.
   2. Brick Mortar Schedule:
      a. Brick Mortar: manufacturer’s colored mortar from one of the following manufacturer’s:

(1) Holcim (US)
(2) CEMEX
(3) LaFarge North America

b. Provide water repellent mortar admixture (equal to Grace Construction Products “DryBrick”) to each batch of mortar.

2.06 MASONRY ANCHORS AND TIES

A. Provide accessories from one of the following manufacturers:
1. Hohmann & Barnard
2. Dur-O-Wal (a Hohmann & Barnard Company)
3. Wire-Bond

B. Materials
1. Anchors and Ties: Carbon Steel: To ASTM A366, hot-dip galvanized after fabrication to ASTM A153, Class B.
2. Wire: Carbon Steel: To ASTM A82, with zinc coating hot-dip galvanized after fabrication to ASTM A153.
a. Tensile Strength: Not less than 80,000 psi (552 MPa).
b. Yield Point: Not less than 70,000 psi (483 MPa).
3. Seismic Reinforcement Retaining Clip: Rigid polyvinyl chloride clip to ASTM D1781, ASTM D2240, ASTM D638, ASTM D790, with ridge to secure continuous wire in mortar and 3 additional ridges to secure masonry wire tie.
4. Anchor (and insulation) tape: Hohmann & Barnard's “X-Seal Transition Anchor Tape”.
a. Provide at all locations where flexible anchors are secured thru to exterior sheathing substrate using mechanical devices (screws).
b. 3 inch wide tape consists of a reinforced polyolefin base, laminated to a polypropylene layer. Adhesive-backed with removable release liner.
c. Manufactured from 45% post-industrial and/or post-consumer recycled material.
d. Apply in continuous lengths only.
e. Permeability:
(1) MVTR: ASTM E96 -B <.075 Perms[1]
(2) Air permeability: TAPPI-460 >5000 Sec/100cc

C. General
1. Tie length required to extend approximately 2 inches into masonry.
2. Provide “Seismic Reinforcement Retaining Clips” at end of ALL pintles. Clip shall engage a 9 ga. continuous pencil rod.

E. Flexible Anchors: Where masonry is indicated to be anchored to structural framework with flexible anchors, provide 2-piece anchors which will permit horizontal and vertical movement of masonry, but will provide lateral restraint.
1. Anchored to metal studs with **no** rigid insulation:

a. Hohmann & Barnard's “DW-10HS Seismiclip® Interlock System” with “#VBT – Vee Byna-Tie”.
(1) Provide ties in lengths as required.
b. Attach each anchor to wall with expansion anchor as recommended by the manufacturer.

2. Anchored to metal studs **with** rigid insulation:
a. Hohmann & Barnard's “X-Seal S.I.S. Anchor” with “#VBT – Vee Byna-Tie”.
(1) Provide ties in lengths as required.
b. Attach each anchor to wall with expansion anchor as recommended by the manufacturer.

3. Anchored to concrete with rigid insulation:
a. Hohmann & Barnard's “#305 Dovetail Slot – 16 gauge” with “#315BT – Dovetail Vee Byna-Tie”.
(1) Provide ties in lengths as required.

F. Intersections of Masonry Walls
1. Wire Mesh Ties
a. To be used at all intersections of exterior masonry walls with interior masonry partitions and where interior masonry partitions intersect with each other, except where noted to use joint stabilizing anchors below.
b. 1/2" mesh, 16 gage, hot-dip galvanized wire mesh, 12" long x 1" less than intersecting partition thickness.
(1) Hohmann & Barnard's “MWT – Mesh Wall Tie”.

2. Joint Stabilizing Anchors:
a. Metal end piece with two integrated 9 gauge rods and a 4" long loose PVC "Slip-Tube"
(1) Hohmann & Barnard's “Slip-Set Stabilizer”
b. To be used at intersections of masonry walls at **all** control joint locations and where one of the intersecting masonry partitions is 8’-0” long or shorter. Install at 32 inches o.c. vertically.

G. Finish for Masonry Anchors and Ties
1. For interior locations, including devices which extend only into interior wythes of exterior masonry, fabricate from steel with mill galvanized finish complying with ASTM A641, Class 1 or 3; or hot-dip coating complying with ASTM A153, Class B-2.
2. For devices which extend into exterior wythe, fabricate from steel with hot-dip galvanized coating, ASTM A153, Class, B-2.

2.07 ACCESSORIES

A. Miscellaneous Anchors
1. Anchor Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153, Class C; of diameter and length indicated and in the following configurations:

a. Headed bolts.
b. Nonheaded bolts, bent in manner indicated.

2. Postinstalled Anchors: Anchors as described below, with capability to sustain, without failure, load imposed within factors of safety indicated, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
   a. Type: Expansion anchors.
   b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild).
   c. For Postinstalled Anchors in Concrete: Capability to sustain, without failure, a load equal to four times the loads imposed.
   d. For Postinstalled Anchors in Grouted Masonry Units: Capability to sustain, without failure, a load equal to six times the loads imposed.

B. Flashing for Masonry (Thru-Wall Flashing):
   1. See WP2 specified in Section 072600
   2. Drip Plate: 26 gauge, type 304 stainless steel with continuous 1/8 inch foam strip
      a. Hohmann & Barnard's "FTS"
   3. Compressible Filler Pad: 3/8" closed cell neoprene sponge equal to Hohmann & Barnard's #NS.

C. Mortar Drip Collector
   1. A fluid conducting, non-absorbent, mold and mildew resistant polyment mesh designed to prevent weephole blockage. Trapezodial shaped, formed at unequal heights.
      a. "Mortar Net with Insect Barrier" as manufactured by Mortar Net USA or approved equal.
      b. Material to be 10" tall x 5'-0" long x as thick as the manufacturer recommends for the air space shown in which the drip collector is being installed.

D. Weephole Vents
   1. UV stable, 90% open recycled polyester mesh weephole vents between units in the weep course.
      a. "Mortar Net Weep Vents" as manufactured by Mortar Net USA or approved equal.
      b. Architect to select color from manufacturer's full line of colors to match mortar color as specified herein.

E. Miscellaneous Masonry Accessories
   1. Reinforcing Bars: Deformed steel, ASTM A615, Grade 60 of the sizes shown.
   2. Premolded Control Joint Strips: Solid rubber strips with a shore A durometer hardness of 60 to 80, designed to fit standard sash block and maintain lateral stability in masonry wall, size and configuration as indicated.
      a. Hohmann & Barnard's "RS Series -Rubber Control Joint"

3. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

F. Cavity Insulation Board
   1. See Section “Building Insulation”

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Thickness: Build masonry construction to the actual thickness indicated. In most cases floor plan dimensions indicate nominal thickness and require deducting 3/8 inch to determine actual thickness.

B. Build chases and recesses as shown and as required for the work of other trades. Provide not less than 8" of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

C. Miter corners of soldier and rowlock courses and bond mitered pieces together with thin set mortar formulated for use with brick in exterior locations.

D. Layout walls in advance for accurate spacing of surface bond patterns, with uniform joint widths and to properly locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half size units at corners, jambs and wherever possible at other locations.
   1. Layout concrete masonry to provide equal cuts at each end of individual wall panels where practicable.
   2. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces concealed.

E. Stopping and Resuming Work: Rack back 1/2-masonry unit length in each course of running bond; do not tooth. Clean exposed surfaces of set masonry, wet units lightly (if specified to be wetted), and remove loose masonry units and mortar prior to laying fresh masonry.

F. Remove masonry units disturbed after placement; clean and set in fresh mortar. Do not pound corners at jambs to fit stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar, and reset in fresh mortar.

G. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

H. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
   1. Confirm with manufacturer prior to laying mock-up.

3.02 CONSTRUCTION TOLERANCES

A. Dimensions and Locations of Elements
   1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
   2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
   3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels
   1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
   2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
   3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
   4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
   5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

C. Joints
   1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
   2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
   3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.03 LAYING MASONRY WALLS

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

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

C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
   1. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of monofilament screen such as Dur-O-Wal's Dur-O-Stop in the joint below and rod mortar or grout into core.

D. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
E. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.04 MORTAR BEDDING AND JOINTING

A. Batch Control
   1. Measure and batch materials either by volume or weight, such that the required proportions for mortar can be accurately controlled and maintained.
      Measurement of sand exclusively by shovel will not be permitted. Use of a 1 cubic foot "box" is required. If "box" method is not used, portions of walls constructed will be considered non-conforming and be removed and replaced.
B. Mix mortar using a mechanical mortar mixer to ensure homogeneity and workability. Hand mixing of the mortar is not permitted.
   1. Observe mixing times of 4 -5 minutes, consistent from batch to batch.
   2. Use clean, potable water, add the maximum amount consistent with optimum workability.
   3. Maintain a uniform water/cement ratio.
C. Rinse out mixer following each batch.
   1. At the end of the day, thoroughly rinse the mixer to avoid contamination of future mortar batches.
D. Do not use mortar which has begun to set, and discard if more than 2 1/2 hours has elapsed since initial mixing.
   1. Retemper mortar during this time by adding additional mixing water only to replace water lost due to evaporation.
   2. Do not retemper colored mortars.
E. Lay hollow brick and CMU as follows:
   1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
   2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
   3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
   4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
F. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
G. Tool exposed joints slightly **concave** when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
H. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

I. Collar Joints: Fill joints between wythes of faced (composite) and solid walls solidly with mortar by pargeting either the back of the facing, or the face of the backing, and shove units solidly into pargeting.

3.05 CAVITY WALLS

A. Coat cavity face of backup wythe to comply with Division 7 Section "Vapor Barriers"
B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
C. Bond wythes of cavity walls together using one of the following methods:
    1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, spaced not to exceed 16 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 24 inches apart around perimeter of openings.
    2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
        a. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
D. Provide not less than 2 inches of air space between back of masonry veneer and face of sheathing.
E. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

3.06 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
    1. Space reinforcement not more than 16 inches o.c.
    2. Space reinforcement not more than 8 inches o.c. in foundation walls, parapet walls and in all corner zones of the building. Corner zones are indicated on Structural Drawings.
    3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

1. Install joint stabilizing anchors not more than 32 inches o.c. at these locations.

C. Provide continuity at corners by using prefabricated L-shaped units.

3.07 ANCHORING MASONRY TO CONCRETE

A. Anchor masonry to concrete where masonry abuts or faces concrete to comply with the following:
   1. Provide an open space not less than 2 inches wide between masonry and concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
   2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
   3. Space anchors as indicated, but not more than 16 inches o.c. vertically and 16 inches o.c. horizontally.

3.08 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows unless otherwise indicated:
   1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
   2. At shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
   3. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.
   4. Install flashings with 6 inch minimum lap at splices. Bond to slab, and seal at penetrations and interruptions with mastic.

C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
   1. Use specified weep/vent products to form weep holes.
   2. Space weep holes 32 inches o.c. unless otherwise indicated.
   3. Install a minimum of two weep hole inserts above openings less than 5’-4” wide.

D. Place cavity drainage material in cavities per the following:
   1. To prevent mortar bridging between the outer wythe and inner wall, install flashing extending from the bottom of the drainage material to at least 6" above the top of the drainage material.

2. Lay the first one (1) or two (2) courses of brick at flashing level, then install drainage material continuously by placing it against the inside of the openings. No fasteners or adhesives are required.

3.09 REINFORCED UNIT MASONRY INSTALLATION

A. Coordinate with Division 4 Section "Structural Concrete Masonry".
B. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
C. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
D. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Low lifting grouting procedures shall be utilized for all masonry filled cell construction. Limit pour heights to a maximum of 48 inches and utilize a course grout mix.

3.10 CONTROL AND EXPANSION JOINTS

A. Provide vertical expansion, control and isolation joints in masonry where indicated on Drawings. Build in related masonry accessory items as the masonry work progresses. See Division 7 Sections “Joint Sealants”.
B. Expansion Joint Spacing: Place expansion joints where indicated on the drawings, but not more than 25’-0” on-center each way, and within 5’-0” of a corner.
   1. Confirm locations with Architect prior to installation.

3.11 PARGING

A. Use a steel-trowel finish to produce a smooth, flat, dense surface. Form a wash at top of parging and a cove at bottom.
B. Damp-cure parging for at least 24 hours and protect parging until cured.

3.12 FIELD QUALITY CONTROL

A. Contractor will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:

1. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.

B. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.

C. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

D. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

E. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019.

3.13 REPAIR

A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints at corners, openings and adjacent work to provide a neat, uniform appearance, properly prepared for application of caulking or sealant compounds.

3.14 CLEANING OF BRICK

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. General

1. **All cleaning methods are to be verified for compliance by the Architect prior to use.**
2. Apply with a standard water hose nozzle. Apply using a circular application pattern and maintain an adequate and consistent distance. **PRESSURE WASHERS WILL NOT BE ALLOWED AS A MEANS OF APPLYING.**

C. Pre-Cleaning

1. Prior to cleaning brickwork, all large mortar droppings should be removed within 24 hours of laying with wood paddles or natural bristle brushes. Cleaning should begin 21 to 28 days with type N, after laying the brick.

D. Cleaning

1. Saturation: Thoroughly saturate all masonry with water before applying any cleaning product.
2. Clean
   a. Use a cleaning solution and procedure recommended by the brick manufacturer.
   b. Apply the cleaning solution as recommended. The cleaning solution should remain on the brickwork 3 to 6 minutes before proceeding to the next step. Clean the brick starting at the top

and working down, being sure to keep areas below the cleaning area saturated with water.

c. Do not allow the cleaning chemicals to dry on the brickwork.

3. Rinse

a. Thoroughly rinse all masonry with water to remove the cleaning compound. It is vital that all chemicals used in cleaning be rinsed out of the brickwork before they dry in place.

b. Begin at the top of the brickwork and work down using two or three passes. Be certain all “dirty” water is flushed all the way to the ground and does not stay on the masonry.

3.15 CLEANING OF CMU

A. Clean exposed CMU masonry by dry brushing at the end of each day's work and after final pointing to remove mortar spots and droppings. Rub joints with carborundum or CMU block to eliminate ridges and irregularities and provide well-formed intersections.

END OF SECTION

SECTION 05.410 METAL STUD SYSTEM

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Section 06.100 Rough Carpentry
B. Section 09.250 Gypsum Board Assemblies

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design manufacturer is Clark Dietrich Building Systems.
B. Provided all other Project Requirements are met, equal products may be submitted for approval. See Sections 00.107 Substitutions and 01.300 Submittals.

2.02 MATERIAL

A. All framing materials shall be galvanized. Interior studs shall be G40. Exterior studs shall be G60.
B. All fasteners shall be cadmium plated.
C. All floor tracks shall be U-runner, 14 gauge, 3" high.
D. All top tracks shall be runner, of gauge to match studs.
E. All exterior studs shall be Type CSJ, 16 gauge, 50 kai, by Dietrich. Sizing shall be as indicated on the Drawings. Exterior studs spacing shall not exceed 16" on centers.
F. All interior studs shall be Type CSJ, 20 gauge, 33 kai. Sizing shall be as indicated on the Drawings. Interior stud spacing shall not exceed 16" on centers.
G. Horizontal bracing shall be 1-1/2” cold rolled channels secured with screw attached 1-1/2" x 2" x 16 gauge clip angles cut to length 1/4" less than stated width.
H. All framing members shall be formed from corrosion resistant steel, corresponding to the requirements of ASTM A446.
I. Metal Furring Channels shall be 7/8" heavy-duty furring channel (16 gauge).

PART 3 EXECUTION

3.01 ERECTION

A. Align runners accurately to the layout, and securely anchor to floor and overhead structure with power driven fasteners as per manufacturer's recommendations.
B. Position exterior studs vertically in runners and space no more than 12" on center. Position interior studs vertically in runners and space no greater than 16" on center. Securely anchor each stud to runners with four screws, two at top and two at bottom with one screw in each flange.

Studs may not be spliced. At corners and intersection stud walls, provide at least three studs for attaching interior and exterior facings.

C. Install horizontal bracing in all stud walls, not to exceed 5'-0" on center vertically. Insert channels through stud web holes and secure with screw attached clip angles at each stud. Horizontal bracing shall prevent stud rotation.

D. For wall openings larger than a single door, assemble lintels from two boxed joist sections and fasten to jamb studs. Install required web stiffeners before assembling headers. Cut sills and headers from studs or runners and install in all openings. Securely attach sills and headers to supporting studs on each side of openings and install cut to length studs as jack studs or cripples between runners.

F. During installation, insulate interior of doubled sections used for jamb studs, lintels, headers or wall intersections/corners which will not be accessible for insulating after erection.

END OF SECTION

SECTION 05.500 METAL FABRICATIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS: Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this and all sections.

1.02 DESCRIPTION OF WORK

A. Definition: Metal fabrications include items made from iron and steel shapes, plates, bars, strips, tubes, pipes and castings which are not a part of structural steel or other metal systems specified elsewhere.
B. Elevator pit ladder.
C. Miscellaneous fasteners, framing and supports.

1.03 QUALITY ASSURANCE

A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrications where possible. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication might delay work.
B. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitation. Clearly mark units for reassembly and coordinated installation.

1.04 SUBMITTALS

A. Shop Drawings: Submit shop drawings for fabrication and erection of miscellaneous metal fabrications. Include plans, elevations and details of sections and connections. Show anchorage and accessory items. Provide templates for anchor and bolt installation by others.

PART 2 PRODUCTS

2.01 MATERIALS

A. Metals
    1. Metal surfaces, General: For Fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.
    2. Steel Plates, Shapes and Bars: ASTM A36
    3. Steel Tubing: Cold formed, ASTM A500; Class A or B.
    4. Steel Pipe: ASTM A53; black finish, unless galvanizing is indicated; standard weight (Schedule 40), unless otherwise indicated.
B. Paint
    1. Metal Primer Paint

a. Red lead mixed pigment, alkyd varnish, linseed oil paint, FS TT-P-86, Type II; or red lead iron oxide, raw linseed oil, alkyd paint, Steel Structures Painting Council (SSPC) Paint 2-64.
b. Primer selected must be compatible with finish coats of paint. Coordinate selection of metal primer with finish paint requirements specified in Division 9.

2. Galvanizing Repair Paint: Equal to Galvilite by ZRC Worldwide, 95% zinc in dry film, Type III ASTM-D-520 zinc; meeting Federal Spec DOD-P-21035A, ASTM A-780 and ASTM B117.
3. Field painting: Where steel is exposed it shall be painted to match other steel in the space. See Section 09.990.

2.02 FABRICATION, GENERAL

A. Workmanship: Use materials of size and thickness shown or, if not shown, of required size and thickness to produce strength and durability in finished product. Work to dimensions shown or accepted on shop drawings, using proven details of fabrication and support. Use type of materials shown or specified for various components of work.
B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32" unless otherwise shown. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
C. Weld corners and seams continuously, complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces.
D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners, wherever possible. Use exposed fasteners of type shown or, if not shown, Phillips flat-head (countersunk) screws or bolts.
E. Provide for anchorage of type shown, coordinated with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.
F. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware and similar items.
G. Galvanizing: Provide a zinc coating for those items shown or specified to be galvanized, as follows:
    1. ASTM A 153 for galvanizing iron and steel hardware.
    2. ASTM A 123 for galvanizing rolled, pressed and forged steel shapes, plates, bars and strip 1/8" thick and heavier.
    3. ASTM A386 for galvanizing assembled steel products.
H. Fabricate joints which will be exposed to weather in a manner to exclude water or provide weep holes where water may accumulate.
I. Shop Painting
    1. Shop paint miscellaneous metal work, except members or portions of members to be embedded in concrete or masonry, surfaces and

edges to be field welded, and galvanized surfaces, unless otherwise specified.

2. Remove scale, rust and other deleterious materials before applying shop coat. Clean off heavy rust and loose mill scale in accordance with SSPC SP-2 "Hand Tool Cleaning", or SSPC SP-3 "Power Tool Cleaning", or SSPC SP-7 "Brush-Off Blast Cleaning".
3. Remove oil, grease and similar contaminants in accordance with SSPC SP-1 "Solvent Cleaning".
4. Immediately after surface preparation, brush or spray on primer in accordance with manufacturer's instructions, and at a rate to provide uniform dry film thickness of not less than 2.0 mils for each coat. Use painting methods which will result in full coverage of joints, corners, edges and exposed surfaces.
5. Apply one shop coat to fabricated metal items, except apply 2 coats of paint to surfaces inaccessible after assembly or erection. Change color of second coat to distinguish it from the first.

2.03 MISCELLANEOUS METAL FABRICATIONS

A. Rough Hardware
   1. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures.
   2. Manufacture or fabricate items of sizes, shapes and dimensions required.
   3. Use galvanized steel hardware for galvanized steel members.

B. Miscellaneous Framing and Supports
   1. Provide miscellaneous steel framing and supports which are not a part of structural steel framework, as required to complete work.
   2. Fabricate miscellaneous units to sizes, shapes and profiles shown or, if not shown, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.

C. Ladder – Elevator Pit
   1. Fabricate ladders for the location shown with dimensions, spacings, details and anchorages as indicated. Comply with the requirements of ANSI A14.3, except as otherwise indicated.
   2. Unless otherwise shown, provide 1/2" x 2-1/2" continuous structural steel flat bar side rails with eased edges, spaced 18" apart.
   3. Provide 3/4" diameter solid structural steel bar rungs, spaced 12 inches on center.
   4. Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.

5. Support each ladder at top and bottom and at intermediate points spaced not more than 5'-0" on center. Use welded of bolted steel brackets, designed for adequate support and anchorage, and to hold the ladder clear of the wall surface with a minimum of 7" clearance from wall to centerline of rungs. Extend rails 42" above top rung, and return rails to wall or structure unless other secure handholds are provided.
6. Provide non-slip surface on top of each rung with aluminum oxide granules set in epoxy resin adhesive.

PART 3 EXECUTION

3.01 PREPARATION: Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchorages, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

3.02 INSTALLATION

A. General

1. Installation of all metal fabrications and associated materials, shall be in strict accordance with the manufacturer's written recommendations.
2. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required.
3. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for item which are to be built into concrete, masonry or similar construction.
4. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch-up shop paint. Do not weld, cut or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.
5. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and the methods used in correcting welding work.

3.03 ADJUST AND CLEAN

A. Touch-up Paint: Immediately after erection, clean ground field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. For Galvanized Surfaces: Clean field welds, bolted connections and abraded areas and apply 2 coats of galvanizing repair paint.

END OF SECTION

SECTION 05.510 ALUMINUM ACCESS LADDER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aluminum access ladder for roof to roof access

1.02 RELATED SECTIONS

A. Section 05.500 - Metal Fabrications.

1.03 REFERENCES

A. AA - Aluminum Association.
B. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
C. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
D. OSHA 1910.27 - Fixed Ladders.

1.04 SUBMITTALS

A. Submit under provisions of Section 01300 - Requirements.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
C. Shop Drawings:
   1. Detail fabrication and erection of each ladder indicated. Include plans, elevations, sections, and details of metal fabrications and their connections.
   2. Provide templates for anchors and bolts specified for installation under other Sections.
   3. Provide reaction loads for each hanger and bracket.
D. Qualification Data:
   1. Refer to Quality Assurance provisions for submittal requirements evidencing experience, certifications and resources.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in producing aluminum metal ladders similar to those indicated for this Project.
   1. Record of successful in-service performance.
   2. Sufficient production capacity to produce required units.
   3. Professional engineering competent in design and structural analysis to fabricate ladders in compliance with industry standards and local codes.

B. Installer Qualifications: Competent and experienced firm capable of selecting fasteners and installing ladders to attain designed operational and structural performance.
C. Product Qualification: Product design shall comply with OSHA 1910.27 minimum standards for ladders.

1.06 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to starting work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.
B. Handling: Handle materials to avoid damage.

1.08 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurement before fabrication.
    1. Established Dimensions: Where field measurements cannot be made without delaying the Work, indicate established dimensions on shop drawing submittal and proceed with fabrication.

1.09 WARRANTY

A. Manufacturer has responsibility for an extended Corrective Period for work of this Section for a period of 5 years commencing on the shipment date of the product against all the conditions indicated below, and when notified in writing from Owner, manufacturer shall promptly and without inconvenience and cost to Owner correct said deficiencies.
    1. Defects in materials and workmanship.
    2. Deterioration of material and surface performance below minimum OSHA standards as certified by independent third party testing laboratory. Ordinary wear and tear, unusual abuse or neglect excepted.
    3. Within the warranty period, the manufacturer shall, at its option, repair, replace, or refund the purchase price of defective ladder.
B. Manufacturer shall be notified immediately of defective products, and be given a reasonable opportunity to inspect the goods prior to return. Manufacturer will not assume responsibility, or compensation, for unauthorized repairs or labor. Manufacturer makes no other warranty, expressed or implied, to the merchantability, fitness for a particular purpose, design, sale, installation, or use, of the ladder; and shall not be liable for incidental or consequential damages, losses of or expenses, resulting from the use of ladder products.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Manufacturer: O'Keefe's Inc.; 100 N. Hill Dr. Suite 12, Brisbane, CA 94005. ASD. Toll Free Tel: (888)-653-3333. Tel: (415) 822-4222. Fax: (415) 822-5222.

B. Provided all other project requirements are met, products by the following manufacturers shall be considered equal:
   1. Precision Ladders, LLC
   2. Alaco Ladder Co.
   3. Approved Equal

2.02 LADDERS - GENERAL

A. Performance
   1. Provide ladders with performance requirements specified and complying with OSHA referenced standard for safety.
   2. Material: Non-spark, high strength 6061-T6 allow rungs and 6063-T5 alloy extrusions.
   3. Capacity: Rungs shall withstand a 1,500 pound (454 kg) load without deformation or failure.
   4. Fixed Ladder Bottom Bracket: Bottom floor supported bracket.

2.03 FIXED ACCESS LADDERS

A. High Parapet Access with Platform and Return:
   1. Product: Model 533 as manufactured by O'Keeffe's Inc.
   2. Dimensions
      a. Height from existing roof to parapet of roof above: approx. 13'-9".
      b. Height from top of parapet to roof surface: approx. 1'-8"
      c. Contractor shall field verify all dimensions prior to ordering ladder.

2.04 FINISHES

A. Mill finish. As extruded.

2.05 MATERIALS

A. Aluminum Sheet: Alloy 5005-H34 to comply with ASTM B209.

B. Aluminum Extrusions: Alloy 6063-T6 to comply with ASTM B221.

2.06 FABRICATION

A. Rungs: Not less than 1-1/4 inches (32 mm) in section and 18- 3/8 inches (467mm) long, formed from tubular aluminum extrusions. Squared and deeply serrated on all sides.
   1. Rungs shall withstand a 1,500 pound (454 kg) load without deformation or failure.

B. Heavy Duty Tubular Side Rails: Assembled from two interlocking aluminum extrusions no less than 1/8 inch (3 mm) wall thickness by 3 inches (76 mm) wide. Construction shall be self-locking stainless steel fasteners, full penetration TIG welds and clean, smooth and burr-free surfaces.
C. Walk-Through Rail and Roof Rail Extension: Not less than 3 feet 6 inches (1067 mm) above the landing and shall be fitted with deeply serrated, square, tubular grab rails.
D. Landing Platform: 1-1/2 inches (38 mm) or greater diameter, tubular aluminum guardrails and decks of serrated aluminum treads.

PART 3 EXECUTION

3.01 EXAMINATION

A. Coordinate anchorages. Furnish setting drawings, templates, and anchorage structural loads for fastener resistance.
B. Do not begin installation until supporting structure is complete and ladder installation will not interfere with supporting structure work.
C. If supporting structure is the responsibility of another installer, notify Architect of unsatisfactory supporting work before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.
B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions and in proper relationship with adjacent construction.

3.04 PROTECTION

A. Protect installed products until completion of project.
B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 06.100 ROUGH CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

A. Scope: Rough carpentry includes carpentry work not specified as part of other sections and which is generally not exposed, except as otherwise indicated. Types of work in this section include rough carpentry for:

1. Wood nailers and blocking.
2. Other rough carpentry indicated.

B. Related Work Specified Elsewhere

1. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the work of this section.
2. Section 05.410 Metal Stud System
3. Section 06.200 Finish Carpentry
4. Section 06.300 Preservative Treatment
5. Section 09.250 Gypsum Board Assemblies
6. Section 09.990 Painting

1.02 SUBMITTALS

A. Wood Treatment Data: For water-borne preservatives, provide certification that moisture content of treated materials was reduced to a maximum of 19% prior to shipment to project site.

1.03 PRODUCT HANDLING

Delivery and Storage - Keep materials dry at all times. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber and provide air circulation within stacks.

1.04 JOB CONDITIONS

Coordination - Fit carpentry work to other work; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, and similar supports to allow proper attachment of other work.

PART 2 PRODUCTS

2.01 WOOD PRODUCT QUALITY STANDARDS

A. Lumber Standards: Comply with PS 20.
B. Plywood Standard: Comply with PS 1 or APA Performance Standards.
C. Factory mark each piece of lumber with type, grade, mill and grading agency.

2.02 MATERIALS

A. Lumber, General

1. Nominal sizes are indicated, except as shown by detail dimension. Provide actual sizes as required by PS 20, for moisture content specified for each use.

a. Provide dressed lumber, S4S, unless otherwise indicated.
b. Provide seasoned lumber with 19% maximum moisture content at time of dressing and delivery.

B. Miscellaneous Lumber
1. Provide wood for support or attachment of other work including bucks, nailers, blocking, furring, stripping and similar members. Provide lumber of sizes shown or specified worked into shapes shown.
2. Grade: Standard or No. 2 Southern Pine.

C. Miscellaneous Materials
1. Fasteners and Anchorages: Provide size, type, material and finish as indicated and as recommended by applicable standards, complying with applicable Federal Specifications for nail, staples, screws, bolts, nuts, washers and anchoring devices.
a. Where rough carpentry work is exposed to weather, provide fasteners and anchorages with a hot-dip zinc coating (ASTM A153).
b. Use screws and glue to attach sub-flooring to wood framing.

2.03 WOOD TREATMENT (See Section 06.300)

PART 3 EXECUTION

3.01 INSTALLATION

A. General Requirements
1. Discard units of material with defects which might impair quality of work, and units which are too small to use in fabricating work with minimum joints or optimum joint arrangement.
2. Framing lumber and other rough carpentry shall be fitted closely, set accurately to the required lines and levels and shall be secured in place in a rigid and substantial manner.
3. All framing and support members, not indicated or specified, shall be provided as necessary for the proper completion of the work.
4. Spiking, nailing and bolting shall be done in an approved manner; spikes, nails and bolts shall be of the proper size, and care shall be used so as not to split the members. Members shall be drilled accurately for bolting; and for nailing where necessary to avoid splitting. Suitable washers shall be provided under bolt heads, and nuts and bolts shall be drawn up tight.
5. Provide framing to support all edges of covering material.

B. Wood Nailers, and Blocking
1. Provide wherever shown and where required for attachment of other work. Form to shapes as shown or required and cut as required for true line and level of work to be attached. Coordinate location with other work involved.

2. Attach to substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise shown. Build into masonry during installation of masonry work. Where possible anchor to formwork before concrete placement.

END OF SECTION

SECTION 06.200 FINISH CARPENTRY

PART 1 GENERAL

1.01 RELATED DOCUMENTS: Drawings and General Provisions for the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05.410 - Metal Stud System
B. Section 06.100 - Rough Carpentry
C. Division 15 - Mechanical
D. Division 16 - Electrical

1.03 DESCRIPTION OF WORK

A. Definition: Finish carpentry includes carpentry and millwork which is exposed to view, is non-structural, and which is not specified as part of other sections. Types of finish carpentry work in this section include:
   1. Plastic laminate cabinets.
B. Other finish wood work indicated.
C. Rough carpentry is specified in another section within Division 6.
D. Quartz Solid Surfacing is specified in another section within Division 6.

1.04 QUALITY ASSURANCE

A. Quality standards - except as otherwise shown or specified, comply with specified provisions of the following:
   1. Architectural Woodwork Institute (AWI) "Quality Standards".
   2. Architectural Woodwork Institute (AWI) "Architectural Casework Details".
   3. Architectural Woodwork Institute (AWI) "Guide to Wood Species".

1.05 SUBMITTALS

A. Shop Drawings - Submit shop drawings showing location of each item, dimensioned plans and elevations, large scale details, attachment devices and other components.
B. Color Samples - Plastic laminates.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect finish carpentry materials during transit, delivery, storage and handling to prevent damage, soiling and deterioration.
B. Do not deliver finish carpentry materials until painting, wet work, grinding and similar operations which could damage, soil or deteriorate woodwork have been completed in installation areas. If due to unforeseen circumstances, finish carpentry materials must be stored in

other than installation areas, store only in areas meeting requirements specified for installation areas.

1.07 JOB CONDITIONS

A. Conditioning: Installer shall advise contractor of temperature and humidity requirements for woodwork installation areas. Do not install woodwork until required temperature and relative humidity have been stabilized and will be maintained in installation areas.
B. Maintain temperature and humidity in installation area as required to maintain moisture content of installed woodwork within a 1.0 percent tolerance of optimum moisture content, from date of installation through remainder of construction period. The fabricator of woodwork shall determine optimum moisture content and required temperature and humidity condition.

PART 2 PRODUCTS

2.01 BASIC MATERIALS AND FABRICATION METHODS

A. General: Except as otherwise indicated, comply with following requirements:
B. Wood Moisture Content: Provide kiln-dried (KD) lumber with an average content range of 6% to 11%. Maintain temperature and relative humidity during fabrication, storage and finishing operations so that moisture content values for woodwork at time of installation do not exceed the following:
    1. Interior Wood Finish: 8% - 13%.
C. Interior Wood for Opaque Finish (Softwood)
    1. Solid Wood: Yellow-Poplar, or any softwood rated "good" or "excellent" for paint finishing in AWI "Guide to Wood Species", and meeting requirements for specified woodwork grade.
    2. Plywood: APA Group 2, Exposure 1 or 2, Grade A on exposed faces, Grade D or better on concealed faces (such as backs of shelving units against wall).
D. Plastic Laminate: Comply with NEMA LD-3, type, thickness, color, pattern and finish as indicated for each application. Acceptable Manufacturers: Wilsonart, Formica, Nevamar.
E. Quality Standards: For following types of architectural woodwork; comply with indicated standards as applicable:
    1. Architectural Cabinets (Casework) and Countertops: AWI Section 400.
    2. Shelving
        a. Shelving Units - AWI Section 400.
F. Design and Construction Features: Comply with details shown for profile and construction of architectural woodwork; and, where not otherwise shown, comply with applicable Quality Standards, with alternate details as fabricator's option.

G. Pre-Cut Opening: Fabricate architectural woodwork with pre-cut openings, where possible, to receive hardware, electrical work and similar items. Locate openings accurately and use templates or roughing-in diagrams for proper size and shape. Smooth edges of cutoffs.
H. Measures: Before proceeding with fabrication of woodwork required to be fitted to other construction, obtain measurements and verify dimensions and shop drawing details as required for accurate fit. Where sequence of measuring substrates before fabrication would delay the project, proceed with fabrication (without field measurements) and provide ample borders and edges to allow for subsequent scribing and trimming of woodwork for accurate fit.

2.02 INTERIOR ARCHITECTURAL WOODWORK

A. Architectural Cabinets, Laminate Clad
   1. Grade: Custom Grade. Plywood base cabinets, doors drawers and drawer faces. Use exterior type plywood for tops which contain a sink or lavatory).
   2. Design: As indicated. Flush overlay style as per AWI Architectural Casework Details.
B. Plastic Laminate Surfacing
   1. High-pressure plastic laminate, for exposed surfaces shall meet NEMA LD3-2000 standards including thickness as listed:
      a. Horizontal Grade: 1/16" thick, to be used for all exposed horizontal surfaces.
      b. Vertical Grade Surfaces: 1/32" thick, to be used for all exposed vertical surfaces
      c. CLS Cabinet Liner; .020" thick, to be used to balance all finished (laminated) surfaces
      d. Countertop, back and side splash
         1. Basis of Design is Paloma Polar 6698-58, matte finish by Formica
      e. Base and wall cabinets:
         2. Basis of Design is Natural Birch 7481-58, matte finish by Formica

2.03 CABINET HARDWARE AND ACCESSORY MATERIALS:

A. General: Provide cabinet hardware and accessory materials associated with Finish Carpentry, unless otherwise specified.
B. Hardware Standards: Except as otherwise indicated, comply with ANSI A156.9 "American National Standard for Cabinet Hardware".
   1. Quality Level: Type 2 (institutional), unless otherwise indicated.
   2. Cabinet Door Hardware: Provide hinges and pulls to accommodate each door size and style.
      a. All metal, adjustable, self-closing, concealed hinges (2 per door unless otherwise indicated).

b. One 5/16-inch diameter x 4-inch pull (Stanley 4484, or equal).

3. Drawer Hardware: Provide slides and pulls of types indicated, to properly accommodate each drawer size and style.
   a. Equip each drawer with side-mounted, full-extension, ball-bearing, nylon roller drawer slides.
   b. Equip each drawer with pull to match doors.
4. Shelf Supports: Where shelving is indicated as "adjustable", provide slotted-type standards and brackets of type needed to properly support shelves with uniform 40-lb. per sq. ft. loading.
5. Round Grommets: EDP Plus Grommet, XT Series, 3" hole, by Doug Mockett & Company. Color to be selected by Architect. Provide one grommet for every three feet of plastic laminate counter unless otherwise indicated.
6. Exposed Hardware Finish: US10B, oil rubbed bronze, unless otherwise indicated.

2.04 ROUGH HARDWARE: Provide all necessary nails, screws and other hardware to properly secure members in place. Use finish or casing nails and trim head screws as appropriate where exposed.

PART 3 EXECUTION

3.01 PREPARATION

A. Condition woodwork to average prevailing humidity conditions in installation areas prior to installing.
B. Prior to installation of Finish Carpentry, examine shop fabricated work for completion, and complete work as required, including removal of packing.

3.02 INSTALLATION

A. Install the work plumb, level, true and straight with no distortions. Shim as required using concealed shims.
B. Scribe and cut work to fit adjoining work.
C. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to the greatest extent possible. Stagger joints in adjacent and related members. Cope at returns, miter at corners, and comply with Quality Standards for joinery.
D. Anchor woodwork to anchors or blocking built-in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for a complete installation. Use fine finishing nails at wood substrate for exposed fastening, countersunk and filled flush with woodwork, and matching final finish where transparent finish is indicated.
E. Architectural Cabinets: Install without distortion so that doors and drawers will fit openings properly and be accurately aligned. Adjust

hardware to center doors and drawers in openings and to provide unencumbered operation. Complete the installation of hardware and accessory items as indicated.

F. Countertops: Anchor securely to base units and other support systems as indicated.

3.03 ADJUSTMENT, CLEANING, FINISHING AND PROTECTION

A. Repair damaged and defective work wherever possible to eliminate defects functionally and visually; where not possible to repair properly, replace work. Adjust joinery for uniform appearance.
B. Clean hardware, lubricate and make final adjustments for proper operation.
C. Clean work on exposed and semi-exposed surfaces.
D. Refer to the Division 9 Sections for finishing of installed woodwork.
E. Protection: Installer of Finish Carpentry shall advise Contractor of final protection and maintained conditions necessary to ensure that work will be without damage or deterioration at time of acceptance.

END OF SECTION

SECTION 06.300 PRESERVATIVE TREATMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes Alkaline copper quaternary (ACQ) insect and decay protection treatment for wood products specified in other division 6 sections.
B. Related work specified elsewhere:
   1. Section 06.100 - Rough Carpentry.

1.02 REFERENCES

A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.
B. American Wood-Preservers Association (AWPA) Standards:
   1. AWPA Standard U1:
      a. Category UC1. Interior, not in contact with ground or foundation.
      b. Category UC2. Interior, subject to dampness.
      c. Category UC3A. Exterior, above ground, coated.
      d. Category UC3B. Exterior, above ground, may be finished.
      e. Category UC4A. Exterior, ground or freshwater contact.
      f. Category UC4B. Exterior, ground or freshwater contact, severe environment, high potential for deterioration.
   2. AWPA Standard T1.
C. International Conference of Building Officials (ICBO) Evaluation Services:
   1. ICBO ES ER-4981.
D. National Evaluation Service, Inc. (NES):
   1. National Evaluation Report (NER): Report No. NER-643.

1.03 SYSTEM DESCRIPTION

A. Performance Requirements: Provide ACQ wood preservative treatment which will perform in accordance with manufacturer’s stated performance criteria without defects, damage or failure.

1.04 SUBMITTALS

A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.
B. Product Data: Submit product data for specified products.

C. Quality Assurance Submittals: Submit the following:
   1. Certificates: Certification from treating plant certifying wood treatment applied complies with the criteria and physical requirements for ACQ preservative-treated wood products as specified herein.

1.05 QUALITY ASSURANCE

A. Source Quality: Obtain alkaline copper quaternary preservative-treated wood products from a single approved source.
B. Wood Treatment Plant Qualifications: Wood treatment plant experienced in performing work of this section which has specialized in the treatment of wood similar to that required for this project, licensed by the manufacturer.
C. Quality Mark: All copper quaternary preservative-treated wood members shall bear an end tag or permanent ink stamp indicating the following:
   1. Name of wood treating company.
   2. Treatment plant city and state.
   3. Symbol for alkaline copper quaternary (ACQ).
   4. Preservative retention level.
   5. Approved use.
   6. Code report number.

1.06 DELIVERY, STORAGE AND HANDLING

A. General: Comply with Division 1 Product Requirement Section.
B. Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
D. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.
   1. Prevent exposure to precipitation during shipping, storage or installation.
   2. Store material off ground and under cover.
   3. Allow materials exposed to incidental moisture to dry thoroughly prior to covering with vapor- or moisture-retarding finish materials.

PART 2 PRODUCTS

2.01 ALKALINE COPPER QUATERNARY (ACQ) PRESERVATIVE-TREATED WOOD PRODUCTS

A. Manufacturer: Chemical Specialties, Inc., or approved equal.
   1. Contact: 200 East Woodlawn Road, Suite 350, Charlotte, NC 28217;
      Telephone: (800) 421-8661, (704) 522-0825;

Fax: (704) 527-8232;
E-mail: acqinfo@chemspec.com;
website: www.treatedwood.com.

B. Proprietary Product(s)/System(s):
   1. Preserve Preservative-Treated Wood Products:
      a. Preservative Treatment: Waterborne, alkaline copper quaternary (ACQ) preservative system containing no arsenic and no chromium.
      b. Material Standards: Comply with the applicable following standards: AWPA Standard U1 (Category UC1, UC2, UC3A, UC3B, UC4A, UC4B), T1.

C. Retention Rate for Various Applications: Above ground (decking, fence boards, handrails): 0.25 - 0.40 pcf (4.0 - 6.4 kg/m^3). Ground contact, fresh water (fence posts, landscaping, piers, docks): 0.40 pcf (6.4 kg/m^3). Permanent wood foundations (permanent wood foundations, crawl spaces): 0.60 pcf (9.6 kg/m^3). Poles (building, transmission and distribution poles): 0.60 pcf (9.6 kg/m^3). Decking use only (5/4-inch (32 mm) decking): 0.15 pcf (2.4 kg/m^3) plus water repellent.

2.02 RELATED MATERIALS

A. Provide the following related materials
   1. End Cut Preservative
      a. Material Type and Name: Acceptable to manufacturer of ACQ preservative.
      b. Manufacturer: Acceptable to manufacturer of ACQ preservative.
   2. Adhesive
      a. Material Type and Name: Acceptable to manufacturer of ACQ preservative.
      b. Manufacturer: Acceptable to manufacturer of ACQ preservative.
   3. Fasteners
      a. Material: Acceptable to ACQ preservative manufacturer.

PART 3 EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions and product carton instructions for installation.

3.02 INSTALLATION

A. Select alkaline copper quaternary (ACQ) preservative-treated wood members in accordance with appropriate untreated lumber and plywood span tables. Provide ventilation of building cavities as required by code.

B. Install ACQ treated wood in accordance with requirements of applicable codes and related Division 6 sections. Avoid milling operations that could adversely affect preservative characteristics of copper quaternary preservative-treated wood.
C. End Cut Treatment: Treat end cuts of ACQ preservative-treated wood members with field-applied end coat prior to installation.
D. Sill Plate: Where applicable, provide sill plate of ACQ preservative-treated wood.
E. Install using stainless steel, hot-dipped galvanized or other approved fasteners required by applicable code for use with treated lumber and plywood.

3.03 FINISHING

A. Prepare ACQ preservative-treated wood for application of finishes in accordance with manufacturer's recommendations.
    1. Allow time for drying. Clean and check for moisture prior to finishing.
B. Apply paint or stain in accordance with Division 9 Section: Painting.

3.04 PROTECTION

A. Protection
    1. Protect ACQ preservative-treated wood from damage due to subsequent construction activity.
    2. Protect ACQ preservative-treated wood from moisture prior to application of finishes.

END OF SECTION

SECTION 07.200 BATT AND BLANKET INSULATION

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. Applications of insulation specified in this section include:
   1. Blanket-type building insulation
      a. Above all acoustical ceilings, and gypsum board ceilings.
      b. In all new interior metal stud partitions.
      c. In exterior metal stud walls where the existing sheathing and insulation is demolished.

1.02 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including Division 1 Specification sections, apply to work of this Section.

1.03 PRODUCT HANDLING

A. General Protection: Do not allow insulation materials to become wet, soiled, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storage and protection during installation.

PART 2 PRODUCTS

2.01 MATERIALS

A. Above all interior suspended ceilings
   1. Unfaced fiberglass batts, equal to Sonobatts by Owens Corning, complying with ASTM C655, Type 1 and ASTM E136, Flame Spread 10 and Smoke Developed 10 as per ASTM 84. 6.25" thick.

B. In all interior metal stud partitions
   1. Sound attenuation batt insulation, unfaced, complying ASTM C665, Type 1 and ASTM E136, Flame Spread 10 and Smoke Developed 10 as per ASTM E 84. 3-1/2" thick.

C. In exterior metal stud walls where existing sheathing and insulation is noted to be demolished.
   1. Provide glass fiber, unfaced batt insulation where existing insulation is demolished. Blankets shall be friction fit between existing studs.
   2. R-19 for 6" studs, R-15 for 3 5/8" studs.
   3. Product shall have a 25 flame spread rating and a 50 smoke developed rating as tested in accordance with UL 723.

PART 3 EXECUTION

3.01 INSPECTION

Installer must examine substrate and conditions under which insulation work is to be performed and must notify Contractor in writing of unsatisfactory conditions. Do not proceed with insulation work until

unsatisfactory conditions have been corrected in a manner acceptable to installer.

3.02 INSTALLATION

A. General
   1. Comply with manufacturer's instructions for particular conditions of installation in each case. If printed instructions are not available or do not apply to project conditions, consult manufacturer's technical representative for specific recommendations before proceeding with work.
   2. Extend insulation full thickness as shown over entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation.
   3. Apply a single layer of insulation of required thickness, unless otherwise shown or required to make up total thickness.

B. Interior ceiling insulation
   1. Apply batts on top of ceiling tiles and blankets on top of gypsum board ceilings. Provide 24" x 48" piece to top of light fixtures in accordance with UL Assembly Number P265 or P268.

C. Interior metal stud partitions
   1. Position to fit snugly between webs of metal studs.
   2. Stuff all cracks around doors.
      a. Staple unfaced insulation to gypsum board with a least five 9/16 inch long staples driven through 1-1/2 inch long pieces of gypsum board joint reinforcement placed on face of insulation to hold insulation in place, or use proprietary fastening system manufactured for this purpose.

D. Exterior metal stud walls
   1. Fit full cavity width insulation tightly into exterior wall steel stud cavity spaces and framing voids to create a continuous insulation layer without gaps. Trim to fill spaces and voids neatly. Fluff insulation to full thickness for specified R-value before installation. Do not compress insulation.
   2. Step 4 Within exterior wall framing, install insulation between pipes, mechanical services, electrical boxes, and backside of sheathing. Cut or split insulation material as required to fit around wiring and plumbing.

END OF SECTION

SECTION 07.410 STANDING-SEAM METAL ROOF PANELS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes standing-seam metal roof panels and all accessories necessary for a complete installation.

B. Related Sections:

1. Section 07.421 Formed Metal Wall Panels
2. Section 07.521 SBS Modified Bituminous Membrane Roofing
3. Section 07.600 Flashing and Sheet Metal
4. Section 07.713 Manufactured Coping System
5. Section 07.950 Sealants and Caulking

1.02 RELATED DOCUMENTS

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

1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review structural loading limitations of purlins during and after roofing.
6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
8. Review temporary protection requirements for metal panel systems during and after installation.

9. Review procedures for repair of metal panels damaged after installation.
10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
11. This meeting may coincide with the preinstallation meeting for copings and membrane roofing.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
B. Shop Drawings
   1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
   2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 3 inches per 12 inches (1:5).
C. Calculations
   1. Include calculations with registered engineer seal, verifying roof panel and attachment method resist wind pressures imposed on it pursuant to applicable building codes.
D. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.
   1. Include similar Samples of trim and accessories involving color selection.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Manufacturer and Installer.
B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
C. Field quality-control reports.
D. Sample Warranties

1.06 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in architectural sheet metal products.
B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
D. Retain strippable protective covering on metal panels until installation. Remove as panels are being installed. Verify film is not left on installed panels.

1.09 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.10 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Special Galvalume Substrate Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
    1. Failures include, but are not limited to, the following:
        a. Structural failures including rupturing, or perforating.
        b. Deterioration of metals and other materials beyond normal weathering.
    2. Warranty Period: 20 years and 6 months from date of Substantial Completion.
B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    c. Cracking, chipping, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: 20 years from date of Substantial Completion.

C. Special Watertightness Warranty: Manufacturer's [standard form] [no dollar limit form] in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain watertight, including leaks, within specified warranty period.
1. Warranty Period: 20 years from date of Substantial Completion.
2. Shop drawings must be provided to, reviewed, and approved by panel manufacturer prior to panel system installation.
3. Inspections by panel system manufacturer technical representative are required. Perform first inspection when underlayment and flashing are in place and second inspection when the roof is complete.

D. Special Installer Warranty: Furnish a written warranty signed by the Panel Applicator guaranteeing materials and workmanship for watertightness of the roofing system, flashings, penetrations, and against all leaks.
1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURER:

A. Basis of Design manufacturer is Berridge Manufacturing Company. Provided all other project requirements are met, products by the following manufacturer’s shall be considered equal:
1. MBCI – Super-Lok
2. Approved equal

2.02 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592
1. Wind Loads: As required by the AHJ

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E 1680 and ASTM E 283 at the following test-pressure difference:
1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 and ASTM E 331 at the following test-pressure difference:
   1. Test-Pressure Difference: 15 lbf/sq. ft. (718.2 Pa).
D. Hydrostatic Head Resistance: No water penetration when tested according to ASTM E2140.
E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
   1. Uplift Rating: UL 90.
F. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
   1. Fire/Windstorm Classification: Class 1A-150 or as required
   2. Hail Resistance: SH.
G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces

2.03 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
   1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels Formed with vertical ribs at panel edges and panel striations between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.
   1. Double-Lock Zee-Lock (180 degree Seam)
   2. Metallic-Coated Steel Sheet: Aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
      a. Nominal Thickness: 0.024 inch (0.61 mm)

b. Exterior Finish: Metallic fluoropolymer.
c. Painted materials shall have a removable plastic film to protect the paint during roll forming, shipping and handling.
d. Color: As selected by Architect from manufacturer's full range

3. Clips: Manufacturer’s recommended clip to accommodate thermal movement.
   a. Material: 0.024-inch (0.61-mm) nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
   b. Material: 0.064-inch (1.63-mm) nominal thickness, zinc coated (galvanized) base with 0.033 inch (0.84 mm) stainless-steel top.
4. Joint Type: Double folded.
5. Panel Coverage: 16 inches (406 mm).
6. Panel Height: 2.0 inches (51 mm).

2.04 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 40 mils (1.02 mm) thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
   1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
   2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.
   3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Soprema Lastobond Shield HT
      b. Tamko TW Underlayment or TW Metal & Tile Underlayment
      c. Grace Ultra
      d. Approved Equal
B. Felt Underlayment: Felt underlayment shall not be acceptable.

2.05 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure

strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

C. Flashing and Trim: See Section Flashing and Sheet metal.
D. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch (2400-mm) long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches (914 mm) o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels.
E. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot (3-m) long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.
F. Splash Pan: Formed stainless steel. 12”x24”x2” with welded corners.
G. Panel Fasteners: Zinc-coated steel, corrosion resisting steel, zinc cast head, or nylon capped steel, type and size as approved for the applicable loading requirements.
H. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Joint Sealant: Silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.

2.06 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using factory set, non-adjustable, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
   1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   2. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
   3. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
      a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.07 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
C. Steel Panels and Accessories
   3. Metallic Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75± 0.05 mil (0.0013 mm) over 0.2± 0.05 mil (0.0013 mm) primer coat, to provide a total dry film thickness of 0.95± 0.10 mil (0.024 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   4. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.35 mil (0.009 mm).

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
   1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
   2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
      a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.03 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated [below] [on Drawings], wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 36 inches (914.4 mm). Roll laps with roller. Cover underlayment within 14 days or as directed by the underlayment product manufacturer.

B. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 07.600 "Flashing and Sheet Metal."

3.04 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels to be level to 1/4 inch in 20 ft. (6 mm in 6.1 m).
2. Flash and seal metal panels at perimeter of all openings. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Locate and space fastenings in uniform vertical and horizontal alignment.
4. Install flashing and trim as metal panel work proceeds.
5. Panels should be continuous without end laps.
6. Align bottoms of metal panels and fasten.
7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners
   1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
   1. Install clips to supports with self-tapping fasteners.
   2. Install pressure plates, if required, at locations indicated in manufacturer's written installation instructions.
   3. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel are completely engaged.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
   1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install

work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Connect downspouts to underground drainage system indicated.

3.05 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.06 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.07 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by

metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07.421 FORMED METAL WALL PANELS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Concealed-fastener, lap-seam metal wall panels.
B. Related Sections:
   1. Section 07.600 Flashing and Sheet metal
   2. Section 07.713 Manufactured Copings

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
C. Shop Drawings:
   1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
   2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 3" = 1'-0" (1:5).
D. Calculations:
   1. Include calculations with registered engineer seal, verifying wall panel and attachment method resist wind pressures imposed on it pursuant to applicable building codes.
E. Samples for Initial Selection: For each type of metal panel indicated with factory-applied finishes.
   1. Include Samples of trim and accessories involving color selection.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and Manufacturer.
B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
C. Sample Warranty

1.05 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
B. Manufacturer Qualifications: Company specializing in Architectural Sheet Metal Products.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
D. Remove strippable protective covering on metal panels as panels are being installed. Do not leave the film on installed panels.

1.08 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.09 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Galvalume Substrate Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
    1. Failures include, but are not limited to, the following:
        a. Structural failures including rupturing or perforating.
        b. Deterioration of metals and other materials beyond normal weathering.
    2. Warranty Period: 20 years and 6 months from date of Substantial Completion.
B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    c. Cracking, chipping, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Basis-of-Design: Basis of Design manufacturer is Berridge Manufacturing Company. Provided all other project requirements are met, products by the following manufacturer's shall be considered equal.
    1. ATAS International, Inc.
    2. MBCI
    3. As approved by the architect

2.02 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
    1. Wind Loads: As indicated on Drawings.
    2. Deflection Limits: For wind loads, no greater than 1/180 of the span.
B. Air Infiltration: Air leakage of not more than 0.01 cfm/sq. ft. (0.05 L/s per sq. m) when tested according to ASTM E 283 at the following test-pressure difference:
    1. Test-Pressure Difference: 4.00 lbf/sq. ft (191.5 Pa).
C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
    1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).

2.02 CONCEALED-FASTENER, LAP-SEAM METAL WALL PANELS

A. Provide FW-12 concealed fastener metal wall panel.
B. General: Provide factory-formed metal panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.

C. Flush-Profile, Metal Wall Panel: Formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced between panel edges; with flush joint between panels.
   1. Metallic-Coated Steel Sheet: Aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
      a. Nominal Thickness: 0.024 inch
      b. Surface: Smooth, flat finish.
      c. Exterior Finish: Two-coat fluoropolymer
      d. Color: As selected by Architect from manufacturer's full range
   2. Panel Coverage: 12 inches (305 mm).
   3. Panel Height: 1.5 inches (38 mm).

2.03 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 40 mils (1.02 mm) thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Grace Ultra
      b. Soprema Lastobond Shield HT
      c. Tamko TW Underlayment or TW Metal & Tile Underlayment
   2. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
   3. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.

2.04 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Sub-framing: Sub-framing and sheathing are existing and shall be reused.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fascia, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
   1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
   2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
   3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure

strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
   1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
   2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
   3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.05 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
   1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.06 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
C. Steel Panels and Accessories:
    1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75± 0.05 mil (0.019± 0.0013 mm) over 0.2± 0.05 mil (0.05± 0.0013 mm) primer coat, to provide a total dry film thickness of 0.95± 0.10 mil (0.024± 0.0025 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.35 mil (0.009 mm).

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
    a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.03 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
    1. Shim or otherwise plumb substrates receiving metal panels.
    2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
    3. Install screw fasteners in predrilled holes.
    4. Locate and space fastenings in uniform vertical and horizontal alignment.
    5. Install flashing and trim as metal panel work proceeds.
    6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
    7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
    8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners
   1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
D. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
   1. Lap ribbed or fluted sheets one full rib. Apply panels and associated items true to line for neat and weathertight enclosure.
   2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
   3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
   4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
   5. Flash and seal panels with weather closures at perimeter of all openings.
E. Watertight Installation
   1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommended by manufacturer on side laps of nesting-type panels; and elsewhere as needed to make panels watertight.
   2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
   3. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.
F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
   1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal wall panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

3.04 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in the manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain a clean condition during construction.
B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07.521 STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Work shall include, but is not limited to, the following:

B. System 1- FM 345
   1. Preparation of steel roof deck, and all flashing substrates.
   2. Thermal Barrier
   3. SBS-modified bitumen vapor barrier self-adhered.
   4. Rigid Insulation (R25 flat)
   5. Cover Board. Presecured
   6. SBS-modified bitumen base ply mechanically fastened.
   7. SBS-modified bitumen cap sheet heat-welded.
   8. SBS-modified bitumen membrane flashings.
   9. Liquid-applied, reinforced flashings.
   10. Edge Metals
   11. All related materials and labor required to complete specified roofing necessary to receive specified manufacturer's warranty.

C. System 2- FM 345
   1. Preparation of Conc roof deck, and all flashing substrates.
   2. SBS-modified bitumen vapor barrier self-adhered.
   3. Rigid Insulation (R25 flat) + 1/8" Tapered adhered
   4. Cover Board. Adhered
   5. SBS-modified bitumen base ply heat welded.
   6. SBS-modified bitumen cap sheet heat-welded.
   7. SBS-modified bitumen membrane flashings.
   8. Liquid-applied, reinforced flashings.
   9. Edge Metals
   10. All related materials and labor required to complete specified roofing necessary to receive specified manufacturer's warranty.

D. System 3- FM 345
   1. Preparation of steel roof deck, and all flashing substrates.
   2. Thermal Barrier
   3. SBS-modified bitumen vapor barrier self-adhered.
   4. Rigid Insulation (R25 flat) + Tapered crickets
   5. Cover Board. Presecured
   6. SBS-modified bitumen base ply mechanically fastened.
   7. SBS-modified bitumen cap sheet heat-welded.
   8. SBS-modified bitumen membrane flashings.
   9. Liquid-applied, reinforced flashings.
   10. Edge Metals
   11. All related materials and labor required to complete specified roofing necessary to receive specified manufacturer's warranty.

E. System 4- FM 345
   1. Preparation of steel roof deck, and all flashing substrates.
   2. Thermal Barrier
   3. SBS-modified bitumen vapor barrier self-adhered.
   4. Rigid Insulation (R25 flat)
   5. Cover Board. Presecured
   6. SBS-modified bitumen base ply mechanically fastened.
   7. SBS-modified bitumen cap sheet heat-welded.
   8. SBS-modified bitumen membrane flashings.
   9. Liquid-applied, reinforced flashings.
   10. Edge Metals
   11. All related materials and labor required to complete specified roofing necessary to receive specified manufacturer's warranty.

1.02 RELATED SECTIONS

A. Division 010000 - General Requirements
B. Division 011000 - Summary of Work

1.03 DEFINITIONS

A. ASTM D 1079-Definitions of Term Relating to Roofing and Waterproofing.
B. The National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual, Fifth Edition Glossary.

1.04 REFERENCES

A. AMERICAN SOCIETY OF CIVIL ENGINEERS - Reference Document ASCE 7, Minimum Design Loads for Buildings and Other Structures.
B. AMERICAN STANDARD OF TESTING METHODS (ASTM):
   1. ASTM C 836 - Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.
   2. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants
   3. ASTM D 41 - Standard Specification for Asphalt Primer Used in Roofing, Damp proofing, and Waterproofing.
   4. ASTM D 1970 - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
   5. ASTM D 3019 - Standard Specification for Lap Cement Used with Asphalt Roll Roofing, Non-Fibered, Asbestos-Fibered, and Non-Asbestos-Fibered.
   6. ASTM D 3746 - Standard Test Method for Impact Resistance of Bituminous Roofing System.
   7. ASTM D 4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free.

8. ASTM D 5147 - Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material.
9. ASTM D 5849 - Standard Test Method for Evaluating Resistance of Modified Bituminous Roofing Membrane to Cyclic Fatigue (Joint Displacement)
10. ASTM D 6164 - Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements.
11. ASTM D 7379 - Standard Test Methods for Strength of Modified Bitumen Sheet Material Laps Using Cold Process Adhesive.
12. ASTM E 108 - Standard Test Methods for Fire Tests of Roof Coverings.

C. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)::
1. ANSI/SPRI/FM 4435/ES-1 Wind Design Standard for Edge System Used with Low Slope Roofing System.
2. ANSI/FM 4474- American National Standard for Evaluating the Simulated Wind Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures.

D. FACTORY MUTUAL (FM):
1. FM 4450 - Approval Standard - Class I Insulated Steel Roof Decks.
2. FM 4470 - Approval Standard - Class I Roof Covers.

E. INTERNATIONAL CODES COUNCIL (ICC):
1. 2018 International Building Code (IBC).

F. NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA).
1. UL 790 Standard Test Methods for Fire Tests of Roof Coverings.
2. UL 1256 - Fire Test of Roof Deck Constructions.

1.05 ACTION SUBMITTALS

A. Product Data Sheets: Submit manufacturer's product data sheets, installation instructions and/or general requirements for each component.
B. Safety Data Sheets: Submit manufacturer's Safety Data Sheets (SDS) for each component.
C. Sample warranty from the manufacturer and contractor.
D. Provide roof plan and representative detail drawings.

1.06 INFORMATIONAL SUBMITTALS

A. Submit a letter from the roofing manufacturer indicating the contractor is an authorized applicator.

1.07 CLOSEOUT SUBMITTALS

A. Warranty: Provide manufacturer's and contractor's warranties upon project completion.

1.08 QUALITY ASSURANCE

A. MANUFACTURER QUALIFICATIONS
   1. Manufacturer shall have 20 years of manufacturing experience.
   2. Manufacturer shall have trained technical service representatives employed by the manufacturer, independent of sales.
   3. Manufacturer shall provide site visit reports in a timely manner.

B. CONTRACTOR QUALIFICATIONS
   1. Contractor shall be authorized by the manufacturer to install specified materials prior to the bidding period through satisfactory project completion.
   2. Applicators shall have completed projects of similar scope using same or similar materials specified.
   3. Contractor shall provide full time, on-site superintendent or foreman experienced with the specified roofing from beginning through satisfactory project completion.
   4. Applicators shall be skilled in the application methods for all materials.
   5. Contractor shall maintain a daily record, on-site, documenting material installation and related project conditions.
   6. Contractor shall maintain a copy of all submittal documents, on-site, available at all times for reference.

1.09 DELIVERY, STORAGE AND HANDLING

A. Refer to each product data sheet or other published literature for specific requirements.

B. Deliver materials and store them in their unopened, original packaging, bearing the manufacturer's name, related standards, and any other specification or reference accepted as standard.

C. Protect and store materials in a dry, well-vented, and weatherproof location. Only materials to be used the same day shall be removed from this location. During cold weather, store materials in a heated location, removed only as needed for immediate use.

D. When materials are to be stored outdoors, store away from standing water, stacked on raised pallets or dunnage, at least 4 in or more above ground level. Carefully cover storage with "breathable" tarpaulins to protect materials from precipitation and to prevent exposure to condensation.

E. Carefully store roof membrane materials delivered in rolls on-end with selvage edges up. Store and protect roll storage to prevent damage.

F. Properly dispose of all product wrappers, pallets, cardboard tubes, scrap, waste, and debris. All damaged materials shall be removed from job site and replaced with new, suitable materials.

1.10 SITE CONDITIONS

A. SAFETY

1. The contractor shall be responsible for complying with all project-related safety and environmental requirements.
2. Heat-welding shall include heating the specified membrane ply using propane roof torches or electric hot-air welding equipment. The contractor shall determine when and where conditions are appropriate to utilize heat-welding equipment. When conditions are determined by the contractor to be unsafe to proceed, equivalent SBS-modified bitumen materials and methods shall be utilized to accommodate requirements and conditions.
3. Refer to NRCA CERTA recommendations, local codes and building owner's requirements for hot work operations.
4. The contractor shall review project conditions and determine when and where conditions are appropriate to utilize the specified liquid-applied, or semi-solid roofing materials. When conditions are determined by the contractor to be unsafe or undesirable to proceed, measures shall be taken to prevent or eliminate the unsafe or undesirable exposures and conditions, or equivalent approved materials and methods shall be utilized to accommodate requirements and conditions.
5. The contractor shall refer to product Safety Data Sheets (SDS) for health, safety, and environment related hazards, and take all necessary measures and precautions to comply with exposure requirements.

B. ENVIRONMENTAL CONDITIONS

1. Monitor substrate temperature and material temperature, as well as all environmental conditions such as ambient temperature, moisture, sun, cloud cover, wind, humidity, and shade. Ensure conditions are satisfactory to begin work and ensure conditions remain satisfactory during the installation of specified materials. Materials and methods shall be adjusted as necessary to accommodate varying project conditions. Materials shall not be installed when conditions are unacceptable to achieve the specified results.
2. Precipitation and dew point: Monitor weather to ensure the project environment is dry before, and will remain dry, during the application of roofing materials. Ensure all roofing materials and substrates remain above the dew point temperature as required to prevent condensation and maintain dry conditions.
3. Self-adhesive membrane application: During cold weather, store the specified self-adhesive membrane and primer materials in heated storage areas to ensure materials remain no less than 70 F (21 C) during application. Ensure conditions allow primer to remain tacky, but not wet so that primer will not transfer to finger when touched. Self-adhesive primer shall not fully dry and lose

tack before applying the self-adhesive membrane. Ensure conditions remain satisfactory to achieve membrane adhesion as specified.

4. Heat-Welding Application: Take all necessary precautions and measures to monitor conditions to ensure all environmental conditions are safe to use roof torches and hot-air welding equipment. Combustibles, flammable liquids and solvent vapors that represent a hazard shall be eliminated. Flammable primers and cleaners shall be fully dry before proceeding with heat-welding operations. Prevent or protect wood, paper, plastics and other such combustible materials from direct exposure to open flames from roof torches. Refer to NRCA CERTA recommendations.

1.11 PERFORMANCE REQUIREMENTS

A. WIND UPLIFT RESISTANCE
   1. Performance testing shall be in accordance with ANSI/FM 4474, FM 4450, FM 4470, UL 580 or UL 1897.
      a. Roof System Design Pressures: Calculated in accordance with ASCE 7-16. Manufacturer must provide a testing in accordance with FM 4474 to resist the uplift pressures in each zone. Extrapolation and/or prescriptive enhancements are not allowed per ASCE 07-16 and the local jurisdiction.
      b. Design Pressures:
         i. Field of Roof (Zone 1): psf.
         ii. Field of Roof (Zone 1'): psf
         iii. Perimeter of Roof (Zone 2): psf.
         iv. Corners of Roof (Zone 3): psf.
      c. Approval Rating:
         i. Zones 2 & 3= FM 1-345

B. FIRE CLASSIFICATION:
   1. Performance testing shall be in accordance with UL 790, ASTM E108, FM 4450 or FM 4470 to meet the 1/4:12 roof slope requirement.
      a. Meets requirements of UL Class A or FM Class A.
   2. Performance testing shall be in accordance with UL 1256, FM 4450 or FM 4470 to meet the specified requirements for interior flame spread and fuel contribution.
      a. Meets requirements of UL 1256, or FM Class 1.

C. ROOF SLOPE:
   1. Finished roof slope for SBS modified bitumen surfaces shall be ¼ inch per foot (2 percent) minimum for roof drainage.

D. IMPACT RESISTANCE:
   1. Performance testing for impact resistance shall be in accordance with FM 4450, FM 4470, ASTM D3746 or CGSB 37-GP 56M to meet the specified impact resistance requirements.

a. Meets requirements for FM-SH (Severe Hail), ASTM D3746, or CGSB 37-GP 56M.

E. CYCLIC FATIGUE:
1. The roof system shall pass ASTM D5849 Standard Test Method for Evaluating Resistance of Modified Bituminous Roofing Membrane to Cyclic Fatigue (Joint Displacement). Passing results shall show no signs of cracking, splitting or tearing over the joint.
a. Roof system shall pass Test Condition 5, tested at -4˚F (-20˚C) in accordance with ASTM D5849. (SOPREMA SOPRALENE polyester reinforced membranes).

1.12 WARRANTY

A. Manufacturer's No Dollar Limit (NDL) Warranty. The manufacturer shall provide the owner with the manufacturer's warranty providing labor and materials for 20 years from the date the warranty is issued.
B. The contractor shall guarantee the workmanship and shall provide the owner with the contractor's warranty covering workmanship for a period of 2 years from completion date.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. SINGLE SOURCE MANUFACTURER: All SBS modified bitumen membrane and flashing sheets shall be manufactured by a single supplier with 20 years or more manufacturing history in the US.
1. Comply with the Manufacturer's requirements as necessary to provide the specified warranty.
B. PRODUCT QUALITY ASSURANCE PROGRAM: Manufacturer shall be an ISO 9001 registered company. A 'Quality Compliance Certificate (QCC) for reporting/confirming the tested values of the SBS-Modified Bitumen Membrane Materials will be supplied upon request.
C. ACCEPTABLE MANUFACTURER:
1. SOPREMA, located at: 310 Quadral Dr.; Wadsworth, OH 44281; Tel: 800-356-3521; Tel: 330-334-0066; Website: www.soprema.us.
2. Acceptable Alternate Manufacturers: Firestone & Siplast.

2.02 ROOFING SYSTEM

A. ROOFING SYSTEM BASIS OF DESIGN: SOPREMA

2.03 SBS-MODIFIED BITUMEN MEMBRANES

A. VAPOR RETARDER/AIR BARRIER
1. SOPREMA SOPRAVAP'R: SBS-modified bitumen self-adhered vapor retarder, air barrier membrane with release film on the

bottom surface and a tri-laminate woven polyethylene film top surface reinforcement.
a. Thickness: 31.5 mils (0.80 mm)
b. Width: 45 in (1.14 m)
c. Length: 133 ft (40.8 m)

B. BASE PLY
1. BASE PLY, MECHANICALLY FASTENED:
a. SOPREMA SOPRAFIX BASE 614: SBS-modified bitumen membrane ply with plastic burn-off film on the top and bottom surfaces. Non-woven polyester reinforcement. Mechanically fastened in 4 in (minimum) heat-welded side-laps. Base ply for heat-welded cap sheet applications. Meets or exceeds ASTM D6164, Type II, Grade S, per ASTM D5147 test methods:
i. Thickness: 157 mils (4.0 mm)
ii. Width: 39.4 in (1 m)
iii. Length: 32.8 ft (10 m)
iv. Roll weight: 107 lb (48.5 kg)
v. Net mass per unit area, lb/100 sq ft (g/sq m):
a) 99 lb (4865 g)
vi. Peak load @ 0°F (-18°C), lbf/in (kN/m).
a) MD 160 lbf/in (28.0 kN/m), XMD 110 lbf/in (19.3 kN/m)
vii. Elongation at peak load @ 0°F (-18°C), lbf/in (kN/m):
a) MD 30%, XMD 35%
viii. Peak load @ 73.4°F (23°C), lbf/in (kN/m):
a) MD 135 lbf/in (23.6 kN/m), XMD 100 lbf/in (17.5 kN/m)
ix. Elongation at peak load @ 73.4°F (23°C), lbf/in (kN/m):
a) MD 55%, XMD 60%
x. Ultimate Elongation @ 73.4°F (23°C), lbf/in (kN/m):
a) MD 70%, XMD 80%
xi. Tear Strength @ 73.4°F (23°C), lbf (N):
a) MD 165 lbf (734 N), XMD 120 lbf (534 N)
xii. Low temperature flexibility, °F (°C):
a) MD/XMD: -15°F (-26°C)
xiii. Dimensional stability, %:
a) MD/XMD: Less than 0.5%
xiv. Compound stability, °F (°C):
a) MD/XMD: 240 F (116 C)

C. HEAT WELDED FIELD AND FLASHING BASE PLY
1. FLASHING BASE PLY, HEAT-WELDED:
a. SOPREMA SOPRALENE FLAM 180: SBS-modified bitumen membrane with plastic burn-off film on top and bottom surfaces. Non-woven polyester reinforcement. Meets or

exceeds ASTM D6164, Type I, Grade S, per ASTM D5147 test methods:

i. Thickness: 118 mils (3.0 mm)
ii. Width: 39.4 in (1 m)
iii. Length: 32.8 ft (10 m)
iv. Roll weight: 81 lb (36.7 kg)
v. Net mass per unit area, lb/100 sq ft (g/sq m):
    a) 75 lb (3662 g)
vi. Peak load @ 0˚F (-18˚C), lbf/in (kN/m).
    a) MD 115 lbf/in (20.1 kN/m), XMD 90 lbf/in (15.8 kN/m)
vii. Elongation at peak load @ 0˚F (-18˚C), lbf/in (kN/m):
    a) MD 35%, XMD 40%
viii. Peak load @ 73.4˚F (23˚C), lbf/in (kN/m):
    a) MD 85 lbf/in (14.9 kN/m), XMD 65 lbf/in (11.4 kN/m)
ix. Elongation at peak load @ 73.4˚F (23˚C), lbf/in (kN/m):
    a) MD 55%, XMD 60%
x. Ultimate Elongation @ 73.4˚F (23˚C), lbf/in (kN/m):
    a) MD 65%, XMD 80%
xi. Tear Strength @ 73.4˚F (23˚C), lbf (N):
    a) MD 125 lbf (556 N), XMD 85 lbf (378 N)
xii. Low temperature flexibility, ˚F (˚C):
    a) MD/XMD: -15˚F (-26˚C)
xiii. Dimensional stability, %:
    a) MD/XMD: Less than 0.5%
xiv. Compound stability, ˚F (˚C):
    a) MD/XMD: 240˚F (116˚C)

D. CAP SHEET
1. FIELD & FLASHING CAP SHEET, HEAT-WELDED:
    a. SOPREMA SOPRALENE FLAM 180 FR GR: SBS-modified bitumen membrane Cap Sheet with a burn-off film bottom surface and mineral granule top surface. Non-woven polyester reinforced. UL Class A for specified roof slope requirements. Meets or exceeds ASTM D6164, Type I, Grade G

i. Thickness: 157 mils (4.0 mm)
ii. Width: 39.4 in (1 m)
iii. Length: 32.8 ft (10 m)
iv. Roll weight: 118 lb (53.5 kg)
v. Net mass per unit area, lb/100 sq ft (g/sq m):
    a) 110 lb (5371 g)
vi. Peak load @ 0˚F (-18˚C), lbf/in (kN/m).
    a) MD 115 lbf/in (20.1 kN/m), XMD 90 lbf/in (15.8 kN/m)

vii. Elongation at peak load @ 0˚F (-18˚C), lbf/in (kN/m):
a) MD 35%, XMD 40%
viii. Peak load @ 73.4 F (23 C), lbf/in (kN/m):
a) MD 85 lbf/in (14.9 kN/m), XMD 65 lbf/in (11.4 kN/m)
ix. Elongation at peak load @ 73.4˚F (23˚C), lbf/in (kN/m):
a) MD 55%, XMD 60%
x. Ultimate Elongation @ 73.4˚F (23˚C), lbf/in (kN/m):
a) MD 65%, XMD 80%
xi. Tear Strength @ 73.4˚F (23˚C), lbf (N):
a) MD 125 lbf (556 N), XMD 85 lbf (378 N)
xii. Low temperature flexibility, ˚F (˚C):
a) MD/XMD: -15˚F (-26˚C)
xiii. Dimensional stability, %:
a) MD/XMD: Less than 0.5%
xiv. Compound stability, ˚F (˚C):
a) MD/XMD: 240 F (116 C)
xv. Granule Surfacing:
a) White mineral granules.

2.04 ACCESSORIES

A. RIGID INSULATION
1. SOPREMA SOPRA-ISO: Closed cell polyisocyanurate foam core bonded on each side to a glass fiber-reinforced felt facer.
a. Thickness: 1.5 in minimum board thickness. Total thickness to meet specified insulation system thermal resistance 'R' value
b. Meets or exceeds ASTM C1289, Type II, Class 1, Grade 2 (20 psi).

B. COVER-BOARD
1. SOPREMA SOPRABOARD (ERS Ecology Roof Board, Viridian Systems, LLC., Pika Ply Recovery Board, IKO Industries, Ltd., ProtectoBoard, Henry Company Recover Board): Mineral fortified, asphaltic roof substrate board with glass fiber facers. For use as roof cover-board and for vertical flashing substrate. ASPHALTIC ROOF BOARD shall be manufactured by the membrane supplier.
a. Thickness: 1/8 in
b. Dimensions: 4 x 8 ft acceptable for mechanical attachment, insulation adhesive or asphalt application.
c. Water absorption: Less than 1 percent per ASTM D994.
d. Impact resistance: Included in FM Approvals per 4450/4470 for FM Severe Hail (SH) rating.
e. Compressive strength, psi (kPa) measured at 50 percent compression, per ASTM C472:
1) 1/8 in board: 1,610 (11,100)

f. Puncture resistance, lbf (N) per ASTM E154:

C. EDGE METALS
   1. SOPRAMETAL: Fascia, Copings and Expansion Joints pre-fabricated and provided by the roof membrane manufacturer. Shop broke or contractor provided edge metals will not Be accepted.
      a. Meets or exceeds ANSI/SPRI ES-1

D. HIGH TEMPERATURE UNDERLAYMENT
   1. LASTOBOND SHIELD HT: Self-Adhered membrane to be applied under all edgemetals and expansion joints.
      a. High Temperature Resistance of 240 deg F
      b. Trilaminate facer

E. PRIMERS:
   1. SOPREMA ELASTOCOL 500 Primer: Asphalt cut-back primer. Primer for the preparation of membrane substrates for asphalt, heat-welded, hot asphalt and COLPLY and COLPLY MODIFIED ADHESIVE, solvent-based, cold adhesive-applied and cement applications.
      a. Meets or exceeds ASTM D41
      b. VOC content: 350 g/L or less.
   2. SOPREMA ELASTOCOL STICK Primer: Self-adhesive membrane primer. SBS polymer, resin and, solvent-based primer for the preparation of membrane substrates for self-adhesive SBS membrane and self-adhered SBS flashing applications.

F. GENERAL PURPOSE ROOFING CEMENT AND MASTIC
   1. SOPREMA SOPRAMASTIC: SBS Mastic. Fiber-reinforced, roofing cement, packaged in 5 gallon pails. General purpose roofing cement for low-slope roofing used for sealing membrane T-joints and membrane edges along terminations, transitions and at roof penetrations.
      a. VOC Content: 190 g/L or less.
      b. Meets or exceeds ASTM D4586, Type I, Class II.
   2. SOPREMA SOPRAMASTIC: SBS Mastic. Fiber-reinforced, roofing cement, packaged in 10.4 oz caulk tubes. General purpose roofing cement for low-slope roofing used for sealing membrane T-joints and membrane edges along terminations, transitions and at roof penetrations.
      a. VOC Content: 190 g/L or less.
      b. Meets or exceeds ASTM D4586, Type I, Class II.

G. INSULATION ADHESIVE
   1. POLYURETHANE FOAM INSULATION ADHESIVE
      a. SOPREMA DUOTACK: Two-component, polyurethane foam insulation adhesive, applied in ribbons from cartridges or two-component bulk packaging with pump-driven delivery system.
         i. Ribbon size: 1/2 in to 3/4 in wide.

ii. Ribbon spacing: As required to meet specified wind uplift resistance performance.
a) Field of Roof (Zone 1): 12 in on-centers
b) Perimeter of Roof (Zone 2): 6 in on-centers
c) Corners of Roof (Zone 3): 4 in on-centers

H. GENERAL PURPOSE SEALANT
1. SOPREMA SOPRAMASTIC SP1: General purpose, paintable, gun-grade, elastomeric, polyether moisture curing sealant for sealing SBS membrane terminations, Kynar 500 PVDF, horizontal and vertical construction joints.
a. VOC Content: 20 g/L or less.
b. Meets or exceeds ASTM C920, Type S, Grade NS, Class 50.
c. Standard color, custom color.
2. SOPREMA SOPRAMASTIC ALU: Modified bitumen mastic, aluminum hued for application to membrane edge and perimeter metal.
a. VOC Content: 270 g/L or less.
b. Standard color.

I. MEMBRANE FASTENERS AND PLATES
1. SOPREMA #15 HD Fastener: Membrane base ply fastener.
2. SOPREMA 3 in INSULATION PLATE: Insulation and Cover Board
3. SOPREMA 2.4 in SEAM PLATE: Membrane base ply seam plate.

J. LIQUID-APPLIED REINFORCED FLASHING SYSTEM
1. ALSAN RS 230 FLASH, Catalyzed polymethacrylate (PMMA) resin with polyester reinforcing fleece fabric fully embedded into the resin to form fully-reinforced waterproofing membrane flashings.
a. VOC Content: No VOC content.
b. ALSAN RS 230 FLASH: polymethacrylate (PMMA) liquid resin.
c. SOPREMA ALSAN RS CATALYST POWDER: Reactive agent added to the PMMA liquid resin to induce curing.
d. SOPREMA ALSAN RS FLEECE: Polyester reinforcement fabric.
e. Color: Flash color and finish to match Field.

K. MINERAL GRANULES
1. SOPREMA Granules: No. 11, mineral coated colored granules, color to match cap sheet, supplied by membrane cap sheet manufacturer.

L. EXPANSION JOINT
1. SOPREMA SOPRAJOINT: Low-profile, polyester knit-reinforced, SBS-modified bitumen expansion joint membrane. Top surface consists of an aluminum-clad bond-breaker, with plastic burn-off film on the bottom surface for torch or hot air welding.
a. Thickness: 160 mils (4.0 mm)

b. Width: 18 in (457 mm)
c. Roll Length: 32.8 ft (10 m)
d. Expansion joint, maximum unsupported span: 2 in (51 mm)
e. Expansion joint, maximum displacement: 5/8 in (16 mm)

M. WALKWAY PROTECTION
1. SOPREMA SOPRAWALK: Polyester reinforced SBS modified bitumen walkway protection with a granule surface and sanded underside.
a. Thickness: 200 mils (5.0 mm)
b. Width: 39.4 in (1 m)
c. Roll Length: 26 ft (7.9 m)
d. Granule Surfacing:
i. Color: black, grey, tan

PART 3 EXECUTION

3.01 EXAMINATION

A. Examination includes visual observations, qualitative analysis, and quantitative testing measures as necessary to ensure conditions remain satisfactory throughout the project.
B. The contractor shall examine all roofing substrates including, but not limited to: insulation materials, roof decks, walls, curbs, rooftop equipment, fixtures, and wood blocking.
C. The applicator shall not begin installation until conditions have been properly examined and determined to be clean, dry and, otherwise satisfactory to receive specified roofing materials.
D. During the application of specified materials, the applicator shall continue to examine all project conditions to ensure conditions remain satisfactory to complete the specified roofing system.

3.02 PREPARATION

A. Before commencing work each day, the contractor shall prepare all roofing substrates to ensure conditions are satisfactory to proceed with the installation of specified roofing materials. Preparation of substrates includes, but is not limited to, substrate repairs, securement of substrates, eliminating all incompatible materials, and cleaning.
B. Where conditions are found to be unsatisfactory, work shall not begin until conditions are made satisfactory to begin work. Commencing of work shall indicate contractor's acceptance of conditions.

3.03 PRIMER APPLICATION

A. Examine all substrates, and conduct adhesion peel tests as necessary, to ensure satisfactory adhesion is achieved.
B. Apply the appropriate specified primer to dry, compatible substrates as required to enhance adhesion of new specified roofing materials.

C. Apply primer using brush, roller, or sprayer at the rate published on the product data sheet. Lightly prime for uniform coverage, do not apply heavy or thick coats of primer.
D. Asphalt Primer: Apply primer to dry compatible masonry, metal, wood and other required substrates before applying asphalt and heat-welded membrane plies. Primer is optional for solvent based solvent-based SBS adhesives and cements. Refer to product data sheets.
E. Self-Adhesive Membrane Primer: Apply to dry, compatible substrates as required to enhance adhesion of self-adhesive membrane plies. Ensure self-adhered membrane primer is tacky to-the-touch, but not wet. Primer should not transfer to the finger tips when touched.
F. Project conditions vary throughout the day. Monitor changing conditions, monitor the drying time of primers, and monitor the adhesion of the membrane plies. Adjust primer and membrane application methods as necessary to achieve the desired results.

3.04 SELF-ADHESIVE VAPOR RETARDER/AIR BARRIER APPLICATION

A. Follow material product data sheets and published general requirements for installation instructions.
B. SOPRAVAP'R is 45 in wide with 3 in side laps and 6 in end laps, produced for self-adhesion directly to steel deck and other approved roof substrates.
C. When applied directly to steel decking, ensure side-laps are aligned parallel with, and supported by, the top flange of the steel deck.
D. When SOPRAVAP'R is adhered to steel decking, in order to fully support 6 in end-laps, fasten a 6 x 42 in (15 x 106 cm) light gage sheet metal plate using truss-head or similar sheet metal screws.
E. Upon removing the SOPRAVAP'R release film from the underside, apply a weighted roller to the top surface to ensure SOPRAVAP'R is fully bonded to the substrate, and along all side-laps and 6 in end-laps. Use a hand-roller and firm pressure, roll-in vertical flashings and confined areas.
F. Install SOPRAVAP'R to flash roof penetrations, terminations and transitions. Ensure minimum 3 in side laps and 6 in end laps are maintained. Flash vertical surfaces as required to seal all substrates.
G. Seal SOPRAVAP'R at all roof penetrations, transitions and terminations. Seal as necessary using SOPRAVAP'R and apply specified general purpose sealant as needed to seal leading edges.
H. Seal irregular shaped or confined roof penetrations such as I-beams, C-channel, small pipes, etc. using specified liquid-applied flashing per the manufacturer's instructions.
I. Examine adhesion of SOPRAVAP'R to ensure results remain satisfactory as project conditions vary.
J. Each day, physically inspect all side and end-laps, and ensure the membrane is sealed watertight.

K. Inspect the installation each day to ensure the plies are fully adhered. Repair all un-adhered voids, wrinkles, open laps and all other deficiencies.

3.05 HEAT WELDING

A. The Contractor is responsible for project safety. Where conditions are deemed unsafe to use open flames, manufacturer's alternate membrane application methods shall be used to install SBS modified bitumen membrane and flashings. Acceptable alternate installation methods include hot asphalt, cold adhesive-applied, self-adhered membranes and mechanically fastened plies. Hot-air welding equipment may be used in lieu of roof torches to seal membrane side and end laps where heat welding the laps is necessary. Refer to NRCA CERTA, local codes and building owner's requirements for hot work operations.

B. Single or multi-nozzle, hand-held propane roof torches shall be used to install heat-welded membrane and flashing plies. Multi-nozzle carts (dragon wagons) may also be utilized to install membrane plies. Seven (7) nozzle carts are recommended for more uniform heat application in lieu of five (5) nozzle carts.

3.06 SBS MASTIC AND GENERAL PURPOSE ROOFING CEMENT APPLICATION

A. Apply SOPREMA SOPRAMASTIC general purpose SBS mastic and roofing cement to seal drain leads, metal flanges, seal along membrane edge at terminations, and where specified and required in detail drawings.

B. Do not use general purpose SBS mastics and roofing cement where flashing cement applications are required. Do not use SBS mastics and roofing cement beneath SBS-modified bitumen membrane and flashing plies.

C. Apply general purpose SBS mastic and elastic roofing cement using caulk gun, or notched trowel at 2.0 - 2.5 gallons per square on each surface. Application rates vary based on substrate porosity and roughness. Tool-in as necessary to seal laps

D. Embed matching granules into wet cement where exposed.

3.07 MECHANICALLY FASTENED SOPRAFIX BASE PLY APPLICATION

A. Refer to agency approvals for fastening and other system requirements.

B. Mechanically fastened membrane base ply installation:

1. Follow product data sheets and published detail requirements for additional installation instructions.
2. Ensure environmental conditions are satisfactory, and will remain satisfactory, during the application.

3. Unroll the sheet onto the roof surface and allow time to relax before fastening as necessary to prevent wrinkling once fastened.
4. Starting at the low point of the roof, lay out the membrane to ensure the plies are installed perpendicular to the roof slope, shingled to prevent back-water laps.
5. Remove all wrinkles from the sheet.
6. Ensure all roofing and flashing substrates are prepared and acceptable to receive the mechanically fastened membrane.
7. Ensure the specified side-lap and end-lap widths are maintained. End-laps should be staggered 3 ft. apart.
8. Unroll the first roll onto the roof substrate, re-roll the adjacent roll.
9. Starting at one end of the sheet, install the mechanical fasteners along the center of the side-lap. Ensure spacing between fasteners in the laps meets specified wind uplift resistance requirements.
10. Do not over-drive fasteners. Install fasteners as necessary to firmly set the fastener and seam plate tight against the sheet. Prevent wrinkles from forming in the sheet as the fasteners are installed.
11. At the end of the sheet where it terminates at roof edges, walls and curbs, fasten the end-laps to the deck 12 in on-centers or less.
12. When the side-lap is fastened, un-roll the adjacent roll over the fasteners. Maintain the required side-lap width.
13. Ensure the full side-lap width, and all 6 in end-laps, are sealed water-tight.
14. For heat-welded side-laps using a torch, ensure the substrate is satisfactory for torch application. Apply heat within the side-lap while unrolling the membrane. Apply heat until the bitumen melts to ensure full adhesion. Ensure a continuous weld is produced across the full side-lap width.
15. For hot-air welded side-laps, insert the hot-air welder shoe within the lap, and adjust the hot-air welder as required to produce a continuous weld across the full lap width.
16. While heat-welding the membrane side-laps, ensure approximately 1/8 to ¼ in bleed-out is achieved at laps.
17. Adjust the application of heat to the underside of the membrane and to substrate as required for varying substrates and environmental conditions.
18. For self-adhesive side-laps, remove the release film on the underside of the membrane while immediately following with a steel roller. Immediately heat-weld all 6 in end-laps, and fully seal all T-joints.
19. At end-laps, cut a 45 degree dog-ear away from the selvage edge, or otherwise ensure the membrane is fully heat-welded watertight at all end- laps and T-joints.

20. Each day, physically inspect all side and end-laps, and ensure the membrane is sealed watertight. Where necessary, use a torch or hot-air welder and a clean trowel to ensure all laps are fully sealed.
21. Offset cap sheet side and end-laps away from the base ply laps so that cap sheet laps are not located within 18 in of adjacent ply laps.
22. Inspect the mechanically fastened base ply each day to ensure the plies are water tight. Repair all un-adhered voids, wrinkles, open laps and all other deficiencies before installing the inter-ply and/or cap sheet over completed fastened base ply sheet.

3.08 HEAT-WELDED, FULLY ADHERED MEMBRANE APPLICATION

A. Follow material product data sheets and published general requirements for installation instructions.
B. Ensure environmental conditions are safe and satisfactory, and will remain safe and satisfactory, during the application of the heat-welded membrane and flashings.
C. Ensure all primers are fully dry before beginning heat-welding operations.
D. Unroll membrane onto the roof surface and allow time to relax prior to heat welding.
E. Starting at the low point of the roof, lay out the membrane to ensure the plies are installed perpendicular to the roof slope, shingled to prevent back-water laps.
F. Ensure all roofing and flashing substrates are prepared and acceptable to receive the heat-welded membrane.
G. Cut membrane to working lengths and widths to conform to rooftop conditions, and lay out to always work to a selvage edge.
H. Ensure specified side-laps and end-laps are maintained. End-laps should be staggered 3 ft apart.
I. Direct roof torch on the roll as necessary to prevent overheating and damaging the membrane and substrates.
J. As the membrane is unrolled, apply heat to the underside of the membrane until the plastic burn-off film melts away. Continuously move the torch side-to-side across the underside of the roll to melt the bitumen on the underside of the sheet, while continuously unrolling membrane.
K. While unrolling and heating the sheet, ensure approximately ¼ to 1/2 in of hot bitumen flows ahead of the roll as it is unrolled, and there is 1/8 to 1/4 in bleed out at all laps.
L. Adjust the application of heat to the underside of the membrane and to substrate as required for varying substrates and environmental conditions.

M. At the 6 in end-laps, melt the plastic burn-off film from the top surface or embed granules and remove surfacing, where present, using a torch or hot-air welder.
N. At end-laps where T-Joints exist, cut a 45 degree dog-ear away from the selvage edge, or otherwise ensure the membrane is fully heat-welded watertight at all T-joints.
O. Each day, physically inspect all side and end-laps, and ensure the membrane is sealed watertight. Where necessary, use a torch or hot-air welder and a clean trowel to ensure all laps are fully sealed.
P. Inspect the installation each day to ensure the plies are fully adhered. Repair all voids, wrinkles, open laps and all other deficiencies.
Q. Offset cap sheet side and end-laps away from the base ply laps so that cap sheet laps are not located within 18 in of base ply laps.

3.09 FLASHING APPLICATION, HEAT WELDED

A. Refer to SBS manufacturer's membrane application instructions, flashing detail drawings, and follow product data sheets and other published requirements for installation instructions. Refer to manufacturer's membrane flashing detail drawings.
B. The contractor is responsible for project safety. Refer to NRCA CERTA recommendations and building owner requirements for hot work operations.
C. Where required to seal substrates for fire safety, install specified adhered, self-adhered or fastened backer ply to the substrate. Ensure backer-ply covers and seals all substrates requiring protection from exposure to torch operations.
D. Ensure all flashing substrates that require primer are primed, and the primer is fully dry.
E. Unroll the flashing base ply and flashing cap sheet onto the roof surface to their complete length. Once relaxed, cut the membrane to the required working lengths to accommodate the flashing height, cants and the required over-lap onto the horizontal roof surface.
F. Cut the flashing membrane from the end of the roll in order to always install flashings to the side-lap line or selvage edge line.
G. Lay out the flashing base ply and flashing Cap Sheet to offset all side-laps a minimum of 12 inches so that side-laps are never aligned on top of the ply beneath. Shingle the flashing ply laps to prevent back-water laps.
H. Install non-combustible cant strips at transitions where required.
I. Ensure correct membrane and flashing sequencing to achieve redundant, multi-ply, watertight flashings.
J. ROOF MEMBRANE BASE PLY:
    1. Before installing flashings, install the roof membrane base ply in the horizontal field of the roof, and extend the base ply up to the top of the cant, where present, at roof terminations, transitions and penetrations.

K. FLASHING BASE PLY:
   1. Install the flashing base ply starting at the top leading edge of the vertical flashing substrate, down over the cant and onto the horizontal surface of the roof a minimum of 3 inches beyond the of base of the cant onto the roof. Cut the base ply at corners to form 3 inch side-laps. Install gussets to seal corner transitions.
   2. Install one or more flashing base ply(s) at all roof terminations, transitions and penetrations.

L. ROOF MEMBRANE CAP SHEET:
   1. Install the roof membrane Cap Sheet in the horizontal field of the roof over the flashing base ply up to the roof termination, transition or penetration, and up to the top of cants where present.
   2. Using a chalk line, mark a line on the membrane cap sheet a minimum of 4 inches from the base of the cant onto the roof. Where granules are present, embed the cap sheet granules using a torch and trowel or granule embedder to prepare the surface to receive the flashing cap sheet.

M. FLASHING CAP SHEET:
   1. Install the flashing Cap Sheet starting at the top leading edge on the vertical substrate, over the cant and onto the roof surface 4 inches from the base of the cant onto the roof.
   2. Install the flashing Cap Sheet to ensure a minimum two (2) ply flashing system is present at all roof terminations, transitions and penetrations.

N. During the membrane and flashing installation, ensure all plies are completely adhered into place, with no bridging, voids or openings. Ensure bitumen or flashing cement bleed-out is present at all flashing side and end-laps.

O. Use a damp sponge float or damp rag to press-in the heat-welded flashing plies during installation.

P. Where sufficient bitumen bleed-out is not present, and for all self-adhered plies, apply specified gun-grade sealant or mastic to seal the membrane termination along all roof terminations, transitions and penetrations. These include gravel stop edge metal, pipe penetrations, along the top edge of curb and wall flashing, and all other flashing terminations where necessary to seal flashings watertight.

Q. Fasten the top leading edge of the flashing 8 in on-centers with appropriate 1 in metal cap nails or other specified fasteners and plates. Seal fastener penetrations watertight using specified sealant or mastic.

R. Manufacturer's liquid-applied, reinforced flashing systems shall be installed where conditions are not favorable to install SBS modified bitumen flashings. Such conditions include irregular shapes penetrating roof surfaces (I-beams), confined areas and low flashing

heights. Manufacturer's liquid-applied, reinforced flashing systems are recommended in lieu of pitch pans and lead pipe flashings.

3.10 LIQUID-APPLIED, (PMA) MEMBRANE AND FLASHING SYSTEM APPLICATION

A. Refer to manufacturer's details drawings, product data sheets and published general requirements for application rates and specific installation instructions.
B. Pre-cut SOPREMA ALSAN RS FLEECE polyester reinforcing fleece to conform to roof terminations, transitions and penetrations being flashed. Ensure a minimum 2 in overlap of fleece at side and end-laps. Ensure the completed liquid-applied flashing membrane is fully reinforced.
C. Apply the base coat of catalyzed SOPREMA ALSAN RS resin onto the substrate using a brush or roller, working the material into the surface for complete coverage and full adhesion.
D. Immediately apply the SOPREMA ALSAN RS FLEECE reinforcing into the wet base coat of resin. Using a brush or roller, work the (SOPREMA ALSAN FLEECE reinforcing fabric into the wet resin while applying the second coat of catalyzed SOPREMA ALSAN RS resin to completely encapsulate the fleece.
E. Refer to reinforced, polymethyl-methacrylate (PMMA) polymethacrylate (PMA) specification section and application instructions, details drawings, product data sheets and published general requirements for installation instructions.

3.11 WALKWAYS

A. At areas outlined on the drawings, and around the perimeter of all rooftop equipment and at all door and stair landings, install walkway protection.
B. Cut walkway from end of rolls. No piece shall be less than 24 in.
C. Spot adhere walkway protection with SOPREMA SOPRAMASTIC SP1.
D. Provide a 2 in space between sheets for drainage.

3.12 AGGREGATE SURFACING

A. Apply 400 to 600 pounds per square of aggregate in nominal 60 pounds per square flood coat of hot asphalt.
B. The aggregate shall be fully embedded into hot asphalt. Loose gravel shall be broomed and embedded or removed to meet the 400 pounds per square requirement.
C. Hold asphalt and gravel back from all SBS modified bitumen flashings.

3.13 CLEAN-UP

A. Clean-up and properly dispose of waste and debris resulting from these operations each day as required to prevent damages and disruptions to operations.

END OF SECTION

SECTION 07.600 FLASHING AND SHEET METAL

PART 1 GENERAL

1.01 SUMMARY

A. The extent of each type of flashing and sheet metal work is indicated on the drawings and by provisions of this section.

B. The types of work specified in this section include the following:
   1. Base Flashing and Counterflashing
   2. Thru-wall scuppers
   3. Termination bars
   4. Sill flashings
   6. Miscellaneous sheet metal accessories.
   7. Coatings and sealants as required for this application.

C. Related Sections include the following:
   1. Section 04.200 Unit Masonry
   2. Section 07.410 Standing Seam Metal Roof Panels
   3. Section 07.421 Formed Metal Wall Panels
   4. Section 07.521 Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing
   5. Section 07.713 Manufactured Copings

1.02 SUBMITTALS

A. Product data including product specifications, standard details, performance data, and general recommendations.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Store materials in a dry, protected, well-vented area. The contractor shall report damaged material immediately to the delivering carrier and note such damage on the carrier's freight bill of lading.

B. Remove protective plastic surface film immediately after installation (if applicable).

1.04 PROJECT CONDITIONS

A. Coordinate work of this section with interfacing and adjoining work for proper sequencing of each installation. Ensure best possible weather resistance and durability of the work and protection of materials and finishes.

1.05 WARRANTY

A. Metal finish and watertightness warranty shall be provided in conjunction with Division 7 Section "Modified Bituminous Membrane Roofing". A full "roofing and metal" warranty is required.

PART 2 PRODUCTS

2.01 MATERIALS

A. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
   1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.
      a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
      b. Thicknesses as indicated.
   2. Color shall be selected by Architect from metal compatible with metal wall panels.

B. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed; 2D (dull, cold rolled) finish.

C. Reglets
   1. Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with interlocking counterflashing on exterior face, of same metal as reglet.
      a. Material: Pre-finished galvanized steel, minimum 22 gauge thick.
   2. Provide “Springlok Flashing System” as manufactured by Fry Reglet where indicated on Drawings.

2.02 ACCESSORIES

A. Metal Accessories: Provide sheet metal clips, straps, anchoring devices and similar accessory units as required for installation of work, matching or compatible with material being installed, noncorrosive, size and gage required for performance.

B. Fasteners: Same metal as flashing/sheet metal or, other noncorrosive metal as recommended by sheet manufacturer.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.

D. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.03 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
   1. Obtain field measurements for accurate fit before shop fabrication.
   2. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
   3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
B. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
C. Expansion Provisions: Where proper backer plates and cover plates cannot be used, form expansion joints lapped expansion provisions.
D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
E. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

2.04 SHEET METAL FABRICATIONS

A. Base Flashing: Pre-finished galvanized steel: 20 gauge thick.
B. Counterflashing and Flashing Receivers: Pre-finished galvanized steel: 22 gauge thick.
C. Parapet Scuppers: Fabricate scuppers of dimensions required with closure flange trim to exterior, minimum 4-inch wide wall flanges to interior, and base extending minimum 4 inches beyond cant or tapered strip into field of roof. Fabricate from the following materials:
   1. Pre-finished galvanized steel: 20 gauge thick.
   2. Around entire perimeter of scupper, provide “polyurethane coating system (Soprema Alsan Flashing System)”.
D. Hanging Gutters: See Section Standing Seam Metal Roof Panels
E. Downspouts: See Section Standing Seam Metal Roof Panels
F. Sill flashings: Stainless Steel: 24 gauge thick.
G. Miscellaneous Flashing: Stainless Steel: 24 gauge thick.
H. One piece subsills for curtainwall window units to be prefinished aluminum - 0.050 gauge. Fabricate as indicated on the drawings.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural

movement so that completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
5. Install sealant tape where indicated.
6. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.

D. Fastener Sizes: Use fasteners of sizes that will penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Seal joints as shown and as required for watertight construction.

3.02 INSTALLATION

A. General: Install sheet metal roof drainage items and flashing to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system. Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

B. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with sealant.

C. Parapet Scuppers: Install scuppers where indicated through parapet. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
   1. After installation of metal and membrane, cover entire area (bottom, sides, and top) with “polyurethane coating system” where connection to modified roofing system occurs as specified in Division 7 Section “Modified Bituminous Membrane Roofing”.

D. Hanging Gutters
   1. Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch long sections. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers and gutter accessories from same metal as gutters.
   2. Fabricate from the following materials
      a. Pre-finished galvanized steel: 0.028 inch thick.
      b. Downspouts shall have inside finish of factory applied polyester with a coating resistant to weathering.

E. Downspouts: Fabricate rectangular downspouts with end as indicated on Drawings (straight for connection to subsurface drainage). Furnish with metal hangers, from same material as downspouts, and anchors.
   1. Fabricate from the following materials
      a. Pre-finished galvanized steel: 0.022 inch thick.
      b. Downspouts shall have inside finish of factory applied polyester with a coating resistant to weathering.

F. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch long, but not exceeding 12-foot long, sections, under copings, at shelf angles, and where indicated. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings. Form with 2-inch high, end dams where flashing is discontinuous.

G. Sill Flashings: Fabricate sill and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch high, end dams.

H. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
   1. After installation of pipe or post counterflashing, install “polyurethane coating system” as specified in Division 7 Section “Modified Bituminous Membrane Roofing”.

3.03 CLEANING

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturers written installation instructions.
B. Clean exposed metal surfaces, removing substances which might cause corrosion of metal.

3.04 PROTECTION

A. Protection: Installer shall advise Contractor of required procedures for surveillance and protection of flashings and sheet metal work during construction, to ensure that work will be without damage or deterioration, other than natural weathering, at time of substantial completion.

END OF SECTION

SECTION 07.713 MANUFACTURED COPINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Prefinished metal copings

1.02 RELATED REQUIREMENTS

A. Section 07.521 SBS Modified Bituminous Membrane Roofing
B. Section 07.950 Joint Sealants.

1.03 REFERENCE STANDARDS

A. Factory Mutual (FM).
B. Miami-Dade County, Florida Notice of Acceptance (NOA).
C. Single Ply Roofing Industry (SPRI) (www.spri.org):
   1. ANSI/SPRI/FM 4435/ES-1 - Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems.

1.04 PREINSTALLATION MEETINGS

A. Require attendance of parties directly affecting Work of this Section, including Contractor, Architect, installer. This meeting may coincide with the roofing preinstallation meeting.
B. Review the Following:
   1. Materials.
   2. Installation.
   3. Adjusting.
   4. Cleaning.
   5. Protection.
   6. Coordination with other Work.

1.05 SUBMITTALS

A. Comply with Division 01.
B. Product Data: Submit manufacturer's product data, including installation instructions.
C. Shop Drawings: Submit manufacturer's shop drawings, including plans, elevations, sections, and details, indicating dimensions, materials, components, fasteners, finish, and accessories.
D. Samples: Submit manufacturer's sample of materials.
   1. Sample Length: Minimum 5-1/2 inches (140 mm).
E. Color Samples: Submit manufacturer's color samples of materials, consisting of complete color chart representing manufacturer's full range of available colors.
   1. Submit metal chips of specific colors as requested by the Architect.

F. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.
G. Warranty Documentation: Submit manufacturer's standard warranty.

1.06 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer regularly engaged in the manufacturing of materials of similar type to that specified for a minimum of 10 years.
B. Installer's Qualifications:
   1. Installer regularly engaged in installation of materials of similar type to that specified for a minimum of 5 years.
   2. Use persons trained for installation of materials of similar type to that specified following manufacturer's installation instructions.
C. Testing: Meet specified testing requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Delivery Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging.
B. Storage and Handling Requirements:
   1. Store and handle materials in accordance with manufacturer's instructions.
   2. Keep materials in manufacturer's original, unopened containers and packaging until installation.
   3. Store materials in clean, dry area indoors.
   4. Do not store materials directly on floor or ground.
   5. Protect materials and finish during storage, handling, and installation to prevent damage.

1.08 WARRANTY

A. Warranty Period, Product:
   1. Wind, 215 mph: Lifetime.
   2. Five-year workmanship warranty covering replacement or repair of products that are defective in material or workmanship.
B. Warranty Period, Finish: Limited 30-year warranty for prefinished coil-coated steel and aluminum coated with Kynar 500 standard colors covering fade, chalk, and film integrity.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Manufacturer: Metal-Era, Inc., 1600 Airport Road, Waukesha, Wisconsin 53188. Phone: 800-558-2162. Fax 800-373-9156. www.metalera.com. info@metalera.com.
B. Provided all other project requirements are met, products by the following manufacturers shall be considered equal:

1. ATAS International, Inc.: Rapid-Lok Ultra Coping
2. As approved by the Architect

2.02 MANUFACTURED COPINGS

A. Coping: Metal-Era "Perma-Tite" coping.
   1. Version: Tapered
   2. Tested: ANSI/SPRI/FM 4435/ES-1 to design pressure as shown on Structural Drawings.
   3. Cover Material: 24-gauge (0.65-mm) galvanized steel
   4. Cover Formed Lengths: 12'-0" (3.65 m).
   5. Concealed Splice Plates: 8 inches (203 mm) wide; with factory-applied, dual, non-curing, isocryl butyl sealant strips at each joint.
   6. Anchor Clips: Galvanized steel, 12 inches (305 mm) wide.
   7. Inside Face: Indicated on the Drawings
   8. Outside Face: Indicated on the Drawings
   9. Horizontal Space Provided for Wall Size Variations: 3/8 inch (10 mm), inside face.

2.03 FINISHES

1. Finish: Hylar 5000/Kynar 500
2. Color: As selected by the Architect from the Manufacturer's standard colors.

2.04 ACCESSORIES

A. Factory-Fabricated Accessories
   1. Miters
      a. As required for a complete installation
   2. Endcaps
      a. As required for a complete installation
   3. Endwall Flashings, Coping Version
      a. As required for a complete installation
   4. Endwall Flashings, Splice-Plate Version:
      a. As required for a complete installation
   5. Pilaster caps.
   6. Accessory Type: Welded
B. Joint Sealants: Specified in Section Sealants and Caulking
C. Fasteners: Appropriate for intended substrate.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to receive materials.
B. Verify surfaces to support materials are clean, dry, straight, secure, and of proper dimensions.
C. Notify Architect of conditions that would adversely affect installation.
D. Do not begin installation until unacceptable conditions are corrected.

3.02 INSTALLATION

A. Install materials in accordance with manufacturer's instructions at locations indicated on the Drawings.
B. Remove protective vinyl film immediately before installation.
C. Install materials to provide watertight termination at leading edge of roofing material.
D. Install materials to allow for thermal movement.
E. Joint Sealants: Apply joint sealants in accordance with manufacturer's instructions.

3.03 ADJUSTING

A. Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.
B. Remove and replace with new material, damaged components that cannot be successfully repaired, as determined by Architect.

3.04 CLEANING

A. Clean materials promptly after installation in accordance with manufacturer's instructions.
B. Do not use harsh cleaning materials or methods that could damage finish.

3.05 PROTECTION

A. Protect installed materials to ensure that, except for normal weathering, materials will be without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 07.720 ROOF ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following factory fabricated items:
   1. Retro fit Roof Drain
B. Related Sections include the following:
   1. Division 7 Section “Modified Bituminous Membrane Roofing”

1.02 SUBMITTALS

A. Product Data: Provide manufacturer’s product data for all materials in this specification.
B. Shop Drawings: Show profiles, accessories, location, dimensions, and details of connection to modified bitumen roofing system.

1.03 DELIVERY, STORAGE AND HANDLING

A. All materials shall be delivered in manufacturer’s original packaging.
B. Store materials in a dry, protected, well-vented area.
C. Remove protective wrapping immediately after installation.

1.04 WARRANTY

A. Materials shall be free of defects in material and workmanship for a period of ten years from the date of Substantial Completion.

PART 2 PRODUCTS

2.01 RETRO-FIT ROOF DRAINS

A. Retro-Fit Roof Drains for shall be equal RD2150 Replacement Roof Drain by Zurn, 16 gage Type 304 stainless steel body and neoprene gasket, complete with Dura-Coated cast iron clamp collar and dome with stainless steel hardware. Drains shall be configured for existing roof decks and shall be sized to fit existing drain piping.

PART 3 EXECUTION

3.01 RETRO-FIT ROOF DRAINS

A. Installation shall be in strict compliance with the roof drain manufacturer’s installation instructions. Installation shall also be in compliance with the roof manufacturer.

END OF SECTION

SECTION 07.840 FIRESTOPPING

PART 1 GENERAL

1.01 SUMMARY

A. Only tested firestop systems shall be used in specific locations as follows:
   1. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical busways and raceways through fire-rated vertical barriers (walls and partitions).
   2. Openings between structurally separate sections of wall.
   3. Gaps between the top of walls and ceilings or roof assemblies.
   4. Openings and penetrations in fire-rated partitions or walls containing fire doors.
   5. Openings around structural members which penetrate fire rated walls.

B. Related work specified elsewhere:
   1. Section 07.950 - Sealants and Caulking

1.02 REFERENCES

A. Test Requirements: ASTM E-814, "Standard Method of Fire Tests of Through Penetration Fire Stops" (July 1997).

B. Underwriters Laboratories (UL) of Northbrook, IL runs ASTM E-814 under their designation of UL 1479 and publishes the results in their "FIRE RESISTANCE DIRECTORY" that is updated annually.
   1. UL Fire Resistance Directory:
      a. Firestop Devices (XHJI)
      b. Fire Resistance Ratings (BXUV)
      c. Through-Penetration Firestop Systems (XHEZ)
      d. Fill, Voids, or Cavity Material (XHHW)
      e. Forming Materials (XHKU)

C. Test Requirements: UL 2079, “Tests for Fire Resistance of Building Joint Systems” (July 1998.)

D. Inspection Requirements: ASTM E 2174 – 01, “Standard Practice for On-site Inspection of Installed Fire Stops.”

E. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments.

F. ASTM E-84, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

A. Product Literature: Submit product data sheets and the manufacturer's installation instructions.
   1. Include Safety Data Sheets.

1.04 QUALITY ASSURANCE

A. Products used for firestopping shall be asbestos free materials classified by Underwriters Laboratories, Inc. as Fill, Void or Cavity Material for Through-Penetration Firestop Systems.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver in manufacturer's original unopened container, clearly identifying each product specified, relating it to the product literature submitted.
B. Store in accordance with manufacturer's recommendation, with proper precautions concerning shelf life, temperature, humidity, and similar storage factors to ensure the fitness of the material when installed.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide firestopping composed of components that are compatible with each other and substrates forming joints under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

2.02 MANUFACTURERS

A. Hilti, Inc.
B. 3M Fire Protection Products
C. Tremco Incorporated

2.03 MATERIALS

A. Use only firestop products that have been UL 1479, ASTM E-814, or UL 2079 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

2.04 VOC CONTENT

A. Provide fire-resistive joint systems that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    1. Architectural Sealants: 250 g/L.
    2. Sealant Primers for Nonporous Substrates: 250 g/L.
    3. Sealant Primers for Porous Substrates: 775 g/L.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
   1. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
   2. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
   3. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
   4. Do not proceed until unsatisfactory conditions have been corrected.

3.02 COORDINATION

A. Coordinate location and proper selection of cast-in-place Firestop Devices with trade responsible for the work. Ensure device is installed before placement of concrete.
B. Responsible trade to provide adequate spacing of field run pipes to allow for installation of cast-in-place firestop devices without interferences.

3.03 INSTALLATION

A. Install firestop materials in accordance with UL Fire Resistance Directory.
B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration and construction joint materials.
   1. Seal all holes or voids made by penetrations to ensure an air and water resistant seal.
   2. Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of UL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
   3. Protect materials from damage on surfaces subjected to traffic.

3.04 FIELD QUALITY CONTROL

A. Examine sealed joints to ensure proper installation before concealing or enclosing areas.
B. Keep areas of work accessible until inspection by applicable code authorities.
C. Perform under this Section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

3.05 CLEANING

A. Remove and recycle excess material, droppings and debris.
   1. Close and seal tightly all partly used sealant containers and store protected in well-ventilated, fire-safe area at moderate temperature.
   2. Place used sealant containers in areas designated for hazardous materials.
B. Remove sealant from materials and surfaces not specifically required to be sealed.

3.06 PROTECTION

A. Protect applied firestopping from damage.

END OF SECTION

SECTION 07.950 SEALANTS AND CAULKING

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The extent of each form and type of joint sealer is indicated on drawings and by provisions of this section.

B. The applications for joint sealers as work of this section include the following:
   1. Wall control joints in non-fire rated walls.
   2. New or existing masonry control / expansion joints
   3. New or existing concrete control / expansion joints
   5. Joints between metal door and window frames and adjacent construction.
   6. Acoustical sealant
   7. At locations where dissimilar metals come together.
   8. At all joints around all frames and sills of doors, window walls, and other openings in exterior walls.
   9. At the base of water closets and the perimeter of lavatories.
   10. Other locations indicated or required to properly seal buildings.

C. The applications for caulking compounds as work of this section include the following:
   1. Openings 1/4 inch and less between walls and partitions and adjacent lockers, casework, laboratory furniture, shelving, built-in or surface mounted equipment, plumbing and lighting fixtures.
   2. Joints of interior masonry walls and partitions which adjourn columns pilasters, concrete walls or exterior walls.
   3. Where caulking is shown on drawings.
   4. Other interior location where small voids between materials require filling for first class workmanship and painting.

1.02 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including Division 1 Specification sections, apply to work of this Section.

B. Section 07.840 - Firestopping

1.03 EXTENT

A. The contractor shall provide all items, articles, materials, operations or methods listed, mentioned, or scheduled on the drawings and or herein, including all labor, materials, equipment and incidentals necessary and required for the completion of caulking work.

1.04 SUBMITTALS

A. Product Literature
   1. Submit product data sheets and the manufacturer's installation instructions. If two or more different sealants are to be in physical

contact with each other, obtain from each manufacturer confirmation that its product is compatible with the proposed and adjacent products, including any other products which may be used by other sub-contractors. Include primer literature with the submittal document unless the manufacturer's sealant submittal specifically eliminates the need for a primer.

2. If a stain type primer is required for the sealant selected, such information shall be specifically included on submittal documents calling attention to the need for such staining type primer and noting the planned precautions to prevent exposed stain residue.
3. Include Safety Data Sheets for sealants.

B. Color Samples: Submit manufacturer's standard color chart. Submit cured samples of each chosen color for verification of actual color to be installed. Multiple cured samples may be required for selection.

1.05 QUALITY CONTROL

A. Mock-up (for masonry and window sealant only)
1. Contractor shall complete a mock-up section showing the materials and methods to be used.
2. Approved mock-ups will become a part of the Work and serve as the quality standard for similar type work on this project.
3. Notify the owner's representative three (3) days in advance of the dates and time when the test sections will be cleaned.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver in manufacturer's original unopened container, clearly identifying each product specified, relating it to the product literature submitted.
B. Store in accordance with manufacturer's recommendation, with proper precautions concerning shelf life, temperature, humidity, and similar storage factors to ensure the fitness of the material when installed.

1.07 PROJECT CONDITIONS

A. Weather Conditions - Do not proceed with installation of liquid sealants under unfavorable weather conditions. Install elastomeric sealants when temperature is in lower third of temperature range recommended by manufacturer for installation.

PART 2 PRODUCTS

2.01 MATERIALS

A. General Sealer Performance Requirements
1. Provide colors indicated or, if not otherwise indicated, as selected by Architect from manufacturer's standard colors. Select materials for compatibility with joint surfaces and other indicated exposures, and except as otherwise indicated, select modulus of elasticity and

hardness or grade recommended by manufacturer for each application indicated.

B. Exterior General Use:
   1. One-part Silicone Sealant conforming to ASTM C920 Type S, Grade NS, Class 50
C. Exterior Concealed Joints and Under Thresholds: One-part butyl rubber caulk conforming to FS TT-S-001657, Type I
D. Exterior Vertical masonry joints
   1. One-part Silicone Sealant conforming to ASTM C920 Type S, Type S, Class 50
   2. Sealant must adhere without primer to a porous substrate.
   3. Sealant must be recommended by the manufacturer for the required application.
E. Exterior sealant at damaged concrete: expansion joint filler. Bituminous, sized as required, per AASHTO M-213.
F. Exterior and Interior Horizontal Joints subject to pedestrian traffic:
   1. Two-part polyurethane conforming to ASTM C920, Class 25, Type M; self-leveling, zero-VOC.
G. Interior Non-Wet Areas: One-component acrylic latex water-based sealant conforming to ASTM C834, VOC content: maximum 42 grams/liter.
H. Interior Wet Areas: One-part, mildew-resistant silicone rubber conforming to ASTM C920, Type S, Class 25, Grade NS.
I. Sealant Backer Rod: Compressible rod-stock polyethylene foam, polyethylene-jacketed polyurethane foam, butyl-rubber foam, neoprene foam, or other flexible, permanent, durable, nonabsorptive material as recommended for compatibility with sealant by sealant manufacturer.
J. Joint Cleaner, Primer, and Bond Breaker: As recommended by sealant manufacturer.
K. Fiber Expansion Joint Material: Preformed cellular fiber complying with ASTM D1751.
L. Acoustical Sealant: Nonskinning, nonhardening, permanently flexible sealant specifically designed for sealing gypsum wallboard.
M. Foam Sealants: Blown with hydrocarbon or HFC-134a.

PART 3 EXECUTION

3.01 PRECONSTRUCTION FIELD-ADHESION TESTING

A. Before installing sealants, field test their adhesion to Project joint substrates. Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

3.02 EXAMINATION

A. Inspect substrate surface to assure that no bond breaker materials contaminate the surface to which the sealant is to adhere and to ensure

that unsound substrates are repaired. Installation of sealant shall be evidence of acceptance of the substrate.

B. Verify joint dimensions prior to installation of the sealant to ensure that all dimensions are within tolerance established in the manufacturer's literature. Unacceptable variations shall be called to the Architects attention for resolution prior to installing any material.

3.03 PREPARATION

A. Clean joint surfaces immediately before installation of sealant or caulking compound. Remove dirt, insecure coatings, moisture and other substances which could interfere with bond of sealant or caulking compound. Etch concrete and masonry joint surfaces as recommended by sealant manufacturer.

B. Prime or seal joint surfaces where indicated, and where not indicated if recommended by sealant manufacturer, prior to installation of any backer rod or bond breaker tape. Do not allow primer/sealer to spill or migrate onto adjoining surfaces.

3.04 INSTALLATION

A. General: Comply with manufacturer's printed instructions, except where more stringent requirements are shown or specified, and except where manufacturer's technical representative directs otherwise.

B. Set joint filler units full depth of joint or position in joint to coordinate with other work, including installation of backer rods and sealants. Do not leave voids or gaps between ends of joint filler units.

C. Install sealant backer rod for liquid elastomeric sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for application indicated in which case a bond breaker tape shall be used to prevent 3-sided adhesion. Apply backer rod using blunt or rounded tools which will ensure a uniform depth without puncturing the material. Use a rod oversized a minimum of 33% for closed cell and 50% for open cell, unless otherwise required by the manufacturer.

D. Employ only proven installation techniques, which will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces, with a smooth, even finish.

E. Install sealant to depths as shown or, if not shown, as recommended by sealant manufacturer but within the following general limitations, measured at center (thin) section of bead.

   1. For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50% of joint width, but neither more than 1/2" deep nor less than 1/4" deep.

2. For joints sealed with non-elastomeric sealants, fill joints to a depth in range of 75% to 125% of joint width.

F. Spillage: Do not allow sealants or compounds to overflow or spill onto adjoining surfaces or to migrate into voids of adjoining surfaces. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage.

G. Curing: Cure sealants and caulking compounds in compliance with manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength and surface durability.

3.05 CLEANING

A. Remove and recycle all excess material.
   1. Close and seal tightly all partly used sealant containers and store protected in well-ventilated, fire safe area at moderate temperature.
   2. Place used sealant tubes and containers in areas designated for hazardous materials.

END OF SECTION

SECTION 08.130 STEEL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Steel doors.
   2. Steel door frames.
   3. Vision lite frames in doors.

1.02. RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections.
B. Section 05.410 - Metal Stud System
C. Section 08.140 - Flush Wood Doors
C. Section 08.700 - Finish Hardware
D. Section 09.250 - Gypsum Board Assemblies
E. Section 09.990 - Painting

1.03 DEFINITIONS

A. Steel Sheet Thicknesses: Thickness dimensions, including those referenced in ANSI A250.8, are minimums as defined in referenced ASTM standards for both un-coated steel sheet and the un-coated base metal of metallic-coated steel sheets.

1.04 SUBMITTALS

A. Product Data: For each type of door and frame indicated, include door designation, type, level and model, material description, core description, construction details, label compliance, sound and fire-resistance ratings, and finishes.
B. Shop Drawings: Show the following:
   1. Elevations of each door design.
   2. Details of doors including vertical and horizontal edge details.
   3. Frame details for each frame type including dimensioned profiles.
   4. Details and locations of reinforcement and preparations for hardware.
   5. Details of each different wall opening condition.
   6. Details of anchorages, accessories, joints, and connections.
   7. Coordination of glazing frames and stops with glass and glazing requirements.
C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for factory-finished doors and frames.
D. Samples for Verification: For each type of exposed finish required, prepare a sample not less than 3 by 5 inches (75 by 125 mm) and of same thickness and material indicated for final unit of Work.

E. Door Schedule: Use same reference designations indicated on Drawings in preparing schedule for doors and frames.
F. Oversize Construction Certificates: For door assemblies required to be fire-protection rated and exceeding size limitations of labeled assemblies.

1.05 QUALITY ASSURANCE

A. Steel Door and Frame Standard: Comply with ANSI A 250.8, unless more stringent requirements are indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.
B. Inspect doors and frames on delivery for damage, and notify shipper and supplier if damage is found. Minor damages may be repaired provided refinished items match new work and are acceptable to Architect. Remove and replace damaged items that cannot be repaired as directed.
C. Store doors and frames at building site under cover. Place units on minimum 4-inch- (100-mm-) high wood blocking. Avoid using non-vented plastic or canvas shelters that could create a humidity chamber. If door packaging becomes wet, remove cartons immediately. Provide minimum 1/4-inch (6-mm) spaces between stacked doors to permit air circulation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with project requirements, provide products by one of the following:
    1. Steel Doors and Frames:
        a. Amweld Building Products, Inc.
        b. Curries Company.
        c. Republic Builders Products.
        d. Steelcraft; a division of Ingersoll-Rand.
        e. Ceco Door Products
        f. Habershame Metal Products Company
        g. Megamet Industries
        h. Meskes Door

2.02 MATERIALS

A. Cold-Rolled Steel Sheets: ASTM A 366/A 366M, Commercial Steel (CS), or ASTM A 620/A 620M, Drawing Steel (DS), Type B; stretcher-leveled standard of flatness.

B. Metallic-Coated Steel Sheets: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with an A40 (ZF120) zinc-iron-alloy (galvannealed) coating; stretcher-leveled standard of flatness.

2.03 DOORS

A. General: Provide doors of sizes, thicknesses, and designs indicated.
B. Interior Doors: Provide doors complying with requirements indicated below by referencing ANSI 250.8 for level and model and ANSI A250.4 for physical-endurance level:
   1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless). Typical doors
C. Exterior Doors: Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:
   1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless), (galvannealed)
D. Vision Lite Systems: Manufacturer's standard kits consisting of glass lite moldings to accommodate glass thickness and size of vision lite indicated.

2.04 FRAMES

A. General: Provide steel frames for doors, transoms, sidelights, borrowed lights, and other openings that comply with ANSI A250.8 and with details indicated for type and profile. Conceal fastenings, unless otherwise indicated. Galvannealed steel at all exterior locations.
B. Frames of 0.053-inch- (1.3-mm-) thick steel sheet for:
   1. Level 3 steel doors, unless otherwise indicated.
   2. Wood doors, unless otherwise indicated.
C. Frames of 0.067-inch- (1.7-mm-) thick steel sheet for:
   1. Paired Door openings wider than 48 inches (1220 mm).
   2. Level 4 steel doors, unless otherwise indicated.
D. Door Silencers: Except on weather-stripped frames, fabricate stops to receive three silencers on strike jambs of single-door frames and two silencers on heads of double-door frames.
E. Supports and Anchors: Fabricated from not less than 0.042-inch- (1.0-mm-) thick, electrolytic zinc-coated or metallic-coated steel sheet.
   1. Wall Anchors in Masonry Construction: 0.177-inch- (4.5-mm-) diameter, steel wire complying with ASTM A 510 (ASTM A 510M) may be used in place of steel sheet.
F. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where zinc-coated items are to be built into exterior walls, comply with ASTM A 153/A 153M, Class C or D as applicable.

2.05 FABRICATION

A. General: Fabricate steel door and frame units to comply with ANSI A250.8 and to be rigid, neat in appearance, and free from defects including warp and buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.

B. Exterior Door Construction: For exterior locations and elsewhere as indicated, fabricate doors, panels, and frames from galvanneal-coated steel sheet. Close top and bottom edges of doors flush as an integral part of door construction or by addition of 0.053-inch- (1.3-mm-) thick, metallic-coated steel channels with channel webs placed even with top and bottom edges.

C. Interior Door and Panel Faces: Fabricate exposed faces of doors and panels, including stiles and rails of nonflush units, from the following material:
   1. Cold-rolled steel sheet, unless otherwise indicated.

D. Core Construction: Manufacturer's standard core construction that produces a door complying with SDI standards.

E. Clearances for Non-Fire-Rated Doors: Not more than 1/8 inch (3.2 mm) at jambs and heads, except not more than 1/4 inch (6.4 mm) between pairs of doors. Not more than 3/4 inch (19 mm) at bottom.

F. Single-Acting, Door-Edge Profile: Square edge, unless beveled edge is indicated.

G. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

H. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.

I. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

J. Thermal-Rated (Insulating) Assemblies: At exterior locations and elsewhere as shown or scheduled, provide doors fabricated as thermal-insulating door and frame assemblies and tested according to ASTM C 236 or ASTM C 976 on fully operable door assemblies.
   1. Unless otherwise indicated, provide thermal-rated assemblies with U-value of 0.41 Btu/sq. ft. x h x deg F (2.33 W/sq. m x K) or better.
   2. All exterior doors must meet ASHRAE 90.1-10; SHGC-0.25
   3. All exterior doors must meet NFRC Air Infiltration Rate of 0.2cfm/SF

K. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements in ANSI A250.6 and ANSI A115 Series specifications for door and frame preparation for hardware.

L. Frame Construction: Fabricate frames to shape shown.
   1. Fabricate frames with mitered and continuously welded corners and seamless face joints.
   2. For interior applications, fabricate frames with mitered and continuously welded corners.
   3. Provide welded frames with temporary spreader bars.
   4. Provide terminated stops, unless otherwise indicated.

M. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.

N. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.

O. Glazing Stops: Manufacturer's standard, formed from 0.032-inch-(0.8-mm-) thick steel sheet.
   1. Provide nonremovable stops on outside of exterior doors and on secure side of interior doors for glass, and other panels in doors.
   2. Provide screw-applied, removable, glazing stops on inside of glass, and other panels in doors.

P. Astragals: Galvanized flat stock mounted on the exterior of active leafs.

2.06 FINISHES

A. All doors and frames shall be G-90 galvanized with primer coat.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install steel doors, frames, and accessories according to Shop Drawings, manufacturer's data, and as specified.

B. Placing Frames: Comply with provisions in SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
   1. Except for frames located in existing walls or partitions, place frames before construction of enclosing walls and ceilings.
   2. In metal-stud partitions, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Attach wall anchors to studs with screws.
   3. For openings 90 inches (2286 mm) or more in height, install an additional anchor at hinge and strike jambs.

C. Door Installation: Comply with ANSI A250.8. Fit hollow-metal doors accurately in frames, within clearances specified in ANSI A250.8. Shim as necessary to comply with SDI 122 and ANSI/DHI A115.1G.
   1. Smoke-Control Doors: Install to comply with NFPA 105.

3.02 ADJUSTING AND CLEANING

A. Prime-Coat Touchup: Immediately after installation, sand smooth any rusted or damaged areas of prime coat and apply touch up of compatible air-drying primer.
B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION

SECTION 08.140 FLUSH WOOD DOORS

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:
   1. Solid-core doors with wood-veneer faces.
   2. Factory fitting flush wood doors to frames and factory machining for hardware.
B. Related Sections include the following:
   1. Section 06.200 Finish Carpentry
   2. Section 08.130 Steel Doors and Frames
   3. Section 08.700 Finish Hardware

1.03 SUBMITTALS

A. Product Data: For each type of door. Include details of core and edge construction, trim for openings, and louvers.
   1. Include factory-finishing specifications.
B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
   1. Indicate fire ratings for fire doors.
C. Samples for Initial Selection: Color charts consisting of actual materials in small sections for the following:
   1. Faces of factory-finished doors with transparent finish. Show the full range of colors available for stained finishes.
D. Samples for Verification: As follows:
   1. Corner sections of doors approximately 8 by 10 inches (200 by 250 mm) with door faces and edgings representing the typical range of color and grain for each species of veneer and solid lumber required. Finish sample with same materials proposed for factory-finished doors.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.
B. Quality Standard: Comply with the following standard:
   1. NWWDA Quality Standard: NWWDA I.S.1-A, "Architectural Wood Flush Doors."

2. AWI Quality Standard: AWI's "Architectural Woodwork Quality Standards" for grade of door, core, construction, finish, and other requirements.

C. Manufacture shall be a member of AWI.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect doors during transit, storage, and handling to prevent damage, soiling, and deterioration. Comply with requirements of referenced standard and manufacturer's written instructions.
   1. Comply with WIC Technical Bulletin 420-R for delivery, storage, and handling of doors.

B. Mark each door with individual opening numbers used on Shop Drawings. Use removable tags or concealed markings.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until conditions for temperature and relative humidity have been stabilized and will be maintained in storage and installation areas during the remainder of the construction period to comply with requirements of the referenced quality standard for Project's geographical location.

1.07 WARRANTY

A. General Warranty: Door manufacturer's warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Door Manufacturer's Warranty: Submit written agreement on door manufacturer's standard form, signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that have warped (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section or that show telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span, or do not comply with tolerances in referenced quality standard.
   1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
   2. Warranty shall be in effect during the following period of time after the date of Substantial Completion:
      a. Solid-Core Interior Doors: Life of installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Manufacturer: Graham Architectural Wood Doors by Masonite Architectural. Provided all other project requirements are

met, products by the following manufacturer's shall be considered equal:

1. Chappell Door Co.
2. Oshkosh Architectural Door Co.
3. Marshfield-Algoma by Masonite Architectural
4. Ampco

2.02 DOOR CONSTRUCTION, GENERAL

A. Doors for Transparent Finish: Comply with the following requirements:
   1. Grade: Custom, with Grade A faces.
   2. Faces: Red Oak, Plain Sliced.
   3. Match between Veneer Leaves: Book running match.
   4. Match within Door Faces: Running match.
   5. Stiles: Same species as face. No exposed crossband blind edge construction.

2.03 SOLID-CORE DOORS

A. Particleboard Cores: Comply with the following requirements:
   1. Particleboard: ANSI A208.1, Grade LD-1.
   2. Blocking: Provide wood blocking at particleboard-core doors as follows:
      a. 5-inch top-rail blocking, at doors indicated to have closers.
      b. 5-inch bottom-rail blocking, at exterior doors and doors indicated to have kick, mop, or armor plates.
      c. 5-inch midrail blocking, at doors indicated to have exit devices.
B. Interior Veneer-Faced Doors: Comply with the following requirements:
   1. Core: Particleboard core.
   2. Construction: five plies with stiles and rails bonded to core, then entire unit abrasive planed before veneering.

2.04 FABRICATION

A. Fabricate flush wood doors in sizes indicated for Project site fitting.
   1. Comply with clearance requirements of referenced quality standard for fitting. Comply with requirements of NFPA 80 for fire-rated doors.
B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
   1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
   2. Metal Astragals: Premachine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

2.05 FACTORY FINISHING

A. General: Comply with referenced quality standard's requirements for factory finishing.
B. Finish wood doors at factory.
C. Transparent Finish: Comply with requirements indicated for grade, finish system, staining effect, and sheen.
    1. Finish: Manufacturer's standard finish with performance requirements comparable to AWI System TR-6 conversion varnish.
    2. Staining: #375 SS1 or match existing.
    3. Effect: Open-grain finish.
    4. Sheen: Semigloss.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine installed door frames before hanging doors.
    1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with plumb jambs and level heads.
    2. Reject doors with defects.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Hardware: For installation, see Division 8 Section "Door Hardware."
B. Manufacturer's Written Instructions: Install wood doors to comply with manufacturer's written instructions, referenced quality standard, and as indicated.
    1. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
C. Job-Fit Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted with fire-rated doors. Machine doors for hardware. Seal cut surfaces after fitting and machining.
    1. Fitting Clearances for Non-Fire-Rated Doors: Provide 1/8 inch at jambs and heads, 1/16 inch per leaf at meeting stiles for pairs of doors, and 1/8 inch from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 1/4-inch clearance from bottom of door to top of threshold.
    2. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
D. Factory-Finished Doors: Restore finish before installation, if fitting or machining is required at Project site.

3.03 ADJUSTING AND PROTECTING

A. Operation: Rehang or replace doors that do not swing or operate freely.
B. Finished Doors: Refinish or replace doors damaged during installation.
C. Protect doors as recommended by door manufacturer to ensure that wood doors are without damage or deterioration at the time of Substantial Completion.

END OF SECTION

SECTION 08.400 ALUMINUM STOREFRONT FRAMES

PART 1 GENERAL

1.01 QUALITY ASSURANCE

A. Acceptable Manufactures
   1. Kawneer Architectural Products
   2. EFCO Corporation
   3. Vistawall
   4. Tubelite

1.02 PERFORMANCE REQUIREMENTS

A. Air Infiltration: The test specimen shall be tested in accordance with ASTM E 283. Air infiltration rate shall not exceed 0.06 cfm/ft^2 at a static air pressure differential of 6.24 psf.
B. Water Resistance, (static): The test specimen shall be tested in accordance with ASTM E 331. There shall be no leakage at a static air pressure differential of 12 psf as defined in AAMA 501.
C. Water Resistance, (dynamic): The test specimen shall be tested in accordance with AAMA 501.1. There shall be no leakage at an air pressure differential of 12 psf as defined in AAMA 501.
D. Uniform Load: A static air design load of 65 psf shall be applied in the positive and negative direction in accordance with ASTM E 330. There shall be no deflection in excess of L/175 of the span of any framing member at design load. At structural test load equal to 1.5 times the specified design load, no glass breakage or permanent set in the framing members in excess of 0.2% of their clear spans shall occur.
E. Seismic: When tested to AAMA 501.4, system must meet design displacement of 0.010 x the story height and ultimate displacement of 1.5 x the design displacement.
F. Impact Resistance: Large missile, tested in accordance with DCBCCO Protocols PA201, SBCC1 SSTD-1512 and ASTM E 1886.

1.03 WIND DESIGN DATA

A. Shall be in accordance with the requirements indicated on the Structural Drawings.

1.04 SUBMITTALS

A. Shop Drawings
   1. Show details of frame construction.
B. Submit certification that system meets the Performance requirements and the Wind Design Data requirements.

PART 2 PRODUCTS

2.01 ALUMINUM STOREFRONT FRAMES

A. Exterior Aluminum storefront frames shall be equal to Kawneer, IR 501 frame system, as indicated on the Drawings. Approved equals: Arch Aluminum & Glass, IFG-5000; Vistawall, GG-5100.
B. Extruded subsills: Provide extruded aluminum subsills with end dams, as required for proper drainage to the exterior of the building. If fabricated, the subsills and end dams shall be of .050 prefinished aluminum with color to match storefront frames.
C. Finish shall be Dark Bronze to match existing.
D. Alloy finish shall be 6063-T-5.
E. Coordinate frames with approved hardware for associated doors.
F. Bolts for attachment of mullions to supporting structure shall be cadmium plated steel. Where required, bolts shall be stainless steel 300 series. Self-tapping screws shall be stainless steel 300 series.
G. Steel angles, where required, shall be galvanized in accordance with ASTM Standard A-388.
H. Aluminum storefront subcontractor shall be responsible for perimeter anchorage of the system to meet wind design requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Storefront Systems shall be installed by experienced workmen. Install all sections plumb, true, and level, securely anchored to the building frame in accordance with manufacturer's recommendations and details shown on approved shop drawings. All sealants, gaskets, etc., to be applied as recommended by the manufacturer.
B. Protect all aluminum surfaces as follows:
    1. Apply in the field, a neat, even, protective coating of alkali resistant asphaltum base pint to aluminum surfaces remaining exposed, and which will come in contact with concrete or plaster.
    2. Paint carbon steel (not galvanized) coming in contact with aluminum with zinc chromate primer and one coat of aluminum metal and masonry paint of one coat of heavy bodied aluminum paint.
    3. Apply waterproof masking tape to aluminum surfaces remaining exposed to the interior building, which may be splattered, etc., to be applied as recommended by the manufacturer.
    4. Apply petroleum jelly to aluminum surfaces exposed on the interior of the building which may be splattered with mortar, paint, and other similar materials. Protect surrounding surfaces to prevent staining from petroleum jelly of other materials used to protect the aluminum.

3.02 GUARANTEE

A. The entire assembly shall be guaranteed watertight upon completion and any necessary measure to correct leaks shall be performed by the Contractor without cost to the Owner for a period of two years from the completion and acceptance of the building.

END OF SECTION

SECTION 08.700 FINISH HARDWARE

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Work under this section consists of furnishing all Finish Hardware necessary to complete the work in accordance with the Plans and Specifications. This Contractor shall verify all quantities, types, or sizes required. In the event that any necessary items of hardware are not found herein, the Contractor shall notify the Architect in writing 10 days prior to bid date. No additional cost to the Architect or Owner shall be accepted after the contract is awarded based on the Plans and Specifications at the time of the General Contract Bid.

1.02 WORK INCLUDED

A. Hardware for all swinging doors.
B. Rekeying information for all interior building doors not otherwise in the project.

1.03 RELATED SECTIONS

A. Section 08.130 Steel Doors and Frames
B. Section 08.140 Flush Wood Doors

1.04 CODES, REFERENCES, AND STANDARDS

A. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
   1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
   2. ICC/IBC - International Building Code.
   3. NFPA 70 - National Electrical Code.
   4. NFPA 80 - Fire Doors and Windows.
   5. NFPA 101 - Life Safety Code.
   6. NFPA 105 - Installation of Smoke Door Assemblies.
   7. UL/ULC and CSA C22.2 - Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
   8. International Building Codes, with Local Amendments.
B. Standards: All hardware specified herein shall comply with the following industry standards:
   1. ANSI/BHMA Certified Product Standards - A156 Series
   2. UL10C - Positive Pressure Fire Tests of Door Assemblies

1.05 SUBMITTALS

A. The Contractor shall prepare and submit to the Architect for approval six (6) copies of this finish hardware schedule. The Schedule is to be submitted in the "Vertical Style" with items as required. No item shall have doors or hardware listed that have a different type or size. Before

any materials are ordered the finish hardware supplier shall have an approved schedule with all keying information.

B. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

1.06 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.07 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and

Owner concerning both standard and electromechanical door hardware and keying.

D. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
   1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
   2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

F. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
   1. Function of building, purpose of each area and degree of security required.
   2. Plans for existing and future key system expansion.
   3. Requirements for key control storage and software.
   4. Installation of permanent keys, cylinder cores and software.
   5. Address and requirements for delivery of keys.

G. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.08 SAMPLES

A. The Architect reserves the right to request physical samples of any product being proposed for use on this project. If such a sample is required, and is approved for use on the project the Architect will forward all samples to the contractor for use on the project.

1.09 DELIVERY AND STORAGE

A. The Hardware Supplier shall not deliver Finish Hardware to the job site. The hardware shall be received at the Supplier's place of business at which time all items shall be properly marked and identified with the Hardware Schedule. The hardware supplier shall deliver Finish Hardware to the job site in one complete shipment.

B. The Finish Hardware shall be stored in a clean, dry room off the floor on temporary shelving provided by the General Contractor. If requested, the hardware supplier shall assist the General Contractor in placing the hardware on the shelves in a manner that will help assure proper hardware installation.

1.10 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
    1. Structural failures including excessive deflection, cracking, or breakage.
    2. Faulty operation of the hardware.
    3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
    4. Electrical component defects and failures within the systems operation.
C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
D. Special Warranty Periods:
    1. Ten years for mortise locks and latches.
    2. Five years for exit hardware.
    3. Twenty five years for manual surface door closer bodies.

1.11 MAINTENANCE SERVICE

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

1.12 INSPECTIONS

A. Upon the request of the Architect, a qualified representative from the Hardware supplier shall accompany the Architect's representative to inspect the installation of all Finish Hardware supplied under this section. If errors in installation are present, it will be brought to the Contractor's attention for correction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Items listed herein are taken from the following manufacturer's catalogs:
    1. McKinney
    2. Yale

3. Trimco
4. Glynn Johnson
6. Pemko

B. Items listed as allowable substitutions and approved by the Architect will be accepted.

C. Finish of product, except as noted in the Hardware sets, shall be as follows:
   1. Butts, 645.
   2. Locksets, 625.
   3. Closers, holders, and brackets, painted SB.

D. Hinges
   1. All hinges shall be 4-1/2 x 4-1/2 unless noted otherwise.

E. Locksets shall be Yale Series with AU, to match existing. Locksets shall be compatible with Yale interchangeable cores. Finishes shall be 626.

F. Keying
   1. All cylinders and locks shall have Yale interchangeable cores keyed as directed by Architect and Owner to the existing systems. (3) keys per lock
      Provide construction cores during the work.
   2. Furnish keys as needed oy the Owner.
   3. Cylinders in other door openings shall have 626 finish.
   4. Provide and install a wall mounted prefinished steel key cabinet with space for 120 keys. Cabinet shall have a cam lock and shall be supplied with two keys.

G. Closers shall be Yale 3301 BF Series, with adjustable delayed action closing. Power adjustments shall be set for Barrier Free range.

H. Stops
   1. Interior stops shall be floor type W1210RP by Trimco or approved equal when door will not swing into wall or where overhead stop is specified. Balance of stops shall be W1276CCS by Trimco or equal.

I. Silencers shall be Glynn Johnson GJ64 or approved equal.

J. Door Seals shall be Pemko

K. Coordinate access control requirements with electrical drawings and specifications.

2.02 HARDWARE SETS

A. The Hardware Sets herein are a list of the type, sizes, materials, and functions required. In the event a door or doors appears on the Drawings, and is not listed in this section, a set number shall be used, which is similar to other doors of the same type and area of use.

GENERAL NOTE: All strikes to be furnished with a wrought box.

HARDWARE SETS

H1 -Mark #'s 204A, 205A

3 ea. hinges	McKinney TA2714 4-1/2” x 4-1/2” x US32
1 ea. push plate	Rockwood 70RC 8" x 16” x US32
1 ea. pull plate	Rockwood 70RC 4” x 16" x US32
1 ea. closer	Sargent EN1431-0 or P9 x TB as required
1 ea. Klckplate	Rockwood 8” x 2" LDW x US32
1 ea. wall bumper	Rockwood 409 x US32 - verify anchor·
3 ea. silencers	Rockwood 608

PART 3 EXECUTION

3.01 HARDWARE LOCATIONS

A. Mounting heights to be in accordance with the Door and Hardware Institute's and Builders Hardware Manufacturing Association's recommended locations.
B. Hands of doors to be scheduled by each opening on the hardware schedule.

3.02 INSTALLATION METHODS AND WORKMANSHIP

A. The hardware installer shall be qualified and experienced in the installation of finish hardware.
B. The hardware installer shall be qualified and experienced in interpreting the plans, the door schedule and the hardware schedule to assure that the correct hardware is installed on the correct opening.
C. All instruction material and adjusting tools that come packed with the finish hardware shall be turned over to the Owner's representative.

END OF SECTION

SECTION 08.800 GLAZING

PART 1 GENERAL

1.01 SUMMARY

A. Types of work in this section include glass and glazing for:
   1. Fixed Glass Units and Doors

B. Related Sections include the following:
   1. Division 8 Section “Flush Wood Doors”
   2. Division 8 Section “Steel Doors and Frames”
   3. Division 8 Section "Aluminum Entrances, Curtainwall and Storefronts”

1.02 SUBMITTALS

A. Samples: Submit 12-inch square samples of each type of glass indicated, and 12 inch long samples of each color required (except black) for each type of sealant or gasket exposed to view.

B. Compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion with glazing sealants and other glazing materials.

C. Product Certificates: Obtain Certificate of Compliance for all glass products

1.03 QUALITY ASSURANCE

A. Design Requirements
   1. Refer to Structural Drawings for pressures required.

B. Safety glass products are to comply with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.
   1. Subject to compliance with requirements, provide safety glass permanently marked with certification label of Safety Glazing Certification Council (SGCC) or other certification agency acceptable to authorities having jurisdiction.

C. Insulating glass products are to be permanently marked either on spacers or at least one component lite of units with appropriate certification label of inspecting and testing agency indicated below:
   1. Insulating Glass Certification Council (IGCC).

D. Single Source fabrication responsibility: Fabrication processes, insulating, laminating, silkscreen, and tempering, shall be fabricated by a single Fabricator.

E. Protect glass from edge damage during handling and installation, and subsequent operation of glazing components of the work. During installation, discard units with significant edge damage or other imperfections.

F. Comply with combined recommendations and technical reports by manufacturers of glass and glazing products as used in each glazing channel, and with recommendations of Flat Glass Marketing

Association "Glazing Manual", except where more stringent requirements are indicated.

1.04 WARRANTY

A. Warranty on Hermetic Seals: Provide insulating glass manufacturer's written warranty, agreeing to, within specified warranty period, furnish FOB project site, replacement units for insulating glass units which have defective hermetic seals (excluding that due to glass breakage); defined to include intrusion of moisture or dirt, internal condensation at temperatures above -20 degrees F (-31 degrees C), deterioration of internal glass coatings, and other visual evidence of seal failure or performance failure. Warranty period is 5 years after seal date permanently imprinted on unit, but not less than 5 years after date of substantial completion of Project.

B. The Contractor shall guarantee to the Owner that the installed storefront systems and glass panels meet all local code wind conditions for 130 mile an hour wind, and that the entire system shall remain free of water leaks for a period of one year from the date of final acceptance.

C. Any leaks or defective work shall be immediately corrected by the manufacturer and Contractor, at no expense to the Owner.

PART 2 PRODUCTS

2.01 MATERIALS

A. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 2190, Class CBA.
   1. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.

B. Basis of Design on insulating units:
   1. Performance Values: (Note: values other than those listed as follows remain unchanged)
      a. Visible Light Transmission %: 51% Minimum
      b. UV Transmission %: 4
      c. Visible Light Out Reflectivity %: 12% Minimum
      d. Visible Light Reflectivity inside %: 11
      e. U-Value Winter Nighttime: 1.52 ($W/m^2x°C$) Maximum
      f. U-Value Summer Daytime: 1.52 ($W/m^2x°C$) Maximum
      g. Shading Coefficient: 0.27 Maximum
      h. Solar Heat Gain Coefficient: 0.23 Maximum
      i. Light-to-Solar Gain: 2.2

2.02 FABRICATION

A. Provide in overall sizes indicated on Drawings and as specified herein.
B. TISG-IR – Tinted Insulated Impact Safety Glass (Low-E Insulated Glass) 1 5/16":
   1. To be installed in all openings over 60" above adjacent floor
   2. 1/4" Heat Strengthened fully tempered Outboard/Exterior Lite equal to Vitro Clear + Solarban 90
   3. 1/2" Air Space
   4. 1/4" Heat Strengthened fully tempered Outboard/Exterior Lite equal to Vitro Clear + Solarban 90
   5. .100 Solutia Saflex HP (PVB)
   6. 1/4" Heat Strengthened fully tempered Inboard Lite
C. TSG-IR – Tinted Impact Safety Glass, at Doors (Low-E Insulated Glass) 9/16":
   1. 1/4" Heat Strengthened fully tempered Outboard/Exterior Lite equal to Vitro Clear + Solarban 90
   2. .100 Solutia Saflex HP (PVB)
   3. 1/4" Heat Strengthened fully tempered Outboard/Exterior Lite equal to Vitro Clear + Solarban 90
D. CSG (Clear Safety Glass) 1/4":
   1. 1/4 inch thick clear fully tempered glass.
E. MSG (Mirrored Safety Glass) 1/4":
   1. 1/4 inch thick clear fully tempered glass, provide one-way mirror security glazing facing corridor.

2.03 COMPONENTS

A. General: Provide color of exposed sealant/compound indicated or if not otherwise indicated, as selected by Architect from manufacturer's standard colors, or black if no color is so selected. Comply with manufacturer's recommendations for selection of hardness, depending upon the location of each application, conditions at time of installation, and performance requirements as indicated. Select materials and variations or modifications carefully for compatibility with surfaces contacted in the installation. Sealants shall contain no asbestos.
B. 2-part Polysulfide Glazing Sealant: Elastomeric polysulfide sealant complying with FS TT-S-227, Class A, Type 2; specially compounded and tested to show a minimum of 20 years resistance to deterioration in normal glazing applications. Use for all exterior locations. Verify compatibility with insulating glass and substitute if necessary.
C. Oleo-resinous Glazing Compound: Oil-based glazing compound; non-staining and non-bleeding; provide proper type as required for channel. Use for interior locations.

2.04 ACCESSORIES

A. Miscellaneous Materials
   1. Cleaners, Primers and Sealers: Type recommended by sealant or gasket manufacturer.
   2. Setting Blocks: Neoprene or EPDM, 79-90 durometer hardness, with proven compatibility with sealants used.
   3. Spacers: Neoprene or EPDM, 40-50 durometer hardness with proven compatibility with sealants used.
   4. Compressible Filler (Rod): Closed-cell or waterproof-jacketed rod stock of synthetic rubber or plastic foam, proven to be compatible with sealants used; flexible and resilient, with 5-10 psi compressive strength for 25% deflection.

B. Structural Sealant
   1. Structural Sealant: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant.
      a. Provide sealants for use inside that have a VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      b. Color: Black.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean glazing channel and other framing members to receive glass, immediately before glazing. Remove coatings which are not firmly bonded to substrate. Remove lacquer from metal surfaces where elastomeric sealants are used.

B. Apply primer or sealant to joint surfaces where recommended by sealant manufacturer.

3.02 INSTALLATION

A. General
   1. Watertight and airtight installation of each glass product is required, except as otherwise shown. Each installation must withstand normal temperature changes, wind loading, and impact loading (for doors), without failure, including loss or breakage of glass, failure of sealants to remain watertight and airtight, deterioration of glazing materials and other defects in the work.
   2. Install insulating glass units to comply with recommendations by Sealed Insulating Glass Manufacturers' Association, except as otherwise specifically indicated or recommended by glass and sealant manufacturers.

B. Glazing
   1. Install setting blocks of proper size in sill rabbet located in 1/4 of glass width from each corner. Set blocks in thin course of heel-bead compound, if any.
   2. Provide spacers inside and out, of proper size and spacing, for glass sizes larger than 50 united inches, except where preshimmed tapes are used for glazing. Provide 1/8" minimum bite of spacers on glass and use thickness equal to sealant width.
   3. Set units of glass in each series with uniformity of pattern, draw, bow and similar characteristics.
   4. Voids and Filler Rods: Prevent exudation of sealant or compound by forming voids or installing filler rods in channel at heel of jambs and head (do not leave voids in sill channels), except as otherwise indicated and depending on light size, thickness and type of glass and complying with manufacturer's recommendations.
   5. Force sealants into channel to eliminate voids and to ensure complete "wetting" or bond of sealant to glass and channel surfaces.
   6. Tool exposed surfaces of glazing liquids and compounds to provide a substantial "wash" away from glass.
   7. Clean and trim excess glazing materials from glass and stops or frames promptly after installation, and eliminate stains and discolorations.
   8. Factory glazing may deviate from these specifications as necessary to accommodate manufacturer's standard glazing procedures which will result in a watertight, rattle free installation.

3.03 CLEANING

A. Wash and polish glass on both faces not more than 4 days prior to date scheduled for inspections intended to establish date of Substantial Completion of project. Comply with glass product manufacturer's recommendations for final cleaning.

B. Remove and recycle excess material.
   1. Separate float glass and place in designated areas for reuse or recycling (cannot be recycled with beverage-container glass).
   2. Separate plastic materials and place in designated areas for reuse or recycling.
   3. Separate corrugated cardboard and place in designated areas for recycling.

3.04 PROTECTION

A. Protect exterior glass from breakage. Do not apply markers to surfaces of glass. Remove non-permanent labels and clean surfaces. Cure sealant for high early strength and durability.

B. Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during construction period, including natural causes, accidents and vandalism.

END OF SECTION

SECTION 08.830 UNFRAMED MIRRORS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Unframed mirrors in the Restrooms as shown on drawings.

PART 2 PRODUCTS

2.01 MATERIALS

A. Mirrors: 1/4" thick mirror glazing polished plate glass with backs silvered. Size as indicated on the drawings. New mirrors shall be guaranteed against silver spoilage for a period of five (5) years.

B. Adhesive: Adhesive shall provide a strong bond between glass mirrors and substrate. Adhesive must be compatible with silver mirror backing paint; and must not cause silver deterioration. Strength of adhesive shall reach 300psi when fully cured.

PART 3 EXECUTION

3.01 INSPECTION

A. Assure that units are centered over lavatories. All dimensions shall be field verified prior to fabrication. Refer to Drawings.

B. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Apply one 2" to 2-1/2" diameter daub of adhesive, about 1" thick, per square foot of mirror. Daub should be large enough to compress to a 3-1/2" to 4" diameter size when mirror is set in place.

B. Mount mirrors plumb and securely to walls; no exposed fasteners.

C. Bottom of edge of reflecting surface shall be mounted no higher than 40" above finished floor, as indicated on the drawings.

3.03 CLEANING

A. Final cleaning of all mirrors shall be performed by the General Contractor. Remove all stickers and decals.

END OF SECTION

SECTION 09.250 GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Mold and Mildew Resistant Gypsum Board
   2. Tile backer board
   3. Wallboard finishing (joint tape-and-compound treatment)
   4. Gypsum wallboard accessories including reveals
   5. Levels of Gypsum Board Finish

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05.410 - Metal Stud Systems
B. Section 06.100 - Rough Carpentry
C. Section 07.950 – Sealants and Caulking
D. Section 09.300 - Tile
E. Section 09.990 - Painting

1.03 SUBMITTALS

A. Product Data
   1. Submit manufacturer’s product specifications and installation instructions for each gypsum board component, including other data as may be required to show compliance with these specifications.
   2. Product Data: Provide Safety Data Sheets for fire resistant (Type X) gypsum board.
B. Samples: 12-inch-long sample of reveals, in finish specified.

1.04 QUALITY ASSURANCE

A. Manufacturer: Obtain gypsum board products from a single manufacturer.
   1. Provide products manufactured in North America only.
B. Gypsum Board:
   1. “GA-216, Application and Finishing of Gypsum Panel Products” by Gypsum Association
   2. “GA-214, Recommended Levels of Gypsum Board Finish” by Gypsum Association.
C. Allowable Tolerances: 1/8" in 8'-0" variation in finish surface

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store gypsum in accordance with GA-238 and manufacturer recommendations.
B. Deliver materials in original packaged, containers or bundles bearing brand name and identification of manufacturer or supplier

C. Store materials inside under cover and in a manner to keep them dry, protected from weather, direct sunlight, surface contamination, corrosion and damage from construction traffic and other causes. Neatly stack gypsum boards flat to prevent sagging.
D. Handle gypsum boards to prevent damage to edges, ends or surfaces. Protect metal corner beads and trim from being bent or damaged.

1.06 PROJECT CONDITIONS

A. Cold Weather Protection: When ambient outdoor temperatures are below 55° F., maintain continuous, uniform, comfortable building working temperatures of not less than 55° F. for a minimum period of 48 hours prior to, during and following application of gypsum board and joint reinforcement materials or bonding of adhesives.
B. Ventilation: Ventilate building spaces as required to remove water in excess of that required for drying of joint treatment material immediately after its application. Avoid drafts during dry, hot weather to prevent too rapid drying.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Gypsum Board:
   1. Georgia-Pacific
   2. US Gypsum Company (USG)
   3. CertainTeed Gypsum
   4. Temple-Inland Corporation

2.02 MATERIALS

A. Mold and Mildew Resistant Gypsum Board: ASTM C 1396, of thickness indicated below to resist mold and mildew; in maximum lengths available to minimize end-to end butt joints. Board shall score minimum 10 when tested per ASTM D 3273.
   1. Type X, 5/8-inch-thick, for fire-resistant rated assemblies and where indicated.
   2. Provide at ALL interior areas unless noted otherwise.
B. Tile Backer Board (provide at all locations where wall tile occurs and other areas indicated). Board shall score minimum 10 when tested per ASTM D 3273.
   1. 5/8” DensShield Tile Backer Board as manufactured by Georgia Pacific Corporation.
   2. 5/8” Fiberock Aqua-Tough as manufactured by USG Corporation.
   3. 5/8” Diamondback GlasRoc Tile Backer as manufactured by CertainTeed Corporation
   4. 5/8” GreenGlass Tile Backer as manufactured by Temple Inland.

2.03 ACCESSORIES

A. General: Except as otherwise specifically indicated, provide trim and accessories by manufacturer of gypsum board materials, made of galvanized steel (required at exterior) or zinc alloy and configured for concealment in mold resistant joint compound.
   1. Include corner beads, edge trim, control joints and other units necessary for project conditions. Provide accessories as required in order to achieve details indicated, whether or not specific accessories are shown on the drawings.
   2. Comply with ASTM C1047-10a Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base, current version.

B. Reveals
   1. Material: extruded aluminum, color to be selected by Architect.
   2. Provide “J-molding -JDM-625” as manufactured by Fry Reglet Corporation or “200-A” as manufactured by USG where gypsum board terminates on surface and other locations indicated on Drawings.
   3. Provide “Reveal Molding” as manufactured by Fry Reglet Corporation in sizes and locations indicated on Drawings.
   4. Provide “860-5/8” as manufactured by Gordon, Inc. where wall metal reveal base is called for on drawings.
   5. Provide “Light Cove 1066T” 6-inch x 8-7/8-inch extruded aluminum cove as manufactured by Gordon, Inc. located at light coves in restroom areas above the vanities and the toilets. Finish to be coating suitable for priming and painting to match adjacent surfaces.
   6. Provide “660-90”, 6”, 90 degree inside corner as manufactured by Gordon, Inc. located above light coves in restroom areas. Finish and paint to match adjacent surfaces.
   7. Provide other reveals where indicated on Drawings.

C. Joint Treatment Materials
   1. General: Comply with ASTM C475 Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board, current version.
   2. Glass-Fiber Mesh Tape: Self-adhering glass-fiber tape, alkali resistant, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch. Mold resistance rating score of 10 when tested in accordance with ASTM D 3273.
      a. For use at all boards (mold and mildew interior, tile backer, and glass-mat sheathing)
      b. Certainteed “FibaTape Mold-X10” is an acceptable alternative (1-7/8” wide).
   3. Exterior sealant: Silicone Emulsion Sealant meeting ASTM C 920, Type S, Grade NS, compatible with glass fiber mesh tape and for covering exposed fasteners.

4. Setting Type Joint Compound: Factory prepackaged, job mixed chemical-hardening powder products for bedding and filling.
    a. Provide equal to USG “Sheetrock Brand Easy Sand Lightweight Setting-Type Joint Compound”.
    b. Use for all areas requiring setting or topping compound (i.e.: taping, filling, and treating fasteners).

D. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
    1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Fasteners: Steel drill screws, in lengths recommended by sheathing manufacturer for thickness of sheathing board to be attached, with organic-polymer or other corrosion-protective coating.
    1. For steel framing less than 0.0329-inch-thick, attach sheathing with steel drill screws complying with ASTM C1002, Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
    2. For steel framing from 0.033 to 0.112 inch thick, attach sheathing with drill screws complying with “ASTM C954 Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. to 0.112 in. in Thickness”.
    3. Provide Type S or Type S-12 screws only.

PART 3 EXECUTION

3.01 PREPARATION

A. Do not deliver or install gypsum board until building is fully enclosed, wet work is complete.

B. Prior to finishing, HVAC system shall be operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

3.02 EXAMINATION

A. Examine substrates to which gypsum board construction attaches or abuts, installed hollow metal frames, cast-in anchors and structural framing with Installer present for compliance with requirements for installation tolerances and other conditions affecting performance of gypsum board assemblies specified in this Section.
    1. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.03 INSTALLATION

A. General
   1. Install and finish in accordance with “GA-216, Application and Finishing of Gypsum Panel Products”, with manufacturer's printed directions and recommendations, and to comply with applicable fire tests where fire rated construction is required.
   2. Install boards with correct side out (typically logo side out). Use maximum lengths possible to minimize number of joints.
   3. Apply fasteners so screw heads bear tightly against face of boards but do not cut into facing (no countersinking).
   4. Horizontal Installation: Install sheathing with long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of stud flanges, and stagger end joints of adjacent boards not less than one stud spacing. Screw-attach boards at perimeter and within field of board to each steel stud.
   5. Caulk/seal cut edges and penetrations around pipes, fixtures, etc., and where sheathing butts against dissimilar materials with applicable sealant.
   6. Do not install imperfect, damaged or damp boards.
   7. Finishing, General: Apply joint treatment at gypsum board joints (both directions); flanges of corner bead, edge trim and control joints; penetrations; fastener heads, surface defects and elsewhere as required to prepare work for decoration.

B. Mold and Mildew Resistant Gypsum Board (includes impact resistant):
   1. Cut boards at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.
      a. Install boards with a minimum 1/4-inch setback at wall-to-floor intersections.
      b. Allow no joints greater than 1/8 inch.
   2. Fastener Spacing
      a. Space fasteners approximately 8 inches o.c. along supported edges and 12 inches o.c. along intermediate supports (or tighter spacing if recommended by manufacturer for specific application) and set back a minimum of 3/8 inch from edges and ends of boards.
   3. Joints and corners shall be treated with 2” fiberglass tape embedded in a skim coat of setting material as specified herein.
      a. Skim coat all fasteners with setting material.

C. Tile Backer Board
   1. Comply with Division 9 Section “Tiling” and TCA Handbook for Ceramic Tile Installation.
   2. Cut boards at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.
      a. Install boards with a 1/4-inch setback where they abut shower receptors to prevent wicking.
      b. Allow no joints greater than 1/8 inch.

3. Do not install an additional vapor barrier in conjunction with tile backer boards.
4. Horizontal Installation: Install sheathing with long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of stud flanges, and stagger end joints of adjacent boards not less than one stud spacing. Screw-attach boards at perimeter and within field of board to each steel stud.
5. Fastener Spacing
    a. Space fasteners approximately 6 inches o.c. (or tighter spacing if recommended by manufacturer for specific application) and set back a minimum of 3/8 inch from edges and ends of boards.
6. Joints and corners shall be treated with 2" fiberglass tape embedded in a skim coat of the tile setting material as specified in Division 9 Section "Tiling".
    a. Skim coat all fasteners with tile setting material.
7. Where tile backer board is indicated to be painted, finish per "Mold and Mildew Resistant Gypsum Board" as specified herein.

F. Accessories
1. Trim
    a. Use same fasteners to anchor trim accessory flanges as required to fasten gypsum board to supports, unless otherwise recommended by trim manufacturer.
    b. Install metal corner beads at external corners and "reveals" in locations as indicated on the Drawings or as specified herein.
        (1) Install metal casing bead trim whenever edge of gypsum board would otherwise be exposed or semi-exposed, unless a "reveal" product is called for on Drawings.
2. Control Joints
    a. Install control joints at locations indicated, or if not indicated, at spacings and locations required by "GA-216, Application and Finishing of Gypsum Panel Products", and as specified herein. Locations shall be approved by Architect prior to installation for visual effect.
        (1) Install control joints at junction of gypsum board partitions with walls or partitions of other finish material.
        (2) A control joint shall be installed where a partition, wall, or ceiling traverses a construction joint (expansion, seismic, or building control element) in the base building structure.
        (3) Control joints shall be installed where a wall or partition runs in an uninterrupted straight plane exceeding 30 linear feet.
        (4) Control joints in interior ceilings shall be installed so that linear dimensions between control joints do not exceed 30 linear feet.

(5) Where gypsum board is vertically continuous, as at stairwells, provide horizontal control joints at each floor level.
(6) A control joint or intermediate blocking shall be installed where ceiling framing members change direction.
(7) Where a control joint occurs in an acoustical or fire-rated system, blocking shall be provided behind the control joint by using a backing material of 5/8 in. type X Mold and Mildew resistant gypsum board as specified herein, mineral fiber, or other tested equivalent.

3.04 LEVELS OF GYPSUM BOARD FINISH

A. Levels of Finish: Provide in accordance with Gypsum Association “GA 214, Recommended Levels of Gypsum Board Finish”.
   1. Level 1: Ceiling plenum areas, exterior, and concealed areas, except provide higher level of finish as required to comply with fire resistance ratings and acoustical ratings.
      a. All joints and interior angles shall have tape set in joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable.
   2. Level 2: all Tile Backer gypsum surfaces to receive tile.
      a. All joints and interior angles shall have tape embedded in joint compound and wiped with a joint knife leaving a thin coating of joint compound over all joints and interior angles. Fastener heads and accessories shall be covered with a coat of joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable. Joint compound applied over the body of the tape at the time of tape embedment shall be considered a separate coat of joint compound and shall satisfy the conditions of this level.
   3. Level 3: Gypsum board substrate at areas of textured finishes and heavy-duty wall coverings.
      a. All joints and interior angles shall have tape embedded in joint compound and one additional coat of joint compound applied over all joints and interior angles. Fastener heads and accessories shall be covered with two separate coats of joint compound. All joint compound shall be smooth and free of tool marks and ridges.
   4. Level 4: provide in service areas (janitor, mechanical, electrical, etc.)
      a. All joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over all flat joints and one separate coat of joint compound applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound.

All joint compound shall be smooth and free of tool marks and ridges.

5. Level 5: all Gypsum board surfaces, except where another finish level is indicated.
    a. All joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over all flat joints and one separate coat of joint compound applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. A thin skim coat of joint compound shall be applied to the entire surface. The surface shall be smooth and free of tool marks and ridges.

3.05 PARTITION IDENTIFICATION

A. Place identification on all partitions indicated on Drawings as having a required fire or smoke rating.
B. Identification shall be as follows:
    1. Location: 10 feet on center, both sides of partitions, above ceiling lines.
        a. Place above access panels in hard ceilings.
    2. Style of Lettering: 2 inches high, helvetica style, painted with aid of stencils.
    3. Color: Red.

3.06 FIELD QUALITY CONTROL

A. Tolerances
    1. Do not exceed 1/8 inch in 8'-0" variation from plumb or level in exposed lines of surface, except at joints between gypsum board units.
    2. Do not exceed 1/16-inch variation between planes of abutting edges or ends.
    3. Shim as required to comply with specified tolerances.

3.07 CLEANING

A. Remove and recycle all excess material.
    1. Separate clean waste gypsum products from contaminants for recycling. Do not include wood, plastic, metal, asphalt-impregnated gypsum board, or any gypsum board coated with glass fiber, vinyl, decorative paper, paint, or other finish. Place in designated area and protect from moisture and contamination.
    2. Separate metal waste and place in designated areas for recycling or reuse.

3.08 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
B. Remove and replace panels that are wet, moisture damaged, and mold damaged.
    1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
    2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

SECTION 09.300 TILE

PART 1 GENERAL

1.01 RELATED DOCUMENTS: Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this and all sections.

1.02 DESCRIPTION OF WORK: Definitions - Tile includes ceramic surfacing units made from clay or other ceramic materials. The types of work of this section include:

A. Ceramic Floor Tile and Trim.
B. Ceramic Wall Tile and Trim.
C. Grout for floor and wall tile
D. Expansion joint sealant is specified in Division 7.

1.03 QUALITY ASSURANCE

A. Manufacturer: Provide products of American Olean, or equal porcelain.
B. Tile Manufacturing Standard: ANSI A137.1. Furnish tile complying with standard grade requirements unless indicated otherwise.
C. Provide materials obtained from one source for each type and color of tile, grout, and setting materials.

1.04 SUBMITTALS

A. Samples - Submit manufacturer's color charts consisting of actual tiles or sections of tiles showing full range of colors available for each type of tile specified.
B. Grout manufacturer's color chart and instructions for use of grout.

1.05 PRODUCT HANDLING: Deliver packaged materials and store in original containers with seals unbroken and labels intact until time of use, in accordance with manufacturer's instruction.

1.06 JOB CONDITIONS: Maintain environmental conditions and protect work during and after installation in accordance with referenced standards and manufacturer's printed recommendations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Atlas Concorde USA
B. Equal as approved

2.02 TILE MATERIALS

A. General
   1. Colors, patterns, and locations of all tile types are as indicated on the Drawings.
B. Floor Tile
   1. CFT
      a. Manufacturer: Atlas Concorde USA
      b. Series: Exist
      c. Color: Root
      d. Size: 12”x24”
      e. Installation Pattern: Install in stacked bond pattern, centered on wall.
C. Wall Tile
   1. CWT
      a. Manufacturer: Atlas Concorde USA
      b. Series: Exist
      c. Color: Pure
      d. Size: 12”x24”
      e. Installation Pattern: Install in stacked bond pattern, centered on wall.

2.03 SETTING MATERIALS

A. Portland Cement Mortar - ANSI A108.1.
B. Dry Set Mortar - ANSI A118.1.
C. Latex-Portland Cement Mortar - ANSI A118.4.
D. Organic Adhesive - ANSI A136.1

2.04 GROUT

A. Basis of Design is Permacolor by Laticrete. Provided all other project requirements are met, products by the following manufacturer’s shall be considered equal:
   1. Mapei
   2. As approved by the Architect
B. Ceramic Tile: Commercial Portland Cement Grout or Dry-Set Grout for floors and masonry walls. Premixed colors as selected by Architect.
C. Ceramic Tile: Commercial Latex Portland Cement for ceramic tile over backer board and metal studs. ANSI A118.6.
D. Colors
   a. Grout for CFT – #57 Hot Cocoa
   b. Grout for CWT- #17 Marble Beige

2.05 EXPANSION JOINTS

A. Tile Council of America installation method EJ711.
B. Back-up strip: flexible and compressible type of closed cell foam polyethylene or butyl rubber, rounded at surface to contact sealant, and as recommended by the sealant manufacturer.

C. Sealant: Two component sealant shall comply with Fed. Spec. TT-S-00227e; use Type II (non-sag) for joints in vertical surfaces and Type I (self-leveling) for joints in horizontal surfaces. Trafficked areas of floors - Shore A hardness greater than 35.

2.06 REDUCER STRIP: Equal to Schluter-Reno AU125. Provide at all locations where porcelain pavers abut vinyl composition tile.

PART 3 EXECUTION

3.01 TILE INSTALLATION STANDARDS

A. ANSI Standards - Comply with applicable requirements of the following, except as otherwise indicated:
   1. ANSI A108.1. Tiles installed with Portland Cement mortar; for floor and wall (except base without wall tile) tile work.
   2. ANSI A108.4. Tiles installed with Organic Adhesive for wall tiles installed over gypsum board and metal studs.
   3. ANSI A108.5. Tiles installed with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar; for ceramic tile base without wall tile.

B. Tile Council of America, Inc.
   1. Handbook No. W242 for metal stud walls.
   2. Handbook No. F113 for ceramic tile floors.

3.02 INSTALLATION

A. Tilework
   1. Extend tile work into recesses and under or behind equipment and fixtures, to form a complete covering without interruptions, except as otherwise shown. Terminate work neatly at obstructions, edges and corners without disrupting pattern or joint alignments.
   2. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures and other penetrations, so that plates, collars or covers overlap tile.
   3. Placement Methods
      a. Install tile on floors using Dry-Set or Latex- Portland Cement.
      b. Install tile on metal stud walls with tile back board using organic adhesive.
   4. Jointing Pattern: Unless otherwise shown, lay tile in grid pattern. Layout tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths.
   5. Grout
      a. For ceramic tile not otherwise specified, use a Commercial Portland Cement Grout.

b. Install in accordance with A108.10.

B. Expansion Joints: Provide openings for joints where shown and required below. Make same width as grouted joints.
   1. Install where tile work abuts restraining surfaces such as perimeter walls, curbs, columns, pipes, etc.
   2. Install directly over joints in structural floor including construction joints or cold joints.
   3. Set compressible back-up strip when mortar is placed or utilize removable wood strips to provide space for back-up after mortar has cured.
   4. Install sealant after tile work and grout are dry. Follow sealant manufacturer's recommendations.

C. Grout Sealer: Provide one coat of grout sealer to all grout joints using foam rubber paint brushes. Care shall be taken to avoid excessive drippage and runs onto tile.

3.03 CLEANING AND PROTECTION

A. Cleaning: Upon completion of placement and grouting, clean all tile surfaces so they are free of foreign matter. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's printed instructions, but not sooner than 14 days after installation. Protect metal surfaces, cast iron and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning.

B. Finished Tile Work: Leave finished installation clean and free of non-uniform joints, cracked, chipped, broken, unbonded, or otherwise defective tile work.

C. Protection: When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile. Protect installed tile work with Kraft paper or other heavy covering during construction period to prevent damage and wear. Prohibit foot and wheel traffic from using tiled floors for at least 3 days after grouting is completed. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

END OF SECTION

SECTION 09.510 ACOUSTICAL PANEL CEILINGS

PART 1 GENERAL

1.01 SUMMARY

A. Extent of each type of acoustical ceiling is shown and scheduled on drawings.

B. Types of acoustical ceilings specified in this section include the following:
   1. Acoustical panel ceilings, exposed suspension.

C. Related Sections include the following:
   1. Division 9 Section “Gypsum Board Assemblies” for gypsum board ceilings

1.02 SUBMITTALS

A. Product Data: Manufacturer’s product specifications and installation instructions for materials and suspension system, including certified laboratory test reports and other data as required showing compliance with these specifications.

B. Coordination Drawings: layout of ceilings drawn to scale coordinating acoustical tile ceiling installation and spacing with hanger attachment to building structure and ceiling mounted items. Include locations of all mechanical and electrical items (light fixtures, mechanical items, fire alarm, and sprinkler heads).
   1. Architect will provide a CAD drawing of the reflected ceiling plan for the contractor’s use in preparing. This is to be used as a guide only – it is the responsibility of the Contractor to ensure that all tile is centered in the space and all items are located properly.

C. Samples: Set of samples for acoustical unit, showing full range of exposed color and texture, and set of 12” long samples of suspension system.

1.03 QUALITY ASSURANCE

A. Installer: Firm with not less than three years of successful experience in installation of acoustical ceilings similar to requirements for this project and which is acceptable to manufacturer of acoustical units.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical ceiling units to project site in original unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination or other causes.

B. Before installing acoustical ceiling units, permit them to reach room temperature and stabilized moisture content.

C. Handle acoustical ceiling units carefully to avoid chipping edges or damaging units in any way. Minor damages may be repaired, provide

finish items are equal in all respects to new work and acceptable to Architect; otherwise, remove and replace damaged items as directed.

1.05 PROJECT CONDITIONS

A. Space enclosure -Do not install interior acoustical ceilings until space is enclosed and weather-proof, until wet work in space is completed and nominally dry, until work above ceilings is completed, and until ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.

1.06 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Acoustical Ceiling Units: Full-size tiles equal to 2.0 percent of quantity installed, but not less than 1 box per tile type.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: Products by Armstrong World Industries form the basis of this specification. For convenience, all product names used in this section refer to products by the Basis of Design manufacturer. Provided all other project requirements are met, the following manufacturers shall be considered equal:
   1. USG Corporation
   2. CertainTeed Ceilings
   3. As approved by Architect

2.02 MINERAL FIBER ACOUSTICAL PANELS

A. General: Where units less than 6 inches wide would occur at edges of room with 24 X 24-inch pattern, provide 24 X 48-inch panels cut to extend to wall, eliminating the tee near the wall. Where tegular tiles occur at these locations, modify tile to sit flush with suspension system.
B. Type 1 (ACT-1)
   1. NRC – 0.85; CAC-35
      a. 2'x2'x1" Calla 15/16” Square Tegular (2822) by Armstrong
      b. Approved Equal
C. Type 2 (ACT-2)
   1. NRC - 0.75; CAC-35
      a. 2'x2'x1" Ultima 15/16” Beveled Tegular (1911) by Armstrong
      b. Approved Equal

2.02 CEILING SUSPENSION MATERIALS

A. General: Comply with ASTM C635, as applicable to type of suspension system required for type of ceiling units indicated. Provide UL listed

system for fire rated ceilings. Coordinate with other work supported by or penetrating through ceilings, including light fixtures and HVAC equipment.
1. Structural Class: Intermediate-duty.

B. Attachment Devices: Size for 5 times design load indicated in ASTM C635, Table 1 Direct Hung. Hanger Wires-galvanized carbon steel, ASTM A641, soft temper, prestretched, yield-stress load of at least 3 times design load, but not less than 12 gage (0.106").

C. Edge Molding: provide manufacturer's standard wall angle (7/8" hemmed angle molding) for edges of ceiling of material and finish to match exposed tee flanges in same space.

D. Perimeter Trim
1. Horizontal gypsum board to ACT
   a. Provide equal to Armstrong "Axiom Transitions AXTRTESTR"
2. Vertical gypsum board to ACT
   a. Provide equal to Armstrong "Axiom Classic AX2STR"

E. Provide "retention clips" at all areas (equal to Armstrong 414).

F. Exposed Suspension System: Manufacturer's standard exposed tees, cross tees and accessories of types indicated, with exposed cross tees coped to lay flush with main runners. Hot dipped galvanized steel on all surfaces of ceiling suspension system, including mouldings, trim and accessories. Fire rated suspension system with fire rated ceiling units.

G. Suspension System
1. ACT-1
   a. Prelude XL 15/16 by Armstrong.
   b. Manufacturer's recommended equal system to coordinate with approved equal acoustical tile
1. ACT-2
   a. Prelude XL 15/16 by Armstrong.
   b. Manufacturer's recommended equal system to coordinate with approved equal acoustical tile

PART 3 EXECUTION

3.01 EXAMINATION

A. Installer must examine conditions under which acoustical ceiling work is to be performed and must notify Contractor in writing of unsatisfactory conditions. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.02 PREPARATION

A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling – in accordance with approved coordination layout drawing.

3.03 INSTALLATION

A. General: Install materials in accordance with manufacturer's printed instructions and to comply with governing regulations, fire resistance rating requirements as indicated, and industry standard applicable to work.

B. Install suspension system to comply with ASTM C636, with hangers supported only from building structural members or from carrying channels supported by structural members. Locate hangers near each end and spaced maximum 4' -0" along each main tee and as required by UL assembly unless otherwise indicated, leveling to tolerance of 1/8" in 12' -0". Provide extra hangers and carrying channels as required to support weight at lighting fixtures and duct outlets.

C. Install edge mouldings of type indicated at perimeter of acoustical ceiling area and at locations where necessary to conceal edges of acoustical units. Attach mouldings to substrate at intervals not over 16" o.c. and not more than 3" from ends, leveling with ceiling suspension system to tolerance of 1/8" in 12' -0". Miter corners accurately and connect securely.

D. Install acoustical panels in coordination with suspension members. Scribe and cut panels to fit accurately at borders and at penetrations.

3.04 CLEANING

A. Clean exposed surfaces of acoustical ceilings, including trim, edge mouldings and suspension members; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

SECTION 09.680 CARPETING

PART 1 GENERAL

1.01 SUMMARY

A. The extent of carpeting is indicated on the Drawings and the Specifications, and is defined to include carpet and accessories.
   1. Modular and broadloom carpet – direct glue-down installation.
   2. Resilient base
B. Related Sections include the following:
   1. Division 9 Section “Tile”

1.02 SUBMITTALS

A. Written warranty as specified above.
B. Manufacturer's descriptive data.
C. Flame Spread Test Reports or Radiant Panel Test to verify the meeting of the various requirements specified herein.
D. Samples, Carpeting - Submit 24 inch x 24 inch samples of each carpet required, and 6" lengths of exposed edge stripping.
E. Product Data: Provide Safety Data Sheets as specified in Division 1 for carpet adhesives.
F. Manufacturer's certificate stating that carpet furnished, identified by register numbers was manufactured according to these specifications.
G. Shop drawings showing layout of carpet, seam location, accessory type and location.

1.03 QUALITY ASSURANCE

A. Installer: Firm with not less than 5 years of carpeting experience, similar to work of this section.
B. Manufacturer: Major Firm (carpet mill) which has not less than 5 years of production experience with carpet similar to types specified in this section; and whose published product literature clearly indicates compliance of products with requirements of this section.
C. General Standard: "Carpet Specifier's Handbook" by the Carpet and Rug Institute; comply with recommendations which can be reasonably applied to types of carpeting work required.
D. Flammability: Flooring Radiant Panel ASTM E 648 (Glue Down) – NFPA Class I and DOC-FF-1-70.
E. Flame Spread Rating: Carpeting shall have flame spread rating of 75 or less in accordance with ASTM Spec. E84-68, Standard Method of Test for Surface Burning Characteristics of Building Materials or pass the National Bureau of Standards Radiant Panel Test.
F. Carpet Identification: Provide hang tag, or other suitable method, to identify carpet delivered as to manufacturer (or supplier), and style.
G. Maintenance Materials: Deliver usable scraps of carpet to Owner's designated storage space, properly packaged (paper wrapped) and

identified. Usable scraps are defined to include roll ends of less than 9'-0" length, and pieces of more than 3 sq. ft. area. Dispose of smaller pieces.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver carpeting material in protective wrapping, and store inside, protected from weather, moisture and soiling.

1.05 WARRANTY

A. CF-1, 2, and 4 (modular tile)
   1. Manufacturer's standard 15 year limited warranty against excessive surface wear, static, delamination, edge ravel, zippering and backing resiliency loss.
B. CF-3 (Broadloom)
   1. Manufacturer's standard Limited Lifetime Warranty against excessive surface wear, edge ravel, zippering, resiliency loss of backing, and delamination of the secondary backing from the primary backing containing the face fiber.

1.06 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. Carpet: Equal to 2.0 percent of quantity installed for each carpet type: CF-1, CF-2, CF-3, and CF-4.
   2. Resilient Base: Equal to 2.0 percent of quantity installed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Carpet - General
   1. Pattern: As indicated on the Drawings.
   2. Basis of Design: Products by Tandus Centiva form the basis of this specification. Provided all other project requirements are met, the following manufacturers are considered equal:
      a. Interface, Inc.
      b. Shaw Floors
B. CF-1
   1. Input 11083 (Golden Master 11604)-Modular Tile, as manufactured by Tandus Centiva.
      a. Product Size: 18" x 36" Tile
      b. Total Product Recycled Content:
         1) Production Waste: 23.0%
         2) Post-Consumer: 34%
      c. CRI Green Label Plus Certification

2. Face Construction
    a. Construction type: Tufted Patterned Symtex
    b. Gauge: 1/10
    c. Stitches per inch: 10/inch
    d. Pile Height (Average): 0.255 inch
    e. Dye Method: Solution dyed
3. Backing
    a. Primary Backing: Synthetic Non-woven
    b. Secondary Backing: ethos Modular with Omnicoat Technology

C. CF-2
1. Input 11083 (Ryolite 11611) Modular Tile, as manufactured by Tandus Centiva.
    a. Product Size: 18" x 36" Tile
    b. Total Product Recycled Content:
        1) Production Waste: 23.0%
        2) Post-Consumer:34%
    c. CRI Green Label Plus Certification
2. Face Construction
    a. Construction type: Sratatec Patterned Symtex
    b. Gauge: 5/64”
    c. Stitches per inch: 9.60/inch
    d. Pile Height (Average): 0.185 inch
    e. Dye Method: Solution dyed
3. Backing
    a. Primary Backing: Synthetic Non-Woven
    b. Secondary Backing: ethos Modular with Omnicoat Technology

B. CF-3
1. Input 11611 (Rhyolite 11611), Broadloom, with Lifelong Backing, as manufactured by Tandus Centiva.
    a. Product size: Roll
    b. Total Product Recycled Content
        1) Total: 9.0%
        2) Pre-Consumer: 0.0%
        3) Post Consumer: 9.0%
    c. CRI Green Label Plus Certification
2. Face Construction
    a. Construction type: Stratatec Patterned Symtex
    b. Fiber: Dynex SD Nylon
    c. Gauge: 5/64
    d. Stitches per inch: 9.6/in
    e. Pile Height (Average): 0.185”
    f. Dye Method: 100% Solution Dyed
3. Backing
    a. Primary Backing: Synthetic Non-Woven
    b. Secondary Backing: Powerbond Cushion

C. CF-4
   1. Tephra G0010 (Rhyolite 66405)-Modular Tile, as manufactured by Tandus Centiva.
      a. Product Size: 18" x 36" Tile
      b. Total Product Recycled Content:
         1) Production Waste: 22.0%
         2) Post-Consumer: 32%
      c. CRI Green Label Plus Certification
   2. Face Construction
      a. Construction type: Tufted Patterned Symtex
      b. Gauge: 1/10
      c. Stitches per inch: 8/inch
      d. Pile Height (Average): 0.235 inch
      e. Dye Method: Solution dyed
   3. Backing
      a. Primary Backing: Synthetic Non-woven
      b. Secondary Backing: ethos Modular with Omnicoat Technology
D. RESILIENT BASE
   1. Basis of Design: Products by Tarkett form the basis of this specification. Provided all other project requirements are met, the following manufacturers are considered equal:
      a. Roppe
      b. FlexCo
   2. Series: Millwork Wall Base System,
      Profile: Inflection 5.25”
      Color: 47 Brown

2.02 ACCESSORIES

A. General: Provide accessories as indicated on Drawings and specified herein.
B. Carpet Edge Guard
   1. Extruded or molded vinyl or rubber of same manufacturer of rubber base of approved size and profile; colors selected by Architect from among standard colors of approved rubber base.
C. Installation Adhesive: Water-resistant type as recommended by carpet manufacturer, and which complies with flammability requirements for installed carpet and which contains no asbestos, and complies with full warranty.
   1. VOC Limits: Provide adhesives with CRI Green Label certified and with VOC content not more than 50g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).
D. Seaming Carpet: Seaming adhesive recommended by carpet manufacturer and which contains no asbestos.
   1. Maximum VOC levels: 50 grams/liter. Do not use seam sealants containing 1,1,1-trichloroethane or toluene.

E. Miscellaneous Materials: As recommended by manufacturers of carpet, and other carpeting products; and selected by installer to meet project circumstance and requirements.
F. Step and Riser Nosing: Equal to Johnsonite; Solid Color Flexible Vinyl Stair Nosing; VCD-XX (1/4" or 5/16" material on step and riser).

PART 3 EXECUTION

3.01 INSTALLERS

A. Installer must examine substrates for moisture content and other conditions under which carpeting is to be installed, and notify Owner and Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed until unsatisfactory conditions have been corrected.
B. Clear away debris and remove any cementitious deposits, and other foreign matter which could interfere with adhesive bond, from surfaces to receive carpeting; vacuum clean immediately before installation.
C. Perform bond and moisture tests on concrete sub-floors to determine if surfaces are sufficiently cured and dry as well as to ascertain presence of curing compounds. Moisture that results must be submitted in writing to the Architect prior to start of installation.
D. Sequence carpeting with other work so as to minimize possibility of damage and soiling of carpet during remainder of construction period.

3.02 PREPARATION

A. Pre-ventilate carpet. Unroll and air out carpet in a well-ventilated, uninhabited space for a minimum of 5 hours prior to installation.
B. Provide maximum ventilation during installation.
C. Isolate area of installation from rest of building.

3.03 INSTALLATION

A. General
    1. Comply with manufacturer's instructions and recommendations for seam locations and direction of carpet; maintain uniformity of direction and lay of pile. At doors, center seams under doors; do not place seams in traffic direction at doorways.
    2. Extend carpet under open-bottomed obstructions and under removable flanges and furnishings, and into adjoining alcoves and closets of each space.
    3. Provide cut-outs where required, and bind cut edges properly where not protected by edge guards or overlapping flanges.
    4. Install carpet metal trim where edge of carpet is exposed; anchor guards to substrate.
    5. At steps and tiers in Tiered Classrooms and Auditorium apply carpet tile to face of the risers and resilient carpet stair nosing continuous.

B. Glue-down Installation
   1. Fit sections of carpet into each space prior to application of adhesive. Trim edges and butter cuts with seaming cement.
   2. Apply adhesive uniformly to substrate in accordance with manufacturer's instructions. Butt carpet edges tightly together to form cemented seams without gaps. Roll lightly to eliminate air pockets and ensure uniform bond. Remove adhesive promptly from face of carpet.

3.04 CLEANING

A. Remove debris, sorting pieces to be saved from scraps to discard.
B. Clean new carpet thoroughly with a high-efficiency particulate air (HEPA) filtration vacuum.
C. Remove spots and replace carpet where spots cannot be removed.

3.05 PROTECTION

A. Contractor to use protection methods and materials needed to ensure that carpeting will be without deterioration or damage at time of substantial completion.

END OF SECTION

SECTION 09.990 PAINTING

PART 1 GENERAL

1.01 EXTENT

A. This work includes all painting and related items required and necessary to complete project indicated by drawings, including all general construction, mechanical, electrical, heating, ventilating, and air conditioning work exposed to view.
B. See schedule for number of coats and types of paint required for surfaces.
C. This Contractor must inspect all surfaces for imperfection and correct before painting begins.

1.02 QUALITY ASSURANCE

A. All paint shall be delivered to site in manufacturer's sealed containers. Each container shall be labeled by the manufacturer. Labels give manufacturer's name, brand, type of paint, color of paint and instructions for reducing. Thinning shall be done only in accordance with directions of manufacturer. Job mixing or job tinting may be done only when approved by the Architect.
B. Fungus control shall be such that organic coatings shall show no fungus growth when tested as specified in Federal Test Method Standard No. 141, Method 6271.1.

1.03 COLORS AND SAMPLES

A. Paint colors shall be as selected by the Architect. Before any work is done the Architect shall furnish the Contractor with color schedule showing where the various colors apply. The Contractor shall then prepare samples as required until the colors and textures are approved.

PART 2 PRODUCTS

2.01 PAINT MATERIALS

A. Paint materials shall be first line products as manufactured by Benjamin Moore Paint Co., Devoe, Glidden, Fuller O'Brien, Pratt & Lambert, Pittsburgh, Sherwin Williams or approved equal. Sherwin-Williams trade name is used hereinafter for convenience only.
B. Materials such as linseed oil, shellac, turpentine, and mineral spirits shall be of highest quality, have identifying labels, and shall be used as recommended by paint manufacturer.
C. Coating Maintenance Manual
    1. Upon conclusion of the project, the Contractor or paint manufacturer / supplier shall furnish a coating maintenance manual, such as Sherwin-Williams "Custodian Project Color and Product Information" report or equal. Manual shall include an Area

Summary with finish schedule, Area Detail designating where each product / color / finish was used, product Data pages, Material Safety Data Sheet (MSDS), care and cleaning instructions, Touch-up procedures.

2.02 SCHEDULE OF PAINTING

A. The kinds and number of coats required on the various surfaces shall be equal to the following:
   1. Interior Gypsum Board (walls and ceilings)
      a. First Coat: ProMar 200 Zero VOC Interior Latex Primer, B28-2600
      b. Second Coat: Cashmere Interior Acrylic Medium Lustre, D18W151
      c. Third Coat: Cashmere Interior Acrylic Medium Lustre, D18W151
   2. Interior Ferrous Metal
      a. First Coat: Touch up shop coat or 1 coat of Pro Industrial Pro-Cryl Universal Primer, B66-310
      b. Second Coat: Solo 100% Acrylic Interior / Exterior Gloss, A77W51 Series
      c. Third Coat: Solo 100% Acrylic Interior / Exterior Gloss, A77W51 Series
   3. Interior Metal (Galvanized)
      a. First Coat: Pro Industrial Pro-Cryl Universal Primer, B66-310
      b. Second Coat: Solo 100% Acrylic Interior / Exterior Gloss, A77W51 Series
      c. Third Coat: Solo 100% Acrylic Interior / Exterior Gloss, A77W51 Series
   4. Interior Wood (Painted)
      a. First Coat: ProBlock Interior / Exterior Latex Primer / Sealer, B51W620
      b. Second Coat: Solo 100% Acrylic Interior / Exterior Gloss, A77W51 Series
      c. Third Coat: Solo 100% Acrylic Interior / Exterior Gloss, A77W51 Series
   5. Exposed Piping, Equipment, Etc.
      a. As specified for Interior Ferrous Metal
   6. Exposed Piping, Conduit, Ductwork, Etc. (Galvanized)
      a. As specified for Interior Ferrous Metal Galvanized
   7. Exterior Steel - Canopy frame and site benches
      a. Prep: Minimum surface prep SSPC-SP3 (Power Tool Clean)
      b. Pre-Prime: SW Macropoxy 5000 preprime
      c. First coat: SW Macropoxy 646 Fast Cure Epoxy
      d. Second coat: SW Macropoxy 646 Fast Cure Epoxy
      e. Third Coat: SW Sherloxane 800 Polysiloxane.

8. Exterior Metal – Other Ferrous and Galvanized
    a. Prep: SSPC-SP3 (Power Tool Clean)
    b. First Coat: PI ProCryl
    c. Second Coat: Sher-Cryl HPA High Performance Acrylic Semi-Gloss
    d. Third Coat: Sher-Cryl HPA High Performance Acrylic Semi-Gloss
9. Exterior Stucco Coating
    a. First Coat: StoCoat Lotusan, by Sto Corporation.
    b. Second Coat: StoCoat Lotusan, by Sto Corporation.

PART 3 EXECUTION

3.01 SURFACE INSPECTION

A. Examine surfaces scheduled to receive paint and finishes for conditions that will adversely affect execution, permanence or quality of work and which cannot be put into an acceptable condition through preparatory work as included in Article 3.02, PREPARATION OF SURFACES.
B. Do not proceed with surface preparation or coating application until conditions are suitable.

3.02 PREPARATION OF SURFACES

A. General
    1. The painting contractor shall be wholly responsible for the quality of his work, and is not to commence any part of it until surface is in proper condition as required by the paint manufacturer.
    2. If the painting contractor considers any surface unsuitable for proper finishing, he is to notify the Architect of this fact in writing. He is not to apply any material until corrective measures have been taken, or the Architect has instructed him to proceed.
    3. All surfaces are to be clean; if for any reason the surface cannot be cleaned, this condition shall be promptly reported to the General Contractor and the Architect.
    4. If the painting contractor has been instructed by the General Contractor to begin painting under conditions circumstances he believes could result in poor performance and early failure of the coatings, he shall request the Architect for a decision in writing.
    5. The prime coat should be applied soon after surface preparation has been completed, to prevent contamination of the substrate.
B. Ferrous Metal
    1. Sand surfaces to remove existing gloss.
    2. Surfaces to be painted must be clean, dry, and free of dirt, dust, grease, oil, soap, wax, scaling paint, water soluble materials, and mildew. Remove any peeling or scaling paint and sand these areas to feather edges smooth with adjacent surfaces.
C. Gypsum Board

1. Sand surfaces to remove existing gloss.
2. All surfaces must be free of sanding dust and joint treatment cement should be thoroughly dry.
3. Damaged or defective surfaces are to be repaired by spackling or by other appropriate measures.
4. Steel corner beading is to be coated with primer-sealer before applying water thinned coatings.

D. Wood
1. All surfaces shall be dry and sanded smooth and free of loose dirt, dust or grit.
2. Putty all nail holes, cracks and blemishes after undercoater has been applied. Knots are to be coated with primer/sealer before overall coat of primer is applied.
3. All coats must be thoroughly dry before applying succeeding coats, and lightly sanded between coats.
4. Avoid general use of shellac as an undercoat.
5. Flaking or scaling coatings must be removed by scraping and sanding with fine grit sandpaper. To assure adhesion, glossy surfaces must be dulled with fine grade steel wool or sandpaper.

3.03 APPLICATION

A. General Requirements
1. Do not apply initial coating until moisture content of surface is within limitations recommended by paint manufacturer.
   a. Test with moisture meter.
2. Apply paint, enamel, stain, varnish and epoxy coating with suitable brushes, rollers, or spraying equipment.
   a. Rate of application shall not exceed that as recommended by product manufacturer for the surface involved.
   b. Keep brushes, rollers, spraying equipment clean, dry, free from contaminates and suitable for the finish required.
3. Comply with recommendation of product manufacturer for drying time between succeeding coats.
4. Vary slightly the color of successive coats.
5. Sand and dust between each coat to remove defects visible from a distance of 5 feet.
6. Finish coats shall be smooth, free of brush marks, streaks, laps or pile up of materials, and skipped or missed areas.
   a. Finished metal surfaces shall be free of skips, voids, or pinholes in any coat when tested with a low voltage detector.
7. Inspection
   a. Do not apply additional coats until completed coat has been inspected by the Architect.
   b. Only inspected coats of paint will be considered in determining number of coats applied.

8. Leave all parts of surfaces clean and true to details with no undue amount of paint in corners and depressions.
9. Make edges of paint adjoining other materials or colors clean and sharp with no overlapping.
10. Apply primer on all work before glazing.
11. Change colors at corner of stop under door where colors differ between adjoining spaces or rooms and where door frames match wall colors.
12. Refinish whole wall where portion of finish has been damaged or is not acceptable.

B. Painted Work
   1. Back prime all interior woodwork with sealer or primer.
   2. Runs on face not permitted.

3.04 CLEANING

A. Touch up and restore finish where damaged.
B. Remove spilled, splashed, or splattered paint from all surfaces.
C. Do not mar surface finish of item being cleaned.
D. Leave storage space clean and in condition required for equivalent spaces in project.

END OF SECTION

SECTION 10.162 SOLID PLASTIC TOILET PARTITIONS

PART 1 GENERAL

1.01 EXTENT

A. This work includes toilet partitions and related items necessary to complete project as indicated on the Drawings.

B. Related Sections

1.	Section 09.300	Tile
2.	Section 10.800	Toilet Accessories
3.	Division 15	Plumbing

1.02 SUBMITTALS

A. Shop drawings for all items of this section shall be submitted to Architect for approval prior to fabrication.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manufacturers: Basis of Design is Eclipse Partitions by Scranton Products. Provided all other project requirements are met, products by the following manufacturer's shall be considered equal:
   1. Capital Partitions
   2. Comtec Industries
   3. Santana Products Company

B. Toilet partitions shall be 1" High Density Polymer, floor supported, overhead braced; Eclipse Partitions, by Scranton Products.
   1. Doors and panels shall be 1" thick with solid color throughout. All edges to be shiplaped and all sharp edges removed.
   2. Doors and Dividing Panels: Provide standard privacy
      1) Height: 55 inches high and mounted at 14 inches the finished floor.
      2) Doors: 60-degree angle on two opposite edges for enhanced privacy.
      3) Dividing Panels: Slotted on one edge to accept wall bracket.

C. Metal Posts: 82.75 inches (2102 mm) high, heavy duty extruded aluminum, clear anodized finish, fastened to foot with stainless steel tamper resistant screw.

D. Hidden Shoe (Foot): One-piece molded polyethylene invisible shoe inserted into metal post and secured to metal post with stainless steel tamper resistant screw.

E. Headrail Cap and Corner Cap: One-piece molded polyethylene secured to metal post with stainless steel tamper resistant screw; adjustable to level headrail to finished floor.

F. Hidden Wall Brackets: Continuous heavy-duty extruded aluminum, clear anodized finish, inserted into slotted panel and fastened to panels

with stainless steel tamper resistant screws.
1. Type: Double ear bracket aluminum.
2. Length: 54 inches

G. Headrail: Heavy duty extruded aluminum, designer anti-grip design, clear anodized finish, fastened to headrail bracket with stainless steel tamper resistant screw and to headrail cap or corner cap with stainless steel tamper resistant screw.
   1. Headrail Brackets: Heavy duty extruded aluminum, clear anodized finish, secured to wall with stainless steel tamper screws.

H. Door Hardware
   1. Hinges
      a. Edge-mounted stainless-steel continuous hinge.
   2. Door Keeper
      a. Fabricated from heavy duty extruded aluminum, clear anodized finish.
      b. Length: 3-1/2 inches (89 mm).
      c. Mount in gap between dividing panel and door.
   3. Latch and Housing
      a. Fabricated from heavy duty extruded aluminum.
      b. Latch housing: Clear anodized finish.
      c. Slide bolt and button: Black anodized finish.
      d. Provide occupancy indicator.
   4. Door Pulls
      a. Fabricated from heavy duty extruded aluminum, clear anodized finish.
      b. Single component providing door pull capability on outswing doors.
   5. Door Stop: Wall stop, as required
   6. Push Plates: Fabricated from heavy duty extruded aluminum, clear anodized finish.

I. Color: Concrete

J. Texture: Orange Peel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's written instructions.

B. Erect rigid, straight, plumb and level, fastened with toggle bolts and expansion bolts securely to floors and walls, in accordance with approved shop drawings.

C. Finish surfaces shall be left cleaned and free from imperfections and hardware properly adjusted.

3.02 WARRANTY

A. Partition material shall be guaranteed against breakage, corrosion, and delamination for a period of fifteen years.

END OF SECTION

SECTION 10.420 PLAQUE

PART 1 GENERAL

1.01 WORK INCLUDED

A. Provide and install project identification plaque.

1.02 SHOP DRAWINGS

A. Provide shop drawings for Architect's and Owner's approval.
B. Provide finish samples for Architect's and Owner's approval.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. A.R.K. Ramos, 1321 South Walker, Oklahoma City, OK 73109. Phone (800) 725-7266. Leeds Aluminum Letters, Leeds, Alabama. Phone: 205-699-5271.
B. Approved equal manufacturers
   1. Leeds Aluminum Letters, Leeds, Alabama. Phone: (205) 699-5271.
   2. Matthews Bronze, 1315 West Liberty Avenue
      Pittsburgh, PA 15226. Phone: (800) 950-1315

2.02 CONSTRUCTION (Based on A.R.K. Ramos)

A. Material: Cast Aluminum
B. Size: 24" W x 36" H.
C. Letter Style: To be selected from manufacturer's full range.
D. Border Style: Raised flat band.
E. Background Texture: To be selected from manufacturer's full range.
F. Mounting: Concealed Studs.

2.03 CONTENT

A. To be provided by Owner.

PART 3 EXECUTION

3.01 EXECUTION

A. Install where directed by Architect/Owner.

END OF SECTION

SECTION 10.440 INTERIOR SIGNAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. All primary and secondary directories, directionals, room identification, workstation ID's and signage for ADA and life safety code compliance.

B. Related Sections:
   1. Division 1: Administrative, procedural and temporary work requirements.

1.02 REFERENCES

A. Signs and their installation shall comply with applicable provisions of the latest edition of the following standards and with requirements of authorities having jurisdiction:
   1. ADAAG - Americans with Disabilities Act Accessibility Guidelines; US Architectural and Transportation Barriers Compliance Board.
   2. International Code Council/American National Standards Institute A117.1-Standard on Accessible and Usable Buildings Facilities.
   3. National Fire Protection Association 101 Life Safety Code.

1.03 SUBMITTALS

A. Submittals for Review
   1. Signage schedule in manufacturer's format for verification of text/copy.
   2. Approval drawings showing materials, construction detail, lay-out, copy, size and mounting methods.
   3. Sample of two sign types for verification of materials, color, pattern, overall quality, and for adherence to drawings and requirements indicated.

1.04 QUALIFICATIONS

A. Manufacturer specializing in manufacturing the products specified in this section with minimum five years experience. Obtain signs from one source and a single manufacturer.

1.05 WARRANTY

A. Provide manufacturer's warranty against defects in materials and workmanship for minimum 5 years.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Basis of Design Signage shall be Fusion 01 as manufactured by Takeform. Provided all other project requirements are met, products by the following manufacturers shall be considered equal:
   1. ASI
   2. Best Sign Systems
   3. As approved by the Architect.

2.02 SIGN STANDARDS

A. Typography
   1. Type style: As selected by Architect. Copy shall be a true, clean, accurate reproduction of typeface(s) specified. Upper and lower case or all caps shall be as indicated in Sign Type drawings and Signage Schedule. Letter spacing to be normal and interline spacing shall be set by manufacturer.
   2. Arrows, symbols and logo art: To be provided in style, sizes, colors and spacing as shown in drawings.
   3. Grade II Braille utilizing perfectly round, clear insertion beads.

B. Evacuation Maps
   1. Evacuation maps shall have a unique "you-are-here" orientation as well as two emergency egress paths. The maps shall show location of fire extinguishers, fire pulls, stairwells, elevators and restrooms.

C. Color and Finishes
   1. Colors, patterns and artwork: As selected by the Architect.
   2. Message Background: As selected by the Architect.
   3. Finishes are to meet current federal ADA and all state and local requirements.

2.03 SIGNS

A. Signage System
   1. The signage shall incorporate a decorative laminate face with applied graphics including all tactile requirements in adherence to ADA specifications.
   2. All signs, including work station and room ID's, overheads and flag mounts, directionals and directories shall have a matching appearance and constructed utilizing the same manufacturing process to ensure a consistent look throughout.

B. Materials
   1. Sign face shall be 0.035" (nominal) standard grade, high pressure surface laminate. A painted sign face shall not be acceptable.

2. The sign shall incorporate balanced construction with the core sandwiched between laminates to prevent warping. Laminate on the sign face only shall not be acceptable.
3. Tactile lettering shall be precision machined, raised 1/32", matte PETG and subsurface colored for scratch resistance.
4. Signs shall incorporate a metal accent bar. Bars shall be anodized with a brushed satin finish. Painted bars shall not be acceptable.

C. Standard Colors:
1. Face color: Premium Laminate Shaker Cherry 7935K-07 Textured Gloss by Wilsonart
2. Metal Accent: Bronze
3. Raised Text: Black, Code CO101
4. Insert Background (where applicable): Concrete CO106
5. Font: ADA Helvetica

D. Construction:
1. The signage shall, with the exception of directories and directionals, be a uniform 8 ½" width to facilitate inserts printed on standard width paper.
2. Insert components shall have a .080 thickness non-glare acrylic window and shall be inlaid flush to sign face for a smooth, seamless appearance.
3. The signage shall include modules allowing for inserts, notice holders, occupancy sliders, marker, magnetic, and cork boards. All modules shall be flush to sign face for a smooth, seamless appearance.
4. The laminates (front and back) shall be pressure laminated and precision machined together to a 90-degree angle. Edges shall be smooth, void of chips, burrs, sharp edges and marks.
5. The signage shall utilize an acrylic sphere for Grade II Braille inserted directly into a scratch resistant, high pressure laminate sign face. Braille dots are to be pressure fit in high tolerance drilled holes.
6. Braille dots shall be half hemispherical domed and protruding a minimum 0.025".
7. The signage shall utilize a pressure activated adhesive. The adhesive shall be nonhazardous and shall allow for flexing and deflection of the adhered components due to changes in temperature and moisture without bond failure.
8. All signs shall be provided with appropriate mounting hardware. Hardware shall be finished and architectural in appearance and suitable for the mounting surface.
9. Some signs may be installed on glass. A blank backer is required to be placed on the opposite side of the glass to cover tape and adhesive. The backer shall match the sign in size and shape.

E. Printed Inserts
   1. The signage shall be capable of accepting paper or acetate inserts to allow changing and updating as required. Insert components shall have a 0.080" thickness non-glare acrylic window and shall be inlayed flush to sign face for a smooth, seamless appearance.
   2. The signage contractor shall provide and install all signage inserts.
   3. Manufacturer shall provide a template containing layout, font, color, artwork and trim lines to allow Owner to produce inserts on laser or ink jet printer. The template shall be in an Acrobat or Word format (.pdf).

F. Quantities

Code and Facility Signage:

Sign Type E	Stairs	4 required
Sign Type E.2	Restroom	9 required
Sign Type G.2	Large Room ID	10 required
Sign Type H	Room ID Changeable Insert	10 required
Sign Type N	Interior Stairwell	5 required

PART 3 EXECUTION

3.01 CODE COMPLIANCE

A. It shall be the responsibility of the successful bidder to meet any and all local, state, and federal code requirements in fabricating and installing signs.

3.02 DELIVERY, STORAGE, PROTECTION

A. Package to prevent damage or deterioration during shipment, handling, storage and installation. Products should remain in original packaging until removal is necessary. Store products in a dry, indoor location.

3.04 EXAMINATION

A. Installer shall examine signs for defects, damage and compliance with specifications. Installation shall not proceed until unsatisfactory conditions are corrected.

3.05 INSTALLATION

A. General: Installation locations shall be in accordance with ADA specifications. Locate signs where indicated using mounting methods in compliance with manufacturer's written instructions:
   1. The signage contractor shall coordinate installation schedules with the Owner and/or Construction Manager.
   2. Installation shall be performed by manufacturer's personnel trained and certified in manufacturer's methods and procedures.

3. The signage contractor shall submit a CAD generated location plan noting the location of all signage and cross referenced to message schedule or plots for architect's approval.
4. Installer to conduct a pre-installation survey prior to manufacturing to verify copy and sign location. Each location shall be noted using a low tack vinyl reproduction of actual sign. Full scale renderings of directories and directionals shall also be provided. Any location discrepancy or message issues shall be submitted to architect for review.
5. Signs shall be level, plumb, and at heights indicated with sign surfaces free from defects.
6. Upon completion of the work, signage contractor shall remove unused or discarded materials, containers and debris from site.

3.05 WEB PORTAL AND STANDARDS MANUAL

A. Web Portal: Manufacturer shall provide a password protected web portal enabling Owner to view and access all sign types comprising the sign system. The sign types shall be priced and shall be capable of purchase directly from the portal.
B. Manufacturer shall provide a comprehensive Standards Manual in both a paper and PDF format. The manual shall include all graphic standards, sign type descriptions, renderings showing color, pattern and finish, engineering drawings, location plans, plots, artwork, insert templates, mounting detail, and reorder information.

END OF SECTION

SECTION 10.523 FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Provide fully charged portable fire extinguisher where noted. The types of fire extinguishers are as follows:
   1. Semi-Recessed Cabinet mounted (FEC)

1.02 REFERENCES

A. NFPA1 0-Portable Fire Extinguishers
B. UBC 43-6 (ASTM E814-83) - Fire rated cabinets fabricated in accordance to measure, restore, perform.
C. Americans with Disabilities Act 1990-Maximum 4-inch cabinet projection for corridors.

1.03 SUBMITTALS

A. Product Data: For extinguishers and cabinets. Include installation instructions for cabinets and brackets.

1.04 QUALITY ASSURANCE

A. Conform to NFPA 10 requirements for portable fire extinguishers.
B. Provide fire extinguishers, cabinets, and accessories by single manufacturer.
C. Conform to UBC 43-6 (ASTM E814-83) for fire resistive wall performance where necessary.
D. Conform to Americans with Disabilities Act 1990 on maximum cabinet projection of C in corridors where necessary.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. J.L. Industries (Activar, Inc.)
B. Larsens Manufacturing Company
C. Potter Roemer

2.02 MATERIALS

A. Provide cabinets with fire-rated option (J.L. Industries FX Fire Rated), if applicable. Rating of the cabinet shall match the rating of the wall in which the cabinet is being installed.
B. Type 1 Fire Extinguisher Cabinets (FEC):
   1. Provide at all locations where cabinets are called for.
   2. Style shall be aluminum, recessed sized for the applicable fire extinguisher as specified herein.
      a. Equal to J.L. Industries “Embassy Series, Model #5634W10”.
         (1) Door Style: Vertical Duo with Saf-T-Lok and pull

(2) Door Glazing: Clear 1/4 inch Acrylic

b. Door & Trim Construction: 7/8” thick formed cabinet doors in #4 satin stainless steel. Doors feature two concealed hinges at top and bottom of door.
c. Trim Style & Depth: trimless, 6 inch recessed cabinet.
d. Tub: The tub is constructed of cold rolled steel with white powder-coat finish standard. Tub forms a 1” flange to cover cut edges of wallboard material.

C. Fire Extinguishers
1. Dry Chemical Type (Type 1): J.L. Industries “Model Cosmic 10E”

PART 3 EXECUTION

3.01 INSTALLATION

A. Install items included in this section in locations and at mounting heights indicated, or if not indicated, at heights to comply with applicable regulations of governing authorities.
B. Prepare recesses in walls for fire extinguisher cabinets as required by type and size of cabinet and style of trim and to comply with manufacturer’s instructions.
C. Securely fasten mounting brackets and fire extinguisher cabinets to structure, square and plumb, to comply with manufacturer’s instructions.
D. Provide and verify servicing, charging and tagging of all fire extinguishers.

END OF SECTION

SECTION 10.800 TOILET ACCESSORIES

PART 1 GENERAL

1.01 EXTENT

A. Provide toilet and other accessory items in locations as indicated on the Drawings and as specified in the schedule herein.
   1. Refer to Toilet Accessory Schedule on Drawings for complete schedule.
   2. Contractor to coordinate installation and provide blocking in wall for all items specified.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 06.100 Rough Carpentry
B. Section 08.830 Unframed Mirrors
B. Section 10.162 Solid Plastic Toilet Partitions

1.03 QUALITY ASSURANCE

A. Inserts and anchorages: Furnish inserts and anchoring devices that must be set in concrete or built into masonry; coordinate delivery with other work to avoid delay.
B. Accessory Locations: Coordinate accessory locations with other work to avoid interference and to assure proper operation and servicing of accessory units.
C. Single-Source Responsibility: Provide products of same manufacturer for each type of accessory unit and for units exposed to view in same areas, unless otherwise acceptable to Architect.
D. Comply with 36 CFR 1191 "Americans with Disabilities Act Accessory Guidelines for Buildings and Facilities" including requirement regarding location and installed structural strength of grab bars.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design manufacturer is Bobrick Washroom Equipment. Unless noted otherwise, all model numbers given refer to products by the basis of design manufacturer. Provided all other requirements are met, products by the following manufacturers shall be considered equal:
   1. American Specialties Inc.
   2. Bradley Corporation

2.02 MATERIALS

A. Stainless Steel: AISI Type 304, with polished No. 4 finish, 22-gauge minimum thickness, unless otherwise indicated.

B. Brass: Leaded and unleaded, flat products, ASTM B 19; rods, shapes, forgings, and flat products with finished edges, ASTM B 16: castings, ASTM B-30
C. Sheet steel: Cold-rolled, commercial quality ASTM A366, 20-gauge minimum, unless otherwise indicated. Surface preparation and metal pretreatment as required for applied finish.
D. Galvanized Steel Sheet: ASTM A527, G60.
E. Galvanized Steel Mounting Devices: ASTM A153, hot-dip galvanized after fabrication.
F. Fasteners: Screws, bolts, and other devices of same materials as accessory unit or of galvanized steel where concealed.
G. Keys: Unless otherwise indicated, provide universal keys for access to toilet accessory units requiring internal access for servicing, resupply, etc. Provide minimum of 6-keys to Owner and obtain receipt.
H. Supply one extra set of batteries for each battery-operated accessory.

2.03 UNITS

A.	42” Grab Bars:	B-6806.99 x 42
B.	36” Grab Bars:	B-6806.99 x 36
C.	18” Vertical Grab Bar:	B-6806.99 x 18
D.	Toilet Paper Dispenser:	B-4288
E.	Sanitary Napkin Disposal:	B-270
F.	Soap Dispensers:	B-2013
G.	Paper Towel Dispenser:	B-29744 with AC adaptor #3974-57
H.	24x36 Mirrors:	B-165 2436
I.	Diaper Changing Station:	Koala Kare KB110-SSWM
J.	Robe Hooks:	B-76727
K.	Mirror	See Section 08.830 Unframed Mirrors

PART 3 EXECUTION

3.01 EXAMINATION

A. Installer must examine substrates, previously placed inserts and anchorages necessary for mounting of toilet accessories and other conditions under which installation is to occur, and must notify Contractor in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.02 INSTALLATION

A. Install toilet accessory units in accordance with manufacturer's instructions, using fasteners which are appropriate to substrate and recommended by manufacturer of unit. Install units plumb and level, firmly anchored in locations indicated.

B. All accessories mounted in wheelchair accessible stalls, in ambulatory stalls and in the open area of the toilet room shall be installed in compliance with the requirements of ADA.

3.03 ADJUSTING

A. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly.

3.04 CLEANING

A. Clean and polish all exposed surfaces after removing protective coatings.

END OF SECTION

SECTION 12.485 RUGS AND MATS

PART 1 GENERAL

1.01 SUMMARY

A. This section includes the following types of entrance flooring systems:
   1. Floor Mats & Frame Assemblies

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)
B. The Aluminum Association
C. The National Floor Safety Institute (NFSI)
D. The Carpet and Rug Institute (CRI)

1.03 SUBMITTALS

A. Product Data
   1. Include Data for each type of floor mat and frame specified, including manufacturer's specifications and installation instructions.
B. Shop Drawings:
   1. Include drawings of sufficient detail showing layout of mat/grid and frame specified including details indicating construction relative to materials, direction of traffic, spline locations, profiles, anchors and accessories.
C. Samples for verification purposes:
   1. Submit an assembled section of floor mat/grid and frame members with selected tread insert showing each type of color for exposed floor mat/grid, frame and accessories required.
D. Maintenance data in the form of manufacturer's printed instructions for cleaning and maintaining floor mats/grids.

1.04 QUALITY ASSURANCE

A. Flammability in accordance with ASTM E648, Class I, Critical Radiant Flux, minimum 0.45 watts/m2.
B. Slip resistance in accordance with ASTM D-2047-96, Coefficient of Friction, minimum .060 for accessible routes.
C. Standard rolling load performance is 300 lb./wheel with larger loading requirements as specified (load applied to a solid 5” x 2” wide polyurethane wheel, 1000 passes without damage).
D. Single Source Responsibility: Obtain floor mats/grids and frames from one source of a single manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the project site ready for use and fabricated in as large sections and assemblies as practical, in unopened original factory packaging clearly labeled to identify manufacturer.

1.06 PROJECT CONDITIONS

A. Field measurements: Check actual openings for mats/grids by accurate field measurements before fabrication. Record actual measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design product is by Balco.
B. Provided all other requirements are met, products from the following manufacturers are considered equal:
   1. Nystrom Building Products
   2. Construction Specialties, Inc
   3. J.L. Industries -Activar Construction Products Group

2.02 MATERIALS

A. Aluminum Extrusions: Aluminum, ASTM B221, alloy 6063-T5.
B. Hinge: PVC
B. Leading edge frames and fillers: Flexible P.V.C.
C. Tread rails: Aluminum, ASTM B221, alloy 6063-T5
D. Carpet: Monofilament tufts, 3700 Denier with 0.010" black monofilament (91 total ends per inch) and solution dyed nylon yarn. Total thickness: 0.350 inch (8.9mm) ±.015" Weight: 33 oz/sq. yd Picks per inch: 13 Anti-static treatment, anti-stain treatment, and anti-microbial treatment. Color to be selected by Architect from manufacturer's standard options.
E. Fasteners, accessories and other materials indicated as provided by the manufacturer on the manufacturer's details and in the manufacturer's installation instructions and required for complete installation to manufacturer's instructions.

2.03 SYSTEM DESCRIPTION

A. Model and Description – FMS-C-Carpet Tread, Vinyl Hinge Surface Roll-Up Floor Mats shall consist of a series of aluminum tread rails spaced 2" o.c. and running counter to the traffic flow. Roll-Up Floor Mats shall be surface mounted, provided with flexible PVC vinyl hinges and standard duty carpet inserts. Floor mats shall allow debris to fall to sub-floor.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Manufacturer shall offer assistance and guidance to provide a template or irregular shaped mat/grid assemblies to ensure a proper installation.

3.03 INSTALLATION

A. Install the work of this section in strict accordance with the manufacturer's recommendations.
B. Set grid at height recommended by manufacturer for most effective cleaning action.
C. Coordinate top of grid surfaces with bottom of doors that swing across to provide ample clearance between door and grid.
D. Coordinate fasteners with installed flooring.

3.04 PROTECTION

A. After completing required frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses, and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and project is near time of substantial completion.
   1. Grouting area around frame is not acceptable.
B. Defer installation of floor grids until time of substantial completion of project.

END OF SECTION

SECTION 14.210 ELECTRIC TRACTION ELEVATORS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Electric Traction Elevators.

B. Products Supplied but Not Installed Under this Section:
   1. Hoist Beam
   2. Pit Ladder
   3. Inserts mounted in block walls for rail attachments

C. Work Supplied Under Other Sections:
   1. Temporary lighting, including temporary lighting in hoistway for machine space with switch located in hoistway on the strike jamb side of top landing door.
   2. Main line disconnects for each elevator.
      a. One fused three phase permanent power in building electrical distribution room
   3. Hoistway ventilation shall be in accordance with local and national building code requirements.
   4. Guide Rail Support shall be structurally adequate to extend from pit floor to top of hoistway, with spans in accordance with requirements of authority having jurisdiction and final layouts.
   5. Removable barricades at all hoistway openings, in compliance with OSHA 29 CFR 1926.502 in addition to any local code requirements.
   6. Lifeline attachments capable of withstanding 5000 lb load in accordance with OSHA 29 CFR 1926.502. Provide a minimum of 2 at the top, front of each hoistway.
   7. Pit lighting: Fixture with switch and guards. Provide illumination level equal to or greater than that required by ASME A17.1/CSA B44 2000, or applicable version.
   8. Control space lighting with switch. Coordinate switch with lighting for machine space as allowable by code.
   9. Access Doors: As required for access to governor and/or seismic switch. Access door shall be self-closing, self-locking if necessary and operable from the inside without a key.

D. Related sections:
   1. Section 01500 - Temporary Facility and Controls
   2. Section 05.410 - Metal Stud System
   3. Section 07.950 – Sealants and Caulking
   4. Section 09.250 – Gypsum Board Assemblies
   5. Section 15 – Mechanical
   6. Section 16 - Electrical

E. Industry and government standards:
   1. ICC/ANSI A117.1 Accessible and Usable Buildings and Facilities
   2. ADAAG - Accessibility Guidelines for Buildings and Facilities

3. ANSI/NFPA 70, National Electrical Code
4. ANSI/NFPA 80, Standard for Fire Doors and Fire Windows
5. ASME/ANSI A17.1, Safety Code for Elevators and Escalators.

1.02 DESCRIPTION OF ELEVATOR

A. Elevator Equipment: Mono500 EB™ gearless traction elevator
B. Equipment Control: KCM831
C. Drive: Non-Regenerative
D. Quantity of Elevators: 1 Elevator
E. Landings: 2
F. Openings: 2 Front Openings, 0 Back Openings
G. Travel: 13' 9"
H. Rated Capacity: 2,500 lb
I. Rated Speed: 150 FPM
J. Clear Inside Dimensions: (W x D) 6' 9" x 4' 1/2"
K. Cab Height: 7'-4"
L. Clear height under suspended ceiling: 7'-4"
M. Entrance Width and Type: 42" and Left Opening
N. Entrance Height: 7'-0"
O. Existing pit depth to be retained
P. Existing hoistway width and depth to be retained
Q. Main Power Supply: 208 V Volts + 5%, three-phase
R. Operation: Simplex
S. Machine Location: Inside the hoistway mounted on car guide rail
T. Control Space Location: Inside the existing elevator equipment room
U. Elevator Equipment shall conform to the requirements of seismic zone: Non-Seismic
V. Maintenance Service Period: 12 Months

1.03 PERFORMANCE REQUIREMENTS

A. Car Performance
   1. Car Speed ± 5% of contract speed under any loading condition or direction of travel.
   2. Car Capacity: Safely lower, stop and hold (per code) up to 125% of rated load.
B. System Performance
   1. Horizontal Vibration (maximum): ISO 18738/ISO 8041 system pk-pk 12 mg
   2. Jerk Rate (maximum): 1 m/s^3
   3. Acceleration (maximum): 0.4 m/s^2
   4. In Car Noise: 55 dB(A) Maximum
   5. Leveling Accuracy: ±0.2 inches
   6. Starts per hour (maximum): 180

1.04 SUBMITTALS

A. Comply with Section 01300 - Submittal Procedures.

B. Product Data: Submit manufacturer's product literature for each proposed system.
   1. Cab design, dimensions and layout.
   2. Layout, finishes, and accessories and available options.
   3. Controls, signals and operating system.
   4. Color selection charts for cab and entrances.
C. Shop Drawings:
   1. Clearances and travel of car.
   2. Clear inside hoistway and pit dimensions.
   3. Location and layout of equipment and signals.
   4. Car, guide rails, buffers and other components in hoistway.
   5. Maximum rail bracket spacing.
   6. Maximum loads imposed on building structure.
   7. Hoist beam requirements.
   8. Location and sizes of access doors.
   9. Location and details of hoistway door and frames.
   10. Electrical characteristics and connection requirements.
D. Operation and maintenance data:
   1. Provide manufacturer's standard maintenance and operation manual.
E. Diagnostic Tools
   1. Prior to seeking final acceptance for the completed project as specified by the Contract Documents, the Elevator Contractor shall deliver to the Owner any specialized tool(s) that may be required to perform diagnostic evaluations, adjustments, and/or parametric software changes and/or test and inspections on any piece of control or monitoring equipment installed.
   2. This shall include any specialized tool(s) required for monitoring, inspection and/or maintenance where the means of suspension other than conventional wire ropes are furnished and installed by the Elevator Contractor. Any and all such tool(s) shall become property of the Owner. Any diagnostic tool provided to the Owner by the Elevator Contractor shall be configured to perform all levels of diagnostics, systems adjustment and parametric software changes which are available to the Elevator Contractor.
   3. In those cases where diagnostic tools provided to the Owner require periodic recalibration/or re-initiation, the Elevator Contractor shall perform such tasks at no additional cost to the Owner for a period equal to the term of the maintenance agreement from the date of final acceptance of the competed project During those intervals in which the Owner might find it necessary to surrender a diagnostic tool for re-calibration, re-initiation, or repair, the Elevator Contractor shall provide a temporary replacement for the tool at no additional cost to the Owner.

4. The Elevator Contractor shall deliver to the Owner, printed instructions for the proper use of any tool that may be necessary to perform diagnostic evaluations, system adjustment, and/or parametric software changes on any unit of microprocessor-based elevator control equipment and means of suspension other than standard elevator steel cables furnished and install by the Elevator Contractor.
5. Accompanying the printed instructions shall be any and all access codes, password, or other proprietary information that is necessary to interface with the microprocessor-control equipment.

1.05 QUALITY ASSURANCE

A. Manufacturer: Minimum of fifteen years' experience in the fabrication, installation and service of elevators of the type and performance of the specified. The manufacturer shall have a documented quality assurance program.
B. Installer: The equipment manufacturer shall install the elevator.
C. Inspection and Testing: In accordance with requirements of local jurisdiction, obtain required permits, inspections and tests.

1.06 DELIVERY, STORAGE AND HANDLING

A. If the construction site is not prepared to receive the elevator equipment at the agreed ship date, the General Contractor shall be responsible to provide a safe, dry, and easily accessible storage area on or off the premises. Additional labor costs for double handling will be the responsibility of the general contractor.
B. Delivered elevator materials shall be stored in a protected environment in accordance with manufacturer recommendations. A minimum storage area of 10 feet by 20 feet is required adjacent to the hoistway.

1.07 WARRANTY

A. Provide manufacturer warranty for a period of one year. The warranty period is to begin upon Substantial Completion of the Contract. Warranty covers defects in materials and workmanship. Damage due to ordinary use, vandalism, improper or insufficient maintenance, misuse, or neglect do not constitute defective material or workmanship.
B. Provide manufactures monitoring service for 12 months to fully comply with the new 2018 IBC communication requirements.

1.08 MAINTENANCE SERVICE

A. The elevator manufacturer shall provide maintenance service consisting of regular examinations and adjustments of the elevator equipment for a period of 12 Months after date of substantial

completion. Replacement parts shall be produced by the original equipment manufacturer.

B. Maintenance service to be performed during regular working hours of regular working days and shall include emergency call back service during regular working hours.

C. Maintenance service shall not include adjustments, repairs or replacement of parts due to negligence, misuse, abuse or accidents.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Provide AC gearless machine room-less elevator systems subject to compliance with the design and performance requirements of this specification. Elevator manufacturers may include but are not limited to one of the following:
   1. Basis of Design: Mono500™ traction elevators by KONE, Inc. (www.kone.com).
   2. Other acceptable machine room-less products: manufacturer with minimum 15 years' experience in manufacturing, installing, and servicing elevators of the type required for the project.

2.02 EQUIPMENT: CONTROL COMPONENTS AND CONTROL SPACE

A. Controller: Provide microcomputer-based control system to perform all functions.
   1. All high voltage (110V or above) contact points inside the controller cabinet shall be protected from accidental contact in a situation where the controller doors are open.
   2. Controller shall be separated into two distinct halves; Motor Drive side and Control side. High voltage motor power conductors shall be routed and physically segregated from the rest of the controller.
   3. Provide a serial cardrack and main CPU board containing a non-erasable EPROM and operating system firmware.
   4. Variable field parameters and adjustments shall be contained in a non- volatile memory module.

B. Drive: Provide Variable Voltage Variable Frequency AC drive system to develop high starting torque with low starting current.

C. Controller Location: Locate controller{s} in the front wall integrated with the top landing entrance frame, machine side of the elevator. One non-fused three phase permanent power in hoist way at top landing. A separate control space should not be required.

2.03 EQUIPMENT: HOISTWAY ENTRANCES

A. Hoistway Entrances
   1. Sills: Extruded Aluminum.

2. Doors: Hollow metal construction with vertical internal channel reinforcements.
3. Fire Rating: Entrance and doors shall be UL fire-rated for 1-1/2 hour.
4. Entrance Finish: Brushed Stainless Steel.
5. Entrance Markings Jamb Plates: Provide standard entrance jamb tactile markings on both jambs, at all floors. Plate Mounting: Refer to manufacturer drawings.

2.04 EQUIPMENT: CAR COMPONENTS

A. Car Frame: Provide car frame with adequate bracing to support the platform and car enclosure.
B. Car Safeties: Device will be provided and mounted under the car platform, securely bolted to the Car Frame. The safety will be actuated by a centrifugal governor mounted at the top of the hoistway. The Safety is designed to operate in case the car attains excessive descending speed.
C. Platform: Platform shall be all steel construction.
D. Car Guides: Provide guide-shoes mounted to top and bottom of both car and counterweight frame. Each guide-shoe assembly shall be arranged to maintain constant contact on the rail surfaces. Provide retainers in areas with Seismic design requirements.
E. Car Wall Finish:
   1. Side Walls: Brushed Stainless Steel (441)
   2. Rear Wall: Brushed Stainless Steel (441)
   3. Car front, Door and Skirting: Brushed Stainless Steel
   4. Ceiling: Round, LED spotlights
   5. Handrails: Brushed Stainless Steel
      a. Rails to be located on Back Wall and Side Walls of car enclosure.
   6. Sills: Aluminum extruded.
F. Cab Wall Protection Pads to be included
G. Flooring: By others. (Not to exceed 3lb/sqft and 1/2" finished depth.)
H. Emergency Car Signals
   1. Emergency Siren: Siren mounted on top of cab that is activated when the alarm button in the car operating panel is engaged. Siren shall have rated sound pressure level of 80 dB(A) at a distance of three feet from device. Siren shall respond with a delay of not more than one second after activation of alarm button.
   2. Emergency Car Lighting: Provide emergency power unit employing a 12- volt sealed rechargeable battery and totally static circuits shall illuminate the elevator car and provide current to the alarm bell in the event of building power failure.
   3. Emergency Exit Contact: An electrical contact shall be provided on the car-top exit.
I. Ventilation: Manufacturer's standard cab fan

2.05 EQUIPMENT: SIGNAL DEVICES AND FIXTURES

A. Car Operating Panel: Provide car operating panel with all push buttons, key switches, and message indicators for elevator operation. Fixture finish to be Brushed Stainless Steel.

Car operating panel must have all features to comply with the new 2018 IBC code requirement. Elevator provider must include 12 months of monitoring for the new 3-way communication requirement.

1. Main Flush mounted car operating panel shall contain a bank of round, mechanical, illuminated buttons marked to correspond to landings served, emergency call button, door open button, door close button, and key switches for lights, inspection, and exhaust fan. Buttons have Amber Dot Matrix illumination (halo). All buttons to have raised text and Braille marking on left hand side. The car operating display panel shall be Amber Dot Matrix. All texts, when illuminated, shall be Amber Dot Matrix. The car operating panel shall have a Brushed Stainless Steel finish.
2. Additional features of car operating panel shall include:
   a. Car Position Indicator within operating panel Brushed Stainless Steel
   b. Elevator Data Plate marked with elevator capacity and car number on car top.
   c. Help buttons with raised markings.
   d. In car stop switch per local code.
   e. Call Cancel Button.

B. Hall Fixtures: hall fixtures shall be provided with necessary push buttons and key switches for elevator operation. hall fixtures shall have a Brushed Stainless Steel finish.

1. Hall fixtures shall feature round, mechanical, buttons in applied mount face frame. Hall fixtures shall correspond to options available from that landing. Buttons shall be in a vertically mounted fixture.

C. Car Lantern and Chime: A directional lantern visible from the corridor shall be provided in the car entrance. When the car stops and the doors are opening, the lantern shall indicate the direction in which the car is to travel, and a chime will sound. The chime will sound once for up and twice for down. The car riding lantern face plate shall have a Brushed Stainless Steel finish.

2.06 EQUIPMENT: ELEVATOR OPERATION AND CONTROLLER

A. Elevator Operation

1. Simplex Collective Operation: Using a microprocessor-based controller, operation shall be automatic by means of the car and hall buttons. If all calls in the system have been answered, the car shall park at the last landing served.
2. Zoned Car Parking.
3. Relative System Response Dispatching.

B. Standard Operating Features to include:
   1. Full Collective Operation
   2. Fan and Light Control.
   3. Load Weighing Bypass.
   4. Ascending Car Uncontrolled Movement Protection
   5. Top of Car Inspection Station.
C. Additional Operating Features to include:
   1. Independent Service.
   2. Hoistway Access Bottom Landing.
   3. Hoistway Access Top Landing.
   4. Car Wall Protection Pads
D. Elevator Control System for Inspections and Emergency
   1. Provide devices within controller to run the elevator in inspection operation.
   2. Provide devices on car top to run the elevator in inspection operation.
   3. Provide within controller an emergency stop switch to disconnect power from the brake and prevents motor from running.
   4. Provide the means from the controller to mechanically lift and control the elevator brake to safely bring car to nearest available landing when power is interrupted.
   5. Provide the means from the controller to reset the governor over speed switch and also trip the governor.
   6. Provide the means from the controller to reset the emergency brake when set because of an unintended car movement or ascending car over speed.
   7. Provide the means for the control to reset elevator earthquake operation.

2.07 EQUIPMENT: DOOR OPERATOR AND CONTROL

A. Door Operator: A closed loop permanent magnet VVVF high-performance door operator shall be provided to open and close the car and hoistway doors simultaneously. Door movement shall be cushioned at both limits of travel. Electro-mechanical interlock shall be provided at each hoistway entrance to prevent operation of the elevator unless all doors are closed and locked. An electric contact shall be provided on the car at each car entrance to prevent the operation of the elevator unless the car door is closed.
B. The door operator shall be arranged so that, in case of interruption or failure of electric power, the doors can be readily opened by hand from within the car, in accordance with applicable code. Emergency devices and keys for opening doors from the landing shall be provided as required by local code.
C. Doors shall open automatically when the car has arrived at or is leveling at the respective landings. Doors shall close after a predetermined time interval or immediately upon pressing of a car

button. A door open button shall be provided in the car. Momentary pressing of this button shall reopen the doors and reset the time interval.

D. Door hangers and tracks shall be provided for each car and hoistway door. Tracks shall be contoured to match the hanger sheaves. The hangers shall be designed for power operation with provisions for vertical and lateral adjustment. Hanger sheaves shall have polyurethane tires and pre-lubricated sealed-for-life bearings.
E. Electronic Door Safety Device. The elevator car shall be equipped with an electronic protective device extending the full height of the car. When activated, this sensor shall prevent the doors from closing or cause them to stop and reopen if they are in the process of closing. The doors shall remain open as long as the flow of traffic continues and shall close shortly after the last person passes through the door opening.

PART 3 EXECUTION

3.01 EXAMINATION

A. Field measure and examine substrates, supports, and other conditions under which elevator work is to be performed.
B. Do not proceed with work until unsatisfactory conditions are corrected.
C. Prior to start of work, verify hoistway is in accordance with shop drawings. Dimensional tolerance of hoistway from shop drawings: -0 inches +2 inches. Do not begin work of this section until dimensions are within tolerances.
D. Prior to start of work, verify projections greater than two inches (four inches if ASME A17.1/CSA B44 2000 applies) must be beveled not less than 75 degrees from horizontal.
E. Prior to start of work, verify landings have been prepared for entrance sill installation. Traditional sill angle or concrete sill support shall not be required.
F. Prior to start of work, verify elevator pit has been constructed in accordance with requirements, is dry and reinforced to sustain vertical forces, as indicated in approved submittal. Verify that sumps or sump pumps located within pit will not interfere with installed elevator equipment.
G. Prior to start of work, verify control space has been constructed in accordance with requirements, with access coordinated with elevator shop drawings, including sleeves and penetrations.
H. Verify installation of GFCI protected 20-amp in pit and adjacent to each signal control cabinet in control space.

3.02 PREPARATION

A. Coordinate installation of anchors, bearing plates, brackets and other related accessories.

3.03 ELEVATOR DEMO

A. Demolition and removal of the existing elevator to be completed by the elevator contractor. This includes the removal and proper disposal of all elevator components and the hydraulic fluid in the existing elevator system. New elevator to be designed to accommodate the existing pit depth, hoistway width and depth.

3.04 INSTALLATION

A. Install equipment, guides, controls, car and accessories in accordance with manufacturer installation methods and recommended practices.
B. Properly locate guide rails and related supports at locations in accordance with manufacturer's recommendations and approved shop drawings. Anchor to building structure using isolation system to minimize transmission of vibration to structure.
C. All hoistway frames shall be securely fastened to fixing angles mounted in the hoistway. Coordinate installation of sills and frames with other trades.
D. Lubricate operating system components in accordance with manufacturer recommendations.
E. Perform final adjustments, and necessary service prior to substantial completion.

3.05 CONSTRUCTION

A. Interface with Other Work:
    1. Guide rail brackets attached to steel shall be installed prior to application of fireproofing.
    2. Coordinate construction of entrance walls with installation of door frames and sills. Maintain front wall opening until elevator equipment has been installed.
    3. Ensure adequate support for entrance attachment points at all landings.
    4. Coordinate wall openings for hall push buttons, signal fixtures and sleeves. Each elevator requires sleeves within the hoistway wall.
    5. Coordinate emergency power transfer switch and power change pending signals as required for termination at the primary elevator signal control cabinet in each group.
    6. Coordinate interface of elevators and fire alarm system.
    7. Coordinate interface of dedicated telephone line or use of Kone wireless monitoring service.

3.06 TESTING AND INSPECTIONS

A. Perform recommended and required testing in accordance with authority having jurisdiction

B. Obtain required permits and provide originals to Owner's Representative.

3.07 DEMONSTRATION

A. Prior to substantial completion, instruct Owner's Representative on the proper function and required daily maintenance of elevators. Instruct personnel on emergency procedures.

END OF SECTION

SECTION 15.010 MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DIVISION OF WORK

A. This section delineates the division of work between Divisions.

B. Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable installation. This section is provided to assist the Contractor in coordination of work scope but shall not be construed to limit Contractor's scope of work encompassed by the contract documents.

C. Coordination with other Trades: The following table is intended to assist the Contractors in coordinating the scope of work between Division 15 (Indicated as 15 in table), Section 15900 Energy Management & Control System (indicated as 15C), and other Divisions as indicated. However, the General Contractor is ultimately responsible for coordination among his subcontractors regardless of what is listed in this Section.

INTERFACE/RESPONSIBILITY MATRIX						
System		Division under which the following is specified				Remarks
		Equipment	Installation	Power Wiring [1]	Control & Interlock Wiring [1]	
MECHANICAL EQUIPMENT						
	Bipolar Ionization	15	15	16	15C	
	Chillers	15	15	16	15C	[4], [7]
	Boilers	15	15	16	15C	[4], [8]
	Variable speed drives, field mounted	15C	16	16	15C	
	Fans	15	15	16	15C	
	Motors, 3 phase	15	15	16	-	

INTERFACE/RESPONSIBILITY MATRIX						
System		Division under which the following is specified				Remarks
		Equipment	Installation	Power Wiring [1]	Control & Interlock Wiring [1]	
	Motors, 1 phase	15	15	16	15C	[6]
	Other powered equipment	15	15	16	15C	
	Disconnects	16/15	16/15	16	16	[9]
	Water treatment systems (open and closed systems)	15	15	16	15C	
ENERGY MANAGEMENT & CONTROL SYSTEM						
	Central control workstations & servers	15C	15C	16	15C	
	Control system network backbone	15C	15C	15C	15C	
	Control panels	15C	15C	15C	15C	[11]
	Control devices	15C	15C	15C	15C	
	Network IT WAN/LAN drop	-	15C	15C	15C	[12]
PLUMBING SYSTEMS						
	DHW heater venting and combustion air	15	15	-	-	
	Condensate drains including traps, primers	15	15	-	-	[17]
	Condensate pumps	15	15	15	-	
	Make-up water to hot/chilled/condenser water including backflow prevention	15	15	-	-	[18]
	Natural gas connections, pressure reducing station, gages	15	15	-	-	[19]
	Gas and water flow meters	15C	15	15C	15C	
	Recirculation pumps or heat tape	15	15	16	15C	
	Pipe gauges, thermometers, test plugs	15	15	-	-	
	Self-powered valves, pressure relief valve, liquid level controllers, etc.	15	15	-	-	
	Sensor wells, meters and other pipe-mounted control devices	15C	15	15C	15C	
	Test plugs	15	15			[20]
HVAC HYDRONIC SYSTEMS						
	Pipe gauges, thermometers, test	15	15	-	-	

INTERFACE/RESPONSIBILITY MATRIX						
System		Division under which the following is specified				Remarks
		Equipment	Installation	Power Wiring [1]	Control & Interlock Wiring [1]	
	plugs					
	Self-powered valves, refrigerant powered head pressure control valves, pressure relief valves, liquid level controllers, etc.	15	15	-	-	
	Relief valve vent piping, equipment drain piping, etc. from equipment to floor drains/sinks	15	15	-	-	
	Automatic isolation and control valves	15C	15	15C	15C	
	Sensor wells, meters and other pipe-mounted control devices	15C	15	15C	15C	
	Test plugs	15	15			[20]
HVAC SHEET METAL						
	Duct mounted sensors	15C	15	15C	15C	
	Filter gauges	15C	15C	-	-	
	Control dampers	15	15	15C	15C	[22]
	Control damper actuators	15C	15C	15C	15C	[22],[23]
HVAC TERMINAL BOXES						
	Terminal box control transformer panel	15C	15C	15C	15C	[11]
	Terminal box with damper	15	15	-	-	
	Digital controller and damper actuator	15C	15	15C	15C	
	Air-flow measurement pickup and piping	15	15	-	-	
	Air-flow measurement transducer and wiring	15C	15C	15C	15C	
	Wall sensor module	15C	15C	15C	15C	
	Terminal fan, including contactors & control transformer	15	15	16	15	[25]
	Electric heating coil, including transformer, safeties & contactors	15	15	16	15	[25]
	HW control valve and actuator	15C	15	15C	15C	
MISCELLANEOUS						

INTERFACE/RESPONSIBILITY MATRIX						
System		Division under which the following is specified				Remarks
		Equipment	Installation	Power Wiring [1]	Control & Interlock Wiring [1]	
	Trenching, backfilling, boring, soil compaction, saw-cutting, patching and paving for underground piping	31	31	-	-	
	Roofing, including cant strips and counterflashing at the sides of roof curbs	7	7	-	-	
	Thermal and acoustical insulation in and on partitions and ceilings	7	7	-	-	
	Louvers	15	8	-	-	
	Combination louver/damper	15	15	15C	15C	
	Concrete housekeeping pads, curbs, pedestals and inertia base fill etc. for equipment	3	3	-	-	[26]
	Equipment, ductwork, and piping steel supports and frames	15	15	-	-	
	Rooftop unit curbs	15	15	-	-	[27]
	Painting of exposed piping, HVAC equipment, etc.	15	15	-	-	
	Fire-stopping around pipe and duct penetrations in floor and walls	15	15	-	-	
	Framing of walls and ceilings to accept air outlets, fire dampers, etc.	9	9	-	-	[28]
	Ceiling and wall access doors	15	8	-	-	[29]

NUMBERED REMARKS:

[2] Wiring of interlock of duct smoke detectors to shut off supply fans upon detection of smoke is specified under Section 15900 Energy Management & Control System. All other smoke control/fire alarm related control wiring is specified under Division 16 Electrical.

[3] End switch required only for monitoring position of damper. See HVAC drawings and Division 15 smoke and fire damper specifications to see where required.

[4] Factory installed starters and variable speed drives are specified under Division 15 HVAC. Prewired control panel is specified under Division 15

INTERFACE/RESPONSIBILITY MATRIX					
System	Division under which the following is specified				Remarks
	Equipment	Installation	Power Wiring [1]	Control & Interlock Wiring [1]	
HVAC, single point power connection (unless otherwise noted on drawings) specified by Division 15 HVAC. Packaged mechanical equipment specified with BACnet communication cards/gateways shall be provided by Division 15 HVAC. Packaged mechanical equipment vendor to provide all necessary technical assistance to Division 15C Contractor in mapping across equipment points to the EMCS. [6] Single phase 120V motors with integral motor overload protection specified under Division 15 HVAC. Line voltage control device such as thermostat or switch specified under 15900 Energy Management & Control Systems; wiring and conduit between control device and motor specified under Division 16 Electrical. [8] BACnet communication card/gateway between the EMCS and boiler control panel specified with boiler under Division 15 HVAC; boiler vendor to provide all necessary technical assistance to Division 15C Contractor in mapping across boiler points to the EMCS [9] Disconnects are specified under Division 15 HVAC where specifically called for in equipment schedules or specifications to be factory installed with equipment. Otherwise all disconnects are specified under Division 16 Electrical. [11] Power to all EMCS control panels is specified under Section 15900 Energy Management & Control Systems, coordinate with Division 16 contractor for available circuits. [12] Network IT LAN drop at required EMCS location(s) specified under Section 15900 Energy Management & Control Systems. It shall be the responsibility of the Division 15C contractor to coordinate required IT LAN network connection location(s) with the Division 16 contractor or Owner's IT Department. Connection(s) to Owner's IT LAN and termination to wall jack specified under Section 15900 Energy Management and Control System. [13] Interface device required in light control relay panels to accept low-voltage switch inputs are specified under Section 15900 Energy Management & Control Systems. [14] Power measuring sensors, installation and wiring to a central controller with Modbus interface specified under Division16 Electrical. Modbus gateway and network connection from gateway to EMCS specified under Section 15900 Energy Management & Control Systems. Power monitoring control vendor to provide all necessary technical assistance to Section 15900 Energy Management & Control Systems Contractor in mapping across					

INTERFACE/RESPONSIBILITY MATRIX					
System	Division under which the following is specified				Remarks
	Equipment	Installation	Power Wiring [1]	Control & Interlock Wiring [1]	
power monitoring control points to the EMCS. [17] Coordinate piping from condensate pans to the sewer system including trap and final connections is specified under Division 15 Plumbing. Piping from auxiliary drain pans where provided at air handling equipment in furred spaces is specified under Division 15 HVAC. [18] Domestic make-up water, including shut-off valve, backflow prevention, rough-in and final connection to hot water, chilled water, condenser water and any other HVAC systems requiring make-up water is specified under Division 15 Plumbing. Pressure reducing valves with bypass valve and shut-off valves at each closed-system make-up water connection are specified under Division 15 HVAC. [19] Pressure reducing valves to deliver gas at the pressure required by mechanical equipment, including final connections and shut-off cock, is specified under Division 15 Plumbing. All other gas control and regulating devices provided under the Section providing the gas-fired equipment. Venting of gas regulating devices and other equipment gas-train devices where required is specified under Division 15 Plumbing. [20] Test plugs mounted adjacent to all temperature well (for calibration) specified under Division 15 [22] Duct access doors required for access to control devices where required specified under Division 15 HVAC. [23] Actuators for motorized dampers supplied with fans or hood where scheduled on HVAC drawings are specified under Division 15 HVAC, mounted and wired. [25] Factory wired control transformer, safeties and contactors with single point power wiring connection specified under Division 15 HVAC. [26] Shop drawings showing dimensions of all curbs, bases, etc. specified under Division 15 HVAC. [27] Shims to level curb specified under Division 6. Curb insulation specified under Division 15 HVAC. All roof curbs shall be approved by roofing manufacturer. [28] Additional T-bar or spline and cut ceiling tile as required to accept air outlets is specified under Division 9. [29] Dimensioning of access doors to mechanical equipment and coordination with Architect and Division 8 specified under Division 15.					

D. HVAC/Electrical Design Coordination

1. The power ratings of motors and other HVAC equipment and the electrical characteristics of electrical systems serving them, as specified herein and indicated on the Drawings, have been established as minimums which will allow that equipment to satisfactorily function while producing the required capacities. These power ratings include a safety factor deemed appropriate to accommodate common differences between design parameters and field construction practices. Under no circumstances shall equipment with power ratings less than those indicated on the Drawings or specified herein be provided.
2. Reasonable efforts have been made to coordinate the electrical requirements of the HVAC equipment with the electrical systems serving that equipment. Differences among manufacturers of HVAC equipment make it impossible to produce a single electrical design which will satisfy the varying electrical requirements of those manufacturers. Consequently, the Contractor shall coordinate the electrical requirements of the HVAC equipment actually furnished on this Project and provide the electrical systems required by that equipment. This coordination effort shall be completed prior to the installation of either the HVAC equipment or the electrical systems serving that equipment. Electrical system revisions required to coordinate with the HVAC equipment actually furnished shall be provided at no additional cost to the Owner.

E. Related Work Specified Elsewhere

1. Utilities five feet beyond building line unless noted otherwise: See Division 33 Utilities
2. Structural steel (except as specified herein): See Division 05 Metals.
3. Grates and railings protecting mechanical shaft and other floor openings: see Division 05 Metals.
4. Miscellaneous lumber and framing work, such as for framing, soffits and support of mechanical materials and equipment. See Division 06 Wood, Plastics, and Composites.
5. Undercutting of doors and door louvers: See Division 08 Openings.
6. Painting (except as specifically indicated): See Division 09 Finishes
7. Fire resistant enclosures around ducts and at fire dampers such as at the bottoms of shafts. See Division 09 Finishes.
8. Electric power, interlock and control wiring, except as specified herein.
9. Installation of starters, contactors, thermal overload switches, and remote push buttons, except as specified herein.
10. Fire alarm initiating devices, control modules, and monitoring modules.
11. Curbs, flashing, and pitch pockets for equipment on roof, except as specified herein.
12. Manhole construction.
13. Louvers and screens, except as specified herein.
14. Concrete equipment pads.

1.3 REFERENCE STANDARDS

A. Reference to codes, standards, specifications and recommendation of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Such codes or standards shall be considered a part of this Specification as though fully repeated herein.

B. Work shall be performed in accordance with all applicable requirements of the latest edition of all governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not.

C. Requirements of Regulatory Agencies

1. In accordance with the requirement of Division 1 General Requirements.
2. Nothing in contract documents shall be construed to permit work not conforming to current and applicable laws, ordinances, rules and regulations.
3. Where contract documents exceed requirements of applicable laws, ordinances, rules and regulations, comply with documents establishing the more stringent requirement.
4. It is not the intent of contract documents to repeat requirements of codes except where necessary for completeness or clarity.
5. Comply with the Safety Orders issued by OSHA and any other safety, health or environmental regulations of the State of Mississippi and any districts having jurisdictional authority. Where an omission or conflict appears between OSHA requirements and the Drawings and Specifications, OSHA requirements shall take precedence.
6. Applicable codes as listed below, in addition to others specified in individual sections.

    a. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) – Standard 90.1-2010 “Energy Standard for Buildings Except Low-Rise Residential Buildings”.
    b. International Building Code (IPC) – 2012.
    c. International Mechanical Code (IMC) – 2012.
    d. International Plumbing Code (IPC) - 2012.
    e. NFPA 1 – 2012, Fire Code
    f. NFPA 70 - 2008, National Electric Code
    g. NFPA 90A - 2009, Installation of Air Conditioning and Ventilating Systems

D. Published specifications, standards, tests or recommended method of trade, industry or governmental organizations as listed below apply to all work in Division 15 HVAC, in addition to other standards which may be specified in individual sections.

E. All base material shall meet ASTM and ANSI standards.

F. All Gas Fired Devices: Comply with standards and bear label of AGA.

G. All Pressure Vessels, Relief Valves, Safety Relief Valves and Safety Valves: Comply with standards, ASME stamped.

H. All Electrical Devices and Wiring

1. Conform to standards of NEC
2. All devices UL or ETL listed and identified

I. Guidelines and Standards: The latest edition of guidelines and standards published by the following govern the Mechanical Systems and associated support system design. The systems shall be designed to meet or exceed these guidelines and standards.

AABC	Associated Air Balance Council
ADC	Air Diffuser Balance Council
AGA	American Gas Association
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASC	Adhesive and Sealant Council
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWS	American Welding Society
ETL	Interlek Semko (Formerly Electrical Testing Laboratories)
GISO	General Industry Safety Orders
HI	Hydraulic Institute
ICBO	International Conference of Building Officials
IEEE	Institute of Electrical and Electronic Engineers
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEC	National Electric Code
NEMA	National Electrical Manufacturer’s Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
UL	Underwriter’s Laboratories, Inc.

1.4 QUALITY ASSURANCE

A. Supply all equipment and accessories in compliance with the applicable standards listed herein and with all applicable national, state and local codes.

B. All equipment and accessories shall be new and the product of a manufacturer regularly engaged in its manufacturer.

C. All items of a given type shall be the products of same manufacturer.

D. Workmanship, material and equipment shall be in accordance with Specifications and Drawings and in some instances the requirements exceed those required by codes and standards. Where not exceeded, the codes and standards shall be considered as absolute minimum requirements.

1.5 SUBMITTALS

A. No work may begin on any segment of this Project until the related submittals have been reviewed for conformance with the design intent and the Contractor has responded to all comments to the satisfaction of the Owner.

B. Submit drawings, product data, samples and certificates of compliance required as hereinafter specified. See also Division 01 – General Requirements.

C. Submit no later than 35-days after signing of Contract, or as otherwise indicated by Architect. Submit a schedule indicating the proposed submission date of each submittal specified herein. Schedule shall anticipate the submittal review time, the possible need for resubmittals, and the time required for fabrication, shipping and integration into the construction sequence. Architect will advise of any conflicts in reviewing submittals that the proposed schedule presents.

1. Complete schedule of submittals for equipment and layout shop drawings. Allow 15-working days for review, unless Architect agrees to accelerated schedule.
2. List of all proposed substitutions: See requirements herein.
3. Designate in schedule dates for submission and dates that reviewed shop drawings, product data and samples will be needed.
4. Provide submittals promptly in accordance with schedule and in such sequence as to cause no delay in work or in work of any other division.

D. Submit drawings, product data, samples and certificates of compliance required hereinafter specified.

1. See also Division 01 General Requirements.
2. Provide submittals promptly in accordance with schedule and in such sequence as to cause no delay in work or in work of any other division.
3. Submittals for each specification section shall be submitted in a single package. However, it is not required (nor desired) for all products to be submitted concurrently. Rather, submittals may be staggered based on schedule and required equipment release dates.
4. Allow 15-working days for review, unless the Architect agrees to accelerated schedule.
5. For substitutions, list any features or characteristics that are not strictly in compliance with specifications. If none are listed with the submittal, Contractor

is guaranteeing that substituted product is functionally equivalent to the specified product in accordance with requirements herein.

6. Submittal reviews by the Architect are intended to assist the Contractor in complying with the design intent and requirements of the drawings and specifications. Reviews do not relieve the Contractor from compliance with these requirements and comments or lack thereof does not constitute approval of changes in these requirements.

E. Submission and Resubmission Procedure.

1. Each submittal cover sheet shall contain the Contractor's review statement. The statement shall be worded as follows:

   a. It is hereby certified that the information included in this submittal and approved/proposed to be incorporated into this project (include official project name on Contract Drawings), is in compliance with the Contract Drawings and specifications, the electrical requirements have been coordinated with the Electrical Sub-Contractor, can be installed in the allocated spaces with adequate service space, and is approved for use and is submitted for Architect's review.

   Authorized Reviewer: _____ Date: _____

2. Each submittal shall have a unique serial number that includes the associated specification section followed by a number for each sub-part of the submittal for that specification section, such as "SUBMITTAL 15000-01".
3. Each resubmittal shall have the original unique serial number plus revision number such as "SUBMITTAL 15000-01 REVISION 1".
4. Submit in format specified below. Submissions made in wrong format will be returned without action.

   a. Product Submittals: One copy in word-searchable electronic format per requirements herein. Submit each specification section in a separate file named with unique name and number described above.
   b. Shop Drawings:

      1) One copy in electronic format .dwg, .dwf, or .pdf
      2) Two and only two copies on paper; any additional copies will not be returned without review

   c. Samples: As indicated in each specification section.

5. Architect will return a memo or mark-up of submittal with comments and connections noted where required.
6. Make corrections

   a. Revise initial submittal to resolve review comments and corrections.

b. Indicate any changes that have been made other than those requested.
c. Clearly identify resubmittal by original submittal number and revision number.

7. Resubmit revised submittals until no exceptions are taken.
8. Once submittals are accepted and stamped with no exceptions taken, provide:

a. Complete submittal of all accepted products in a single electronic file for each specification section.
b. Photocopies for coordination with other trades, if and as required by the Contractor or Architect. Photocopies will serve as submittal for record and coordination.

F. Product Data Submittals

1. Contents.

a. Manufacturer's name and model number.
b. All information required to completely describe materials and equipment and to indicate compliance with drawings and specifications, including, but not limited to:

1) Schedule when more than one of each item is covered by submittal.
2) Physical data, as applicable.

a) Dimensions.
b) Weights.
c) Finishes and colors.
d) Dimensional shop drawings.

3) Performance data, as applicable.

a) Rated capacities.
b) Performance curve.
c) Operating temperature and pressure.
d) Efficiency.

4) Flow and wiring diagrams as applicable.
5) Description of system operation.

c. All other pertinent information requested in individual sections.

2. Format.

a. See Division 01 – General Requirements.
b. Identify clearly if submittal is substitution: See requirements herein.
c. Reference specification Division, Section, Title, Paragraph and Page number or drawing number as applicable
d. Use same nomenclature, legend, symbols and abbreviations on submittal material as used in contract documents.

1.6 COORDINATION DRAWINGS (LAYOUT SHOP DRAWINGS)

A. Coordination drawings.

1. Drawings shall be developed in format compatible with AutoCAD version 2010 or later.
2. Shop fabrication, coordination and installation drawings by the Contractor, are for the Contractor's use and shall be the Contractor's responsibility. These Drawings indicate where the Contractor intends to install the material and equipment as required by the Contract Documents. Submit coordination drawings in a timely manner so that they can be utilized by all trades. Use of contract documents or electronic files of contract documents for shop drawings is not sufficient.
3. Clearly indicate deviations from Contract Drawings.
4. Review is not intended to verify dimensions or quantities, or to coordinate items shown on these Drawings. Review is for general conformance with design concept of the Project and general compliance with the information given in the Contract Documents. Contractor is responsible for dimensions, which shall be confirmed and correlated at the Jobsite, for fabrication processes and techniques or construction, for coordination of Work with that of all other trades and the satisfactory performance of Work.
5. Prepare and submit layout drawings, sections and details for following areas, minimum 1/4 inch scale:

    a. Mechanical equipment rooms.
    b. Equipment mezzanines.
    c. Congested areas (ceiling plenums, furring's, shafts, etc.)

6. Prepare layout shop drawings for all other areas; minimum 1/8 inch scale.
7. Layout drawings, as a requirement of Division 15 HVAC, shall indicate, superimposed, Work of all Sections involved in congested area, including ductwork, piping, electrical work, ceiling work, etc. Include all mechanical rooms. Identification of space problems without solutions is not acceptable.
8. Individual coordinated trade layout drawings are to be prepared for all deviations from design documents.
9. Contractor is to assure that each trade has coordinated work with other trades, prior to submittal.

    a. Include stamp on each submittal indicating that layout shop drawing has been coordinated:
    b. No layout shop drawing will be reviewed without stamped and signed coordinated assurance by Contractor.

10. All changes shall be clearly marked on each submitted layout drawing.
11. Drawings shall show work of all trades including but not limited to:

    a. Ductwork.
    b. Piping: All Trades, including Fire Sprinklers and electrical installations.
    c. Mechanical Equipment.

d. Electrical Equipment.
e. Main Electrical conduits and bus ducts.
f. Equipment supports and suspension devices.
g. Structural and architectural constraints (structural steel, columns, ceilings, walls, floors, etc.).
h. Show location of:

1) Valves: manual and automatic.
2) Air distribution devices (including sidewall devices with dimensions from finish floor elevation).
3) Exterior wall penetrations (include dimensions from reference elevation).
4) Piping specialties.
5) Dampers: fire/smoke, automatic and manual volume, etc.
6) Access doors.
7) Control and electrical panels.
8) Others as required for clear coordination.

12. Drawings shall indicate coordination with work specified in other Divisions which must be coordinated with work specified under Division 15 Mechanical, including, but not limited to:

a. Irrigation equipment and piping.
b. Elevator equipment.
c. Building vacuum cleaning systems.
d. Pneumatic tube systems.
e. Cable trays.
f. Computer equipment.
g. Others as required.

13. Equipment, control devices, dampers, valves, etc. requiring periodic maintenance or adjustment shall be included in coordination drawings. Specifically, the contractor shall verify and coordinate that access is provided to these components via lay-in ceiling or adequately sized access doors in walls, floors, ceilings, etc.
14. Submission of drawings.

a. Submit to other trades for review of space allocated to all trades.
b. Revise drawings to compensate for requirements of existing conditions and conditions created by other trades.
c. Ensure that each trade has coordinated work with other trades.
d. Submit with stamps of General and all other applicable Contractors, initialed and signed certifying.

1) Review of submittal.
2) Verification of products, field measurements and field construction criteria.
3) Coordination of information in submittal with requirements of work of this Division and other divisions of Contract Documents.

e. No layout shop drawing will be reviewed without stamped and signed coordination assurance by the Contractor.

1.7 COMPLETION REQUIREMENTS

A. Procedure.

1. Until the documents required in this section are submitted and approved, the system will not be considered “accepted”.
2. Before requesting acceptance of work, submit one set of Completion Documents for review and approval of Architect.
3. After review, furnish quantity of sets indicated below to Owner.
4. Format:

a. See herein for required format of Completion Documents.
b. Paper copies; assemble in chronological order following alpha-numeric system used in specification, in heavy three-ring binder.
c. Where electronic copies are called for herein, comply with the following:

1) Provide in word-searchable electronic format; acceptable formats are MS Word, Adobe Acrobat (pdf) and HTML; submit other formats for review and approval prior to submission; scanned paper documents not acceptable.
2) For submittals, provide separate file for each type of equipment.
3) For Test & Balance report, provide separate files for each air handling system.
4) Record drawings shall be in original format.

B. Operating and Maintenance (O&M) Manual.

1. See O&M Manual requirement herein

C. Record Drawings.

1. Keep up-to-date during progress of job one set of Mechanical Drawings indicating the Record installation. In addition to changes made during course of Work, show following by dimension from readily obtained base lines.

a. Fully illustrate all revisions made by all crafts in course of work.
b. Include all field changes, adjustments, variances, substitutions and deletions, including all Change Orders.
c. Exact location, type and function of concealed valves, dampers, controllers, piping, air vents and piping drains.
d. Exact size, invert elevations and location of underground and under floor piping and ducts.

1) Progress drawing set shall be available for inspection by Architect weekly.

2) Update engineering design drawings and shop drawings to reflect revisions and additional data listed above at completion of Project.

e. Original engineering design drawings will be provided to Contactor in electronic format compatible with AutoCAD version 2010 or later.
f. Both shop and engineering design drawings shall be in format compatible with AutoCAD version 2010 or later.
g. Drawings required to be updated if revisions were made.

1) Floor plans.
2) Shop drawings required herein.
3) Sections.
4) Riser diagrams.

D. Test and Balance Reports.

1. See Section 15950 – Testing, Adjusting, and Balancing for HVAC.

E. Training Materials.

1. See Training Materials requirements herein.

F. Miscellaneous Certificates.

1. Pressure and Leakage Test documentation/certificates.
2. Training/Instruction completion certificates.
3. Fire Marshal and Fire Department approvals of system, as required.
4. Final inspection certificate signed by governing authorities.
5. Warranty period, including start and end period.
6. Field test report, including as applicable.
7. Start-up documents with date and name of technician.
8. Piping pressure tests.
9. Flex coupled pump alignment verification.
10. Duct leakage and pressure tests.
11. Drain pan drainage tests.
12. Letters from manufacturers certifying their supervision of equipment installation and start-up procedures.
13. Machinery vibration test reports.
14. Certificates of sterilization/chlorination of plumbing systems.
15. Others as specified herein and in other Division 15– Mechanical sections.

G. Format of Completion Documents.

1. Provide the type and quantity of media listed in table below.
2. Optical media shall be readable on a personal computer.
3. Where indicated in table, the electronic files shall be stored on the EMCS systems' Operator Workstation and hyperlinked to the front-end DDC controls graphics so operators can get the details of a certain device or balance reports

by clicking on the link: See Section 15900 – Energy Management & Control Systems.

	Document	Paper (Binder or bound)	Electronic	
			Read only optical disk	Loaded Onto Operator Workstation
1	O&M Manuals	3	1	1
2	Record Drawings	2 Full size 2 Half size	1	1
3	Original issue EMCS software & manuals	1	1	1
4	Control sequences	1	1	1
5	Test and Balance Report	5	1	1
6	Miscellaneous Certificates	1	1	1
7	Warranty documents	1	1	1
8	Training materials	1 per trainee	1	1

1.8 SUBSTITUTIONS AND PRODUCT OPTIONS

A. For specific substitution requirements, See Division 00 and Division 01.

B. Where equipment and materials are shown on the drawings and/or specified hereinafter by a manufacturer's name and/or model number, it is the intent of these specifications to set minimum definite standards for equipment and materials to be used on the project. It is not the intent of these specifications to preclude the use of materials and equipment of similar design and quality to manufacturer's name specified. If the Contractor desires to substitute materials and equipment, he shall obtain written approval through the materials submittals process of all such substitutions before such substitutions are made. Unauthorized substitutions of materials and equipment may be ordered removed from the project without further grounds. The Architect will not approve any substitutions for specified materials and equipment unless such substitutions are requested by the Contractor.

C. The products of particular manufacturers have been used as the basis of design in preparation of these documents. It shall be the responsibility of this Contractor to determine if the submitted materials and equipment will fit into the space allotted with all required clearances as the materials and equipment utilized as the basis of design. Furthermore, the Contractor and shall verify and maintain adequate access to equipment, valves, filters, lubrication outlets, etc. Any changes to the building or system design necessary shall be arranged for in writing before the materials and equipment is ordered. All costs involved in making such changes shall be borne by the Contractor. If such changes are deemed inadvisable by the Architect, the Contractor shall install items specified even though materials and equipment had been

previously approved. Architect's approval of materials and equipment other than the basis of design is for performance only.

D. Contractor shall consider the following parameters (at a minimum) when considering materials and equipment substitutions:

1. Capacities: The capacities included in the Contract Documents are absolute minimum and the substitution shall have equal or greater capacities.
2. Physical size limitations: Substitutes shall fit in the allotted space and shall have the manufacturer's minimum clearances.
3. Installation and operation weights.
4. Structural properties.
5. Noise levels.
6. Vibration.
7. Interchangeability.
8. Accessibility for maintenance, operation, and replacement.
9. Compatibility with other materials and assemblies.
10. Equal quality and style.

1.9 DESCRIPTION OF BID DOCUMENTS

A. The Contractor shall be responsible for becoming thoroughly acquainted with all Contract Document contents that affect his work under this contract. Work required under this section includes, but is not limited to, all material, equipment transportation, services and labor required to complete the entire mechanical system as required by the Contract Documents.

B. The Specifications and the associated Drawings are complimentary, and any portion of the work described in one shall be provided as if described in both.

C. Specifications.

1. Specifications, in general, describe quality and character of materials and equipment.
2. Specifications are of simplified form and include incomplete sentences.
3. Words or phrases such as "The Contractor shall," "shall be," "furnish," "provide," "a," "an," "the," and "all" have often been omitted from specifications for brevity.

D. Drawings.

1. Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate approximate locations of apparatus, equipment, ductwork and piping. Changes in the location, and offsets, of same which are not shown on the Drawings but are necessary in order to accommodate building conditions and coordination with the work of other trades, shall be made during the preparation of coordination drawings and prior to initial installation, without additional cost to the Owner. Contractor shall install all system components in such a manner as to conform to the structure, avoid obstructions, preserve headroom, keep openings

and passageways clear and maintain required servicing clearances without further instructions or additional cost to the Owner.

2. Scaled and figured dimensions are approximate and are for estimating purposes only. Indicated dimensions are limiting dimensions where noted. Duct and piping elevations are indicated for initial coordination; final requirements shall be determined by the Contractor after final coordination with other trades.
3. Before proceeding with work, check and verify all dimensions in field.
4. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
5. Make adjustments that may be necessary or requested in order to resolve space problems, preserve headroom and avoid architectural openings, structural members and work of other trades.
6. It is intended that all mechanical, plumbing and fire protection devices, piping, etc. be located symmetrically with all architectural elements. Refer to Architectural, Structural, Plumbing, Fire Protection, Mechanical and Electrical Specifications and Drawings in completing the required coordination.
7. The Contractor shall fully inform himself regarding any and all peculiarities and limitations of the spaces available for the installation of all work and materials furnished and installed under this Contract. He shall exercise due and particular caution to determine that all parts of his work are made readily accessible.
8. The Contractor shall study all drawings and specifications to determine any conflict with all applicable ordinances and statutes. Any discrepancies shall be reported to the Owner and any changes shall be shown on the as-built drawings with the additional work performed at no cost to the Owner.
9. The submittal of his bid shall indicate the Contractor has examined the site, drawings and specifications and has included all required allowances in his bid. No allowance shall be made for any error or omission resulting from the Contractor's failure to visit job site and to review drawings and specifications. The Contractor's bid shall include costs for all required drawings and changes as outlined above at no cost to the Owner.
10. Provide access to equipment and apparatus requiring operation, service or maintenance throughout the life of the system.

E. Do not use equipment exceeding dimensions indicated on drawings or equipment or arrangements that reduce required clearances or exceed specified maximum dimensions.

F. If any part of Specifications or Drawings appears unclear or contradictory, apply to Architect for an interpretation and decision prior to as early as possible.

1. Do not proceed with work without the decision of the Architect.

1.10 DEFINITIONS

A. In addition to those defined in Division 01 – General Requirements, the following additional definitions shall apply. Definitions of term used in Division 15 HVAC may differ from those given in general and supplementary conditions.

B. “Provide”: to furnish, supply, install and connect up complete and ready safe and regular operation of particular work referred to unless specifically noted.

C. “Supply”: to purchase, procure, acquire and deliver complete with related accessories.

D. “Work”: includes labor, materials, apparatus, controls, equipment services and all related accessories necessary for the proper and complete installation of complete systems.

E. “Piping”: includes pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation and all related accessories.

F. “Wiring”: includes raceway, fittings, wire, boxes and all related accessories.

G. “Concealed”: not in view, installed in masonry or other construction, within furred spaces, double partitions, hung ceiling, trenches, crawl spaces, or enclosures.

H. “Exposed”: in view, not installed underground or “concealed” as defined above. Exposed piping, conduit, or ductwork is that which can be seen when the building is complete without opening or removing access doors or panels or accessible ceiling components.

I. “Control or Actuated Devices”: includes automatic sensing and switching devices such as thermostats, pressure, float, flow, electro-pneumatic switches and electrodes controlling operation of equipment.

J. “Indicated,” “shown” or “noted”: as indicated, shown or noted on drawings or specifications.

K. “Reviewed,” “approved,” or “directed”, as reviewed, approved or directed by or to Owner.

L. “Motor Controllers”: starter, variable speed drives and other devices controlling the operation of motors.

1.11 PROJECT CONDITIONS

A. Examine site related work and surfaces before starting work of any Section.

1. In case of conflict, the most stringent takes precedence.
2. For purposes of clarity and legibility, Drawings are essentially diagrammatic to extent that many offsets, bends, unions, special fittings, exact locations of items are not indicated, unless specifically dimensioned. Especially note a number of required duct and pipe offsets to coordinate with structure and not shown. Coordinate dimensioned conditions, including invert elevations, with other trades prior to installation by any trade.
3. Exact routing of piping, ductwork, etc. shall be governed by structural conditions and other obstructions. Not all offsets in ductwork or piping are shown on the

Drawings. Determine which item to offset or relocate. Maintain required slope in piping. Make use of data in Contract Documents. In addition, Architect reserves right, at no additional cost to the Owner, to make any reasonable change in location of mechanical items, exposed at ceiling or on walls, to group them into orderly relationships or increase their utility. Verify Owner's requirements in this regard prior to rough-in.

4. Take dimensions, location of doors, partitions, similar physical features from Architectural Drawings. Verify at Site under this Division. Consult Architectural Drawings for exact location of outlets to center with Architectural features, panels, etc., at the appropriate location shown on Mechanical Drawings.
5. Mounting heights of brackets, outlets, etc., as required.
6. Report to Architect, in writing, conditions which will prevent proper provision of this work.
7. Beginning work of any Section without reporting unsuitable conditions to Architect constitutes acceptance of conditions by Contractor.
8. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no additional cost to the Owner.

B. Coordination.

1. Work out all "tight" conditions involving Work specified under this Division and work in other Divisions in advance of installation, if necessary, and before Work proceeds in these areas, prepare supplementary Drawings under this Division for review showing all Work in congested area. Provide supplementary Drawings, additional Work necessary to overcome congested conditions, at no additional cost to the Owner.
2. Conflicts: Difference or disputes concerning coordination, interference or extent of Work between sections shall be decided as follows:

    a. Install mechanical and electrical systems in the following order of preference (those trades listed below another must reroute to resolve the conflict):

        1) Drain piping required by code to be sloped.
        2) Supply air and exhaust air ductwork connected to fans.
        3) Electrical conduit 4 inches and larger.
        4) Hydronic piping connected to pumps.
        5) Domestic water piping.
        6) Fire sprinkler piping.
        7) Electrical conduit smaller than 4 inches.
        8) Transfer ducts and other ductwork not connected to fans.
        9) Control system piping and wiring.

    b. Continued disputes shall be decided by Contractor and Contractor's decision, if consistent with Contract Document requirements, shall be final.

3. Supervision: Personally, or through an authorized and competent representative, constantly supervise the work from beginning to completion and,

within reason, keep the same foreman and workmen on the Project throughout the Project duration.

4. Provide templates, information and instructions to other Divisions to properly locate hides and openings to be cut or provided.
5. The drawings govern in matters of quantity, and the specifications govern in matters of quality. In the event of conflict within the drawings involving quantities, or within the specifications involving quantities, or within the specifications involving quality, the greater quantity and higher quality shall apply. Such discrepancies shall be noted and clarified in the Bid. No additional allowances will be made because of errors, ambiguities, or omissions that reasonably should have been discovered during the preparation of the Bid.

C. Equipment Rough-in.

1. Rough-in locations shown on Mechanical Drawings for equipment furnished by the Owner and for equipment furnished under other Divisions are approximate only. Obtain exact rough-in locations from following sources.

    a. From Shop Drawings for equipment provided under this contract.
    b. From Architect for Owner Furnished-Contractor installed equipment.
    c. From existing equipment where such equipment is relocated under this Contract.

2. Verify mechanical characteristics of equipment before starting rough-in. Where conflict exists between equipment and rough-in shown on Drawings obtain clarification from Architect and provide as directed by the Architect at no additional cost to the Owner.
3. Make final connections.

1.12 CLEARANCE FROM ELECTRICAL EQUIPMENT

A. Piping, equipment or ductwork.

1. Prohibited, except as noted in:

    a. Electric rooms and closets over equipment, as restricted by NEC.
    b. Telephone rooms and closets.
    c. Elevator machine rooms.
    d. Elevator shafts.
    e. Electrical switchboard room.
    f. Communications room.

2. Prohibited, except as noted, over or within 5 feet of:

    a. Transformers.
    b. Substations.
    c. Switchboards.
    d. Motor control centers.

e. Standby power plant.
f. Bus ducts.
g. Electrical panels.
h. Variable frequency drives.
i. Starters.

B. Drip pans under piping.

1. Where piping is located over any electrical equipment listed above; reroute piping if possible, rather than use drip pan.
2. 28 gage galvanized steel.
3. 18 gage copper.
4. Reinforced and supported.
5. Watertight.
6. With 1-1/4 inch drain outlet piped to floor drain or service sink.

C. Electrical Working Space: Dimensions of the working space shall be a minimum depth of 42" horizontally, the width of the equipment or 30", whichever is greater, and the height of the equipment or 78", whichever is greater. Minimum depth shall be increased to 60" for equipment rated over 600 V.

1.13 PRODUCT DELIVERY, HANDLING AND STORAGE

A. See Division 01 – General Requirements (Product Requirements).

B. Deliver equipment in its original package to prevent damage or entrance of foreign matter. Provide materials on factory provided shipping skids and lifting lugs if required for handling. Provide protective coverings during construction.

C. Handle and ship in accordance with manufacturer's recommendations.

D. Identify materials and equipment delivered to Site to permit check against approved materials list, reviewed with no exceptions taken Shop Drawings.

E. Protect from loss or damage. Replace lost or damaged materials and equipment with new at no additional cost to Owner.

F. Where necessary, ship in crated sections of size to permit passing through available space.

1.14 PROJECT MANAGEMENT AND COORDINATION SERVICES

A. See Division 01 – General Requirements.

B. Overview: Provide a project manager/engineer for the duration of the Project to coordinate the Division 15 HVAC work with all other trades. Coordination services, procedures and documentation responsibility shall include, but shall not be limited to the items listed in this section.

C. Review of shop drawings prepared by other subcontractors

1. Obtain copies of all shop drawings for equipment provided by others that require electrical service connections or interface with Division 15 HVAC work.
2. Perform a thorough review of the shop drawings to confirm compliance with the service requirements contained in the Division 15 HVAC contract documents. Document and discrepancy or deviation as follows:

    a. Prepare memo summarizing the discrepancy.
    b. Provide a copy of the specific shop drawing, indicating via cloud, the discrepancy.

3. Prepare and maintain a shop drawing review log indicating the following information.

    a. Shop drawing number and brief description of the system/material.
    b. Date of review.
    c. Indication if follow-up coordination is required.

D. Request for Information (RFI)

1. See Division 1 Request for Information

1.15 REVIEW OF CONSTRUCTION

A. Work may be reviewed at any time by representatives of the Owner and/or Architect.

B. Advise Owner that work is ready for review at the following times.

1. Prior to backfilling buried work.
2. Prior to concealment of work in walls and above ceilings.
3. When all requirements of Contract have been completed.
4. When testing will be performed.

C. Do not backfill or conceal work without Architect’s consent.

D. Maintain on site, one set of Specifications and Drawings for use by Owner and/or Architect.

E. Contactor is responsible for construction methods, sequences and safety precautions.

1. Include all change orders

1.16 SCHEDULE OF WORK

A. In accordance with Division 01 – General Requirements and as follows:

1. Arrange work to conform to schedule of construction established or required to comply with Contract Documents.

2. In scheduling, anticipate means of installing equipment through available openings in structure.

B. Confirm in writing to Architect, within 35-days of signing of contract, anticipated number of days required to perform test, balance, acceptance testing and commissioning of mechanical systems. Schedule test balance and acceptance testing of mechanical systems as follows:

1. Submit for review at this time, names and qualifications of test and balancing agencies to be used.
2. Test, Adjusting and Balancing and commissioning must occur after completion of mechanical systems, including all control calibration and adjustment, and requires substantial completion of the building, including closure, ceilings, lighting, partitioning, etc.
3. Allow 21-days after test and balance for system commissioning and life safety testing (where applicable).

1.17 CUTTING AND PATCHING

A. See Division 01 – General Requirements.

1.18 UTILITY CONNECTIONS

A. Utilities include but are not limited to, water, sanitary sewer, storm sewer, natural gas, fire protection water, chilled water, heating water, steam, Energy Management and Control System, etc.

B. Connect to utility company mains as required. Include all meters and other ancillary components required by serving utility company.

C. Connect to on-site piping mains.

D. Contractor shall be responsible for payment of all service charges.

E. Contractor shall be responsible for provisions for temporary utilities.

F. (Others as required).

1.19 WARRANTY

A. In accordance with Division 1 Guarantees, Warranties, Bonds, Service & Maintenance Contracts and as follows.

B. Warranty all materials, equipment, apparatus and workmanship to be free of defective materials and faulty workmanship for a period of one year from and after date of acceptance of completed contract.

C. Provide new materials, equipment, apparatus and labor to replace that determined by Architect to be defective or faulty.

D. This guarantee also applies to services including instructions, adjusting, testing, noise, balancing, etc.

E. Furnish Manufacturer's standard Warranties in excess of one year.

F. Refrigerant compressors to have an additional four-year parts warranty.

G. Nothing herein intends or implies that guarantee shall apply to work which has been abused or neglected by the Owner or the Owner's successor in interest.

1.20 PERMITS

A. Obtain all permits, certificates of inspections, patent rights and licenses that are required for the performing of this work by all laws, ordinances, rules and regulations or orders of any officer and/or body. Provide all notices necessary in connection therewith, and pay all fees relating thereto and all costs and expenses incurred on account thereof. No work shall be covered before inspection by the jurisdiction authorities and observation by the Architect.

1.21 CONTINUITY OF EXISTING SERVICE AND SYSTEMS

A. Schedule work so existing systems will not be interrupted. Obtain approval from the Owner and Architect at least 14 days prior to any utility interruption or connection.

B. Perform work at such time and in such a manner as to cause minimum inconvenience to the Owner and as approved by the Architect. No allowance will be made for lack of knowledge of existing conditions.

C. Existing utility service and systems:

1. Protect existing active utilities.
2. Relocate as indicated on Construction Drawings.
3. Existing inactive utilities shall be capped or plugged (below grade).

D. Connections to existing work:

1. Install new work and connect to existing work with minimum interference to existing facilities.
2. Connect new work to existing work in neat and acceptable manner. Restore existing disturbed work to original condition.

E. Removal and relocation of existing work.

1. Disconnect, remove or relocate piping, ductwork, conduit, and other work noted or required by alterations, modifications or changes in existing construction.

2. Plug or cap affected active lines behind or below finished walls and/or floors.
3. Dispose of removed piping and material.

F. Special Traffic Requirements:

1. Maintain emergency and service entrances so they are usable for pedestrian, truck and emergency vehicles at all times.
2. Where trenches are cut, provide adequate bridging for above-mentioned traffic.

1.22 PROCEDURE OF WORK

A. The Contractor is hereby cautioned that although he will be permitted to conduct his work during regular working hours (see exceptions below), his work shall be performed in such a manner so as not to interfere with the conduct of regular business unless approval for such interference has been obtained from the Owner and Architect. No reimbursement shall be made to the Contractor for losses sustained due to delays and interruptions of his work to accommodate the operation and business of the Owner.

B. Regular working hours exceptions: Extended utilities shutdowns and/or major equipment changeouts.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Listed “Acceptable Manufacturers” are those considered capable of manufacturing products or equipment conforming to detailed Specifications and Schedules, and as such, are invited to compete provided the offering is comparable in every respect to scheduled or specified products and actually conforms to the detailed Specifications and Schedule requirements. Listing herein as “Acceptable Manufacturers” does not imply “Accepted”, “Approved”, “Prior Approval” or any other connotation. All product offerings must be submitted for approval after Contract Award.

B. Alternate manufacturers as identified in each section will be considered under conditions specified herein.

C. Identify materials, equipment by manufacturer's name, nameplate data. Remove unidentified materials, equipment from Site.

D. Equipment specified by manufacturer's number shall include all accessories, controls, etc., listed in catalog as standard with equipment. Furnish optional or additional accessories as specified.

E. Where no specific make of material or equipment is mentioned, any first-class product of reputable manufacturer may be used, provided it conforms to requirements of system and meets with acceptance.

F. Provide an authorized representative to constantly supervise work of this Division, check all materials prior to installation for conformance with Drawings, Specifications, reviewed Submittals and reviewed Shop Drawings.

G. Conform to conditions shown and specified. Coordinate with other trades for best possible assembly of combined Work. Relocate equipment when necessitated by failures to coordinate Work or to advise Architect of conflicts in writing.

H. Material and Equipment-General Requirements

1. New.
2. Approved for use by State Fire Marshal and local building inspection department when applicable.
3. Testing agency labeled or with other identification wherever standards have been established.
4. Architect reserves right to reject items not in accordance with Specification either before or after installation.
5. Comprised to render complete and operable systems; provide additional items needed to complete installation to realized design.
6. Compatible with space allocated; modifications necessary to adjust items to space limitations at Contractor's expense.
7. Installed fully operating and without objectionable noise or vibration.
8. Design of mechanical systems is generally based on product of the first named manufacturers cited. Where systems for product installed necessitate modification of systems shown on drawings, Contractor is responsible for installation of systems appropriate to product installed.

I. Electrical Requirements

1. Electrical Work performed under Division 15 – Mechanical shall conform to requirements of Division 16 Electrical.
2. Provide weatherproof devices and installation for out-of-doors work.

2.2 PAINTING

A. Finish painting (other than factory applied) of mechanical equipment and associated piping and ductwork shall be as specified in Division 09 “Painting” Section(s). Provide touch up painting of prefinished mechanical products.

1. All equipment, ductwork, piping conduit and associated supports, attachments, hardware and connectors exposed to the weather shall be properly coated, painted or otherwise protected from corrosion caused by the elements (sun, wind, rain, snow, ice, etc.).

B. Surfaces shall be left clean, debris shall be removed, and equipment shall be furnished in prime coat finish ready for finish coats.

1. Piping, Ductwork and Equipment: Clean exterior of piping, ductwork and equipment removing rust, plaster and dirt by wire brushing. Remove grease, oil and similar materials by wiping with clean rags and suitable solvents.
2. Motors, Pumps and Other Items with Factory Finish: Remove grease and oil and leave surfaces clean and polished.

C. Cleaning operations may be supplemented by more detailed instructions in various other Sections of this Specification.

D. Paint for high temperature piping and equipment shall be high temperature resistant, designed for the temperatures at which the system will operate.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify that conditions are satisfactory for the installation of materials and equipment. Notify Architect if conditions are not satisfactory and do not commence work until conditions have been corrected.

3.2 INSTALLATION

A. Install materials and equipment in compliance with governing codes.

B. Use printed descriptions, specifications and recommendations of manufacturers as a guide for installation of Work. Follow in all cases where manufacturers of articles used furnish directions covering points not specified or shown.

C. Equipment.

1. Assemble equipment which is required to be field assembled under the direct supervision of the manufacturers' agent.
2. Prior to the final acceptance submit letters from the manufacturers that equipment has been assembled under the direct supervision of the manufacturers' agent.
3. Accurately set and level equipment with supports neatly placed and properly fastened.
4. Properly fasten equipment in place with bolts to prevent movement.
5. Coordinate the installation of equipment with openings in structure.
6. Coordinate and fully dimension steel supports for mechanical equipment where shown on drawings with installing contractor.
7. Provide all roof curbs for roof mounted fans, flues, piping and duct penetrations, etc.
8. Concrete.

    a. Concrete work, include forming, steel bar reinforcing, cast-in-place concrete, finishing and grouting is specified under Division 03 Concrete.

b. Coordinate and fully dimension concrete housekeeping pads and curbs with installing contractor; dimensions shall be as required for structural requirements.
c. Coordinate inertia base fill with installing contractor

D. Electrical.

1. See Division 16 Electrical.
2. Install electrical devices with code required clearances and access.
3. Assist the electrical contractor in the proper connecting of all electrical wiring and equipment required for mechanical equipment.

E. Sleeves, Chases and Concrete Inserts.

1. Provide all required sleeves, chases, concrete inserts, anchor bolts, etc.
2. Sleeves, chases are prohibited in structural members, except where shown or as directed by Architect in writing.
3. Embed no piping in concrete or masonry.

F. Waterproof Construction.

1. Comply with Division 07 – Thermal and Moisture Protection.
2. Include membrane clamps, sheet metal flashing, counter flashing, caulking and sealant as required for waterproofing of mechanical penetrations and sealing penetrations in or through fire walls, floors, ceiling slabs and foundation walls.
3. All penetrations through vapor barriers at slabs on grade shall be taped and made vapor tight.
4. Provide galvanized sheet metal weather protection canopies, hoods or enclosures over all out-of-doors equipment, the operation or maintenance of which would be impaired by rain water; this requirement applies to damper operators and bearings, damper motors, controls and instruments; see other Sections in this Division for application of this requirement to motors, drives, ducts and fans.

G. Restoration of Damage.

1. Repair or replace, as directed by Architect, materials and parts of premises which become damaged.
2. Remove replaced parts from premises at no additional cost to the Owner.

H. Review architectural drawings and coordinate with Architect and other contractors to be sure that all architectural shafts, plenums, rated duct enclosures etc. required for mechanical systems are properly located and dimensioned.

I. Access Panels and Doors.

1. Coordinate size requirements and exact locations with Contractor who will install access doors.

2. Minimum Sizes: 18 inches by 18 inches unless otherwise shown on Drawings or approved by Architect.
3. Provide where shown, or required by Regulatory Agencies, for access of all concealed equipment such as terminal units, valves, fire/smoke dampers, etc., for Mechanical Work:

    a. Equipment shall be located wherever practical over accessible ceilings or rooms to avoid access doors.
    b. Access doors shall not be used solely for access to balancing dampers; use instead remote control devices specified under Section 15820 – Air Duct Accessories.

J. Openings.

1. Coordinate and fully dimension all openings in walls, floors, roofs and structural elements required for mechanical work.
2. Provide all required fire-stopping around pipe, duct and other penetrations required for mechanical work in rated partitions where required by code.
3. Fire damper openings: Contractor shall provide damper UL installation requirements to contractor installing partitions to ensure construction complies with listing.
4. Air outlet openings.
    a. Contractor shall coordinate exact locations of air outlets in floors, walls and ceilings with contractor installing partition.
    b. Contractor shall coordinate additional T-bar or spline required to accept air outlets with contractor providing and installing ceiling and associated materials.

3.3 PROTECTION OF EQUIPMENT AND MATERIALS DURING CONSTRUCTION

A. See Division 01 – General Requirements.

B. Provide protective covers, skids, plugs or caps to protect equipment and materials from damage or deterioration during construction.

C. Store equipment and material under cover, and off the ground or floors exposed to rain.

D. For outdoor storage, protective covers of 10 mil thick black sheet plastic shall be fitted over equipment and materials. Covers shall be reinforced to withstand wind and precipitation. Set equipment and material on skids or platforms of height to avoid damage or deterioration from spattering and ground water.

E. Protect coils against damage by installing temporary closure panels over exposed coil faces. Panels shall be minimum 24 gauge sheet metal or 0.375" plywood.

F. Completely cover motors and other moving machinery to protect from dirt and water during construction.

G. Close open ends of fans, air valves, terminal units, energy recovery units, air handling units, and ductwork with temporary closures of sheet plastic taped in place.

H. Plug ends of pipes when work is stopped to prevent debris from entering the pipes.

I. Provide dust and debris protection for ductwork, coils, fans, equipment, motors, and bearings operated during construction up to date of substantial completion.

J. Cover open ends of exhaust and return ducts with temporary filter media while fan systems are operating.

K. Material, equipment or apparatus damaged because of improper storage or protection will be rejected.

1. Remove from site and provide new, duplicate, material, equipment or apparatus in replacement of that rejected.
2. Any porous materials, such as duct liner, insulation or flexible ductwork that becomes wet; for example due to rain, shall be replaced; drying is not sufficient (due to possible microbial contamination).

L. Perform Work in manner precluding unnecessary fire hazard.

3.4 ADJUSTMENT

A. Preliminary Operation.

1. Operate any portion of installation for Owner's convenience if so requested by Architect. Such operation does not constitute acceptance of Work as complete but does constitute beneficial use. Cost of utilities, such as gas and electrical power, will be borne by the Owner if operation is requested by Owner.

B. Startup Service.

1. Prior to startup, ensure that systems are ready, including checking the following: Proper equipment rotation, proper wiring, auxiliary connections, lubrications, venting fan balance, controls and installed and properly set relief and safety valves. See pre-function tests in Division 15 – Mechanical.
2. Start and operate all systems.
3. Provide services of factory trained technicians for startup of major equipment and systems including boilers, chillers, fire pumps, etc.
4. Adjusting: See Section 15950 – Testing, Adjusting and Balancing for HVAC.
5. Functional Testing: See Section 15900 – Energy Management & Control Systems.
6. Life Safety Testing.

a. Assist Division 16 Electrical contractor in testing fire alarm controls, including control of smoke dampers and shut-off of fan systems.
b. Correct any problems related to equipment supplied under Division 15 – Mechanical.

c. Complete the control matrix with details such as fan tags, FSD tags, etc. based on control matrix provided with Life Safety Report.
d. Assist Life Safety System commissioning agent in testing and commissioning Life Safety System.
e. Provide all tests, air balance and start-up personnel required to start and commissioning the system and for assisting the design/construct team in demonstrating system compliance with the local fire district and building department.

C. Noise.

1. Cooperate in reducing any objectionable noise or vibration caused by mechanical systems to the extent of adjustments to specified and installed equipment and appurtenances.
2. Completely correct noise problems caused by failure to make installation in accordance with Contract Documents, including labor and materials required as a result of such failure, at no additional cost to the Owner.

3.5 SPECIAL TOOLS

A. Furnish to Owner at completion of work.

1. One set of any special tools required to operate, adjust, dismantle or repair equipment furnished under any section of this Division.
2. Pressure gage and temperature sensor for piping test plug.

3.6 CLEANING

A. Cleaning.

1. See Division 01 – General Requirements.

B. Thoroughly clean equipment, fans, pumps, motors, piping and other materials under this Division free from all rust, scale and all other dirt before any covering or painting is done, or the systems put in operation; leave in condition satisfactory to Architect.

C. At all times keep the premises free from accumulation of waste material and debris caused by his employees. At the completion of the Project, and at other times as Architect may direct, remove refuse from within and around the building. All tools, scaffolding and surplus materials shall also be removed, leaving the Site of his Work clean.

D. Completely cover all plumbing fixtures and all motors and other moving machinery to prevent entry of dirt and water during construction.

E. Effectively cap all openings into ducts and pipes to keep moisture and foreign matter out during construction.

F. Clean and polish identification plates.

G. Clean equipment, ductwork, insulation, piping, conduit, and room surfaces from dust and dirt and maintain in a clean condition from date of substantial completion until final completion of work and corrective work.

3.7 PAINTING

A. Painting.

1. Piping exposed to outdoors and where indicated elsewhere.

    a. One coat primer.
    b. Two coat alkyd oil paint, UV resistant for PVC piping, color as indicated.
    c. Not required for copper, galvanized steel, or insulated piping.

2. Steel hangers and supports exposed to outdoors.

    a. One coat primer.
    b. Not required for galvanized steel.

3. Interior of ductwork and duct accessories, including insulation stick pins, at air outlets as far back as visible from occupied spaces.

    a. Flat black.

4. Marred surfaces of factory painted equipment.

    a. Spot coat to match adjacent coat.

5. Insulation exposed to sunlight:

B. Execution.

1. Protect flooring and equipment with drop cloths.
2. Paint and materials stored in location where directed.
3. Oily rags and waste removed from building every night.
4. Wire brush and clean off all oil, dirt and grease areas to be painted before paint is applied.
5. Workmanship.

    a. No painting or finishing shall be done with:

        1) Dust laden air.
        2) Unsuitable weather conditions.
        3) Space temperature below 60 deg. F.

    b. Pipes painted containing no heat and remain cold until paint is dried.

c. Paint spread with uniform and proper film thickness showing no runs, sags, crawls or other defects.
d. Finished surfaces shall be uniform in sheen, color and texture.
e. All coats thoroughly dry before succeeding coats are applied, minimum 24 hours between coats.
f. Priming undercoat of slightly different color for inspection purposes.

6. Piping continuously painted in all exposed areas.

C. Paint.

1. High gloss medium or long alkyd paint.
2. Best grade for its purpose.
3. Deliver in original sealed containers.
4. Apply in accordance with manufacturer's instructions.

D. Colors.

1. Colors as directed by Architect unless specified herein.
2. Interior of ductwork as far back as visible from outside: flat black.
3. Uncoated hangers, supports, rods and insets: dip in zinc chromate primer.

E. Factory Finish.

1. Ceiling and wall mounted air outlets in acoustical tile ceilings: Baked white enamel.
2. Aluminum air outlets that are not to be painted: anodized.
3. Exposed fan coil units: baked enamel.
4. Unit ventilators and unit heaters: baked enamel.
5. Fans, pumps, compressors, tanks and like items.
6. Air handlers, pumps, water heaters and like items where exposed.

F. Marred surfaces of prime coated equipment and piping: spot prime coat to match adjacent coat.

G. Properly prepare Work under this Division to be finish painted under Division 09 – Painting.

H. Provide moisture resistant paint for exterior painting and heat resistant paint for hot piping, equipment and materials.

I. For the following, provide factory prime coat. Also, provide factory finish painting on each if not specified in Painting Division.

1. Other air outlets.

J. Paint all equipment out-of-doors and equipment supports with two coats of weather resistant enamel.

K. Protect all finished surfaces of fixtures with heavy paper pasted thereon, or by other means, throughout the period of construction.

L. Refinish Work supplied with final finish under this Division if damaged under this Division to satisfaction of Architect.

3.8 FIELD QUALITY CONTROL

A. See Division 01 – General Requirements (Quality Control).

B. Tests.

1. Perform as specified in individual sections and as required by authorities having jurisdiction.
2. Duration as noted.

C. Provide required labor, material, equipment and connections.

D. Furnish written report and certification that tests have been satisfactorily completed.

E. Repair or replace defective work, as directed by Architect in writing, at no additional cost to the Owner.

F. Restore or replace damaged work due to tests as directed by Architect in writing, at no additional cost to the Owner.

G. Restore or replace damaged work of others, due to tests, as directed by Architect in writing, at no additional cost to the Owner.

H. Remedial work shall be performed to the satisfaction of the Architect, at no additional cost to the Owner, including:

1. Work related to all Division 15 – Mechanical tests.
2. Division 15 – Mechanical work related to Section 15950 – Testing, Adjusting and Balancing for HVAC.

I. Remedial work shall include performing any tests related to remedial work and additional time at no additional cost to the Owner.

3.9 EXISTING EQUIPMENT AND SYSTEMS

A. Owner has first right of refusal of all existing equipment and components indicated to be removed.

B. Material and equipment which has been removed and not accepted by the Owner shall become the property of the Contractor and shall be removed from the site.

C. Material and equipment which has been removed shall not be used in the new work, except as specified herein.

D. Where existing piping, ductwork and equipment is indicated on the Drawings, its size and location shall be verified.

3.10 EQUIPMENT AND INSTALLATION REQUIREMENTS

A. Air systems shall operate without aerodynamic noise generated from the faulty installation of ductwork or any component of the air distribution system.

B. Equipment shall be installed and connected as specified herein or indicated on the Drawings in accordance with the manufacturers' instructions and recommendations for this Project. Furnish and install auxiliary piping, water seals, valves, and electrical connections recommended by the manufacturer for operation.

C. Provide roughing, fittings, accessories, and connecting piping, and make final connections to all equipment. Coordinate carefully with equipment vendor prior to starting rough-in work.

D. In unfinished areas designated for future build-out, install piping, ductwork, conduit and equipment tight against the structure to maximize future ceiling height.

E. Motor quantities, sizes and equipment wattage ratings specified herein or indicated on the Drawings are the minimum requirements, unless noted otherwise. Motor quantities, sizes and equipment wattage ratings less than those specified herein or indicated on the Drawings are not acceptable. Larger motor sizes and equipment wattage ratings may only be provided if necessary, to meet the prescriptive requirements specified herein or indicated on the Drawings. Where multiple motors or motor sizes or equipment wattage ratings larger than specified herein or indicated on the Drawings are furnished, provide and coordinate the corresponding increased number or capacity of feeders and other electrical equipment serving them, at no additional cost to the Owner.

F. Fans, drive sheaves, motors, and pumps shall be statically and dynamically aligned and balanced. Each shall have steady state radial vibration levels which do not exceed the following:

Equipment	Peak-to-Peak Displacement (mils)
Fans, drive sheaves, and motors	
under 600 rpm	4
600 to 1000 rpm	3
1000 to 2000 rpm	2
over 2000 rpm	1
Pumps and motors	
over 1800 rpm	1
under 1800 rpm	2

G. Field-installed equipment controls or sensor wiring shall be installed in conduit. Low voltage control and sensor wiring shall be installed in conduits separate from line voltage control wiring and power wiring.

H. Where water connection sizes at equipment vary from the pipe size indicated on the Drawings, provide appropriate reducers/increasers directly adjacent to the pipe-equipment unions. Unless otherwise specified herein or indicated on the Drawings, the size of the valves and accessories dedicated to the equipment shall not be less than the pipe size to which they are connected.

I. Install all work so that parts requiring periodic inspection, operation, maintenance and repair are readily accessible and with the manufacturer's minimum required clearances provided. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made without written approval.

1. Group concealed valves, controls and equipment requiring access, so as to be freely accessible through access doors.

3.11 EXCAVATION AND BACKFILLING

A. In accordance with the requirements of Division 31 – Earthwork for excavating, trenching, and backfilling.

B. Provide barricades, signs, lanterns, shoring, sheeting and pumping as part of Work in this Division as required to ensure safe conditions. Comply with OSHA requirements.

C. Dig trenches straight, true to line and grade with sides and bottoms smoothed of any rock points.

1. Excavate 6 inches below grade of pipe.
2. Fill with sand properly packed.
3. Support pipe for entire length on packed sand.
4. Shape or pack bottom of trenches for pipe, duct fittings, hubs, couplings, etc., using templates to fit outside periphery of lower third of piping and ductwork.
5. Provide piping outside building with 36-inch minimum cover from top of pipe to finished grade.
6. Minimum width 16 inches.

D. Dispose of all surplus excavation material and seepage water as directed by the Architect.

E. Backfill.

1. After piping has been installed, tested and approved, backfill all excavation, tamp and compact by sheeps foot tampers.
2. Backfill to 6-inches above crown of pipe with unwashed sand, with remainder of trench back-filled and mechanically tamped in 6-inch maximum layers of selected excavated materials, free from organic matter, rocks, etc. Provide 90-

percent compaction in accordance with ASTM D 1557-58T; 95-percent compaction for trenches below building slabs.

F. When piping is installed, prior to backfilling, advise Architect; do not backfill without acceptances of Architect. Replace to original condition all paving, curbs, gutters, walks, etc., which become disturbed by trenching.

3.12 DIAGRAMS

A. Frame and mount the following information:

Information	Location
HVAC diagrams, start-stop procedures, valve schedules, and valve location floor plans.	Appropriate mechanical rooms.
Energy Management control diagrams and sequences.	Adjacent to each control panel.
Appropriate control and interface drawings, including a simplified guide to local programming through the digital display unit, a directory of I/O points connected to that panel, and variables which may be displayed.	Posted on the inside cover of each EMCS panel.

B. Diagrams shall be computer generated. Diagrams shall be as-built, and shall include interfaces and interlocks with other equipment. Diagram framing system: 0.125" thick acrylic with satin finish aluminum frames.

3.13 MAINTENANCE

A. Equipment operated prior to the date of substantial completion shall be maintained in accordance with manufacturer's recommendations. In addition, provide complete water treatment for hydronic and steam systems operated prior to date of substantial completion.

B. Prepare and submit a lubrication chart listing for each piece of equipment:

1. Points requiring lubrication.
2. Recommendations for a single manufacturer's lubricants with brand name and designation.
3. Frequency of lubrication required.

C. Lubricate each item of apparatus requiring lubrication prior to start-up in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 15020 MECHANICAL CLOSE-OUT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Summary Includes

1. As-Built Drawings.
2. Operation and maintenance documentation directory.
3. Emergency manuals.
4. Operation manuals for systems, subsystems, and equipment.
5. Maintenance manuals for the care and maintenance of systems and equipment.
6. Closeout Documentation Checklists.
7. Warranties

1.3 SUBMITTALS

A. Initial Submittal: Submit draft copy of each manual a minimum of 60 days prior to requesting Substantial Completion inspection. Include a complete operations and maintenance directory. Architect will return draft copy and mark whether general scope and content of manuals are acceptable.

B. Submit manuals according to the following table.

1. “R” means required.

Item	Product Data	O&M Manual	Samples	Shop Drawing
As-Built drawings		R		
Operation and Maintenance Documentation Directory		R		
Emergency Manual		R		
Operation Manual		R		
Systems and Equipment Maintenance Manual		R		
Closeout Documentation Checklists		R		
Warranties		R		

PART 2 - PRODUCTS

2.1 AS-BUILT DRAWINGS

A. Maintain at job site a set of contract record documents kept current by indicating thereon all changes, substitutions, etc., between work as specified and as installed.

B. Show on record documents actual air quantities, water flow rates, valve or damper positions after balancing, etc.; also show, by actual dimension, location of all new and known existing underground work.

C. At the completion of the project, furnish the Owner three sets of drawings and three complete, clean sets of specifications showing installed location, size, etc., of all work and material as taken from record documents. All as-built (on record) drawings shall be labeled “As-Built Drawings,” dated and certified accurate by Contractor with his signature, on front page of all Drawing sets and Specifications.

2.2 OPERATION AND MAINTENANCE MANUALS

A. These operation and maintenance manual requirements supplement operation and maintenance manual documentation requirements of other Sections of these specifications.

B. Operation and maintenance documentation, in hardback 3-ring loose-leaf binders except full size drawings and CDs, shall cover the HVAC and building automation systems. Documentation shall include an operations and maintenance documentation directory, emergency information, operating manual, maintenance manual, test reports, and construction documents.

C. Initial Submittal: The operation and maintenance documentation package shall be submitted as one comprehensive package to the Owner 1 month before systems start-up, and shall be updated, revised and completed at completion of construction.

D. Final Submittal: Provide two (2) complete manuals.

1. Correct or modify each manual to comply with Architect’s comments. Submit Final manuals shall be submitted 15 working days prior to demonstration and training of Owner’s personnel. Manuals are to be used in training sessions by Owner’s personnel.

E. Compile and coordinate the documentation for equipment and systems installed. Unless otherwise indicated, organize each manual into a separate section for each system and subsystem and a separate section for each piece of equipment not part of a system. Documentation shall be typewritten and shall contain, at a minimum, the following information.

1. Introduction:

a. Project name, contractors' and subcontractors' names, addresses, telephone numbers, email addresses and facsimile numbers. Indicate the portion of the work for which each subcontractor was responsible.
b. List of Documents.
c. List of systems.
d. List of equipment.
e. Table of Contents.

2. Operations and Maintenance Documentation Directory:

   a. Explanation of the identification system used, including lists of systems, equipment, and component identifiers and names. Use the same system, subsystem and equipment designation as used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, “Preparation of Operating and Maintenance Documentation for Building Systems.”

3. Manual Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

   a. Title page.
   b. Warranty Page
   c. Table of contents.
   d. Manual contents.

4. Manual Title Page: Enclose title page in transparent plastic sleeve. Include the following information:

   a. Project name, contractors' and subcontractors' names, addresses, telephone numbers, email addresses and facsimile numbers. Indicate the portion of the work for which each subcontractor was responsible.
   b. Subject matter included in manual.
   c. Name and address of Project.
   d. Name and address of Owner.
   e. Date of submittal.
   f. Name, address, telephone number, fax number and email address of Contractor.
   g. Name and address of Architect and other Architects.
   h. Cross-reference to related systems in other operation and maintenance manuals.

5. Warranty Page

   a. Provide table as shown at end of this section. Table to be on separate page in O&M. two (2) copies of table to be laminated and turned over to owner. All products and other warranties to be listed in table.

6. Manual Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume and cross-referenced to Specification Section number in Project Manual.

    a. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table for all volumes in each volume of the set.

7. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem and equipment. If possible, assemble instructions for subsystems, equipment and components of one system into a single binder.

    a. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2 x 11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

        1) If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary, to provide essential information for proper operation or maintenance of equipment or system.
        2) Identify each binder on front and spine, with printed title “OPERATION AND MAINTNANCE MANUAL,” Project title or name, project number and subject matter contents. Indicate volume number for multiple-volume sets and six-digit Section number on bottom of spine.

    b. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the system on each divider, cross-referenced to Specification Section number and title of Project Manual.
    c. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
    d. Supplementary Text: Prepared on 8-1/2 x 11-inch, “20-lb” white bond paper.
    e. Drawings: Attached reinforced, punched binder tabs on drawings and bind with text.

        1) If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
        2) If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual or reduced drawings. DO NOT USE BINDER POCKETS. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents and drawing locations.

f. Provide color photographs instead of drawings where necessary to demonstrate unusual or complex installations.

8. Emergency Information:

a. Information for technical and nontechnical personnel about actions recommended during emergency situations to protect life and property and to minimize disruption to the building occupants. Emergencies shall, at a minimum, include:

1) Fire.
2) Security breach.
3) Water outage.
4) Power failure.
5) Refrigerant release.
6) Heating failure.
7) Cooling failure.

2.3 EMERGENCY MANUALS

A. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment and component:

1. Fire.
2. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem or equipment failure.
8. Chemical release or spill.
9. Sub-freezing weather conditions.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier and manufacturer to maintain warranties.

D. Emergency Procedures: Include the following as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.

3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

2.4 OPERATION MANUAL

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem and equipment descriptions.
2. Performance and design criteria if Contractor is delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Valve tag lists.
10. Precautions against improper use.
11. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number.
2. Manufacturer’s name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves for pumps, fans and heat exchangers.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment of system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation and diagram controls as installed.

E. Piped Systems: Diagram piping as installed and identify color-coding where required for identification.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, product information, maintenance procedures, repair materials, warranty information and bond information as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address and telephone number of Installer or supplier and maintenance service agent. Cross-reference Specification Section number and title in Project Manual.

C. Manufacturer's Maintenance Documentation: Manufacturer's maintenance documentation including the following information for each component part or piece of equipment:

1. Standard printed maintenance instructions and bulletins.
2. Drawings, diagrams and instructions required for maintenance including disassembly and component removal, replacement and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly: component removal, repair and replacement and reassembly Instructions.
5. Aligning, adjusting and checking instructions.
6. Manufacturer's demonstration and training videotape or DVD, if available.
7. Required maintenance documentation to uphold warranties.

E. Maintenance and Service Schedule: Include service and lubrication requirements, list of required lubricants for equipment and separate schedules for preventative and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual and annual frequencies.
2. Maintenance and Service Record: Include manufacturer's forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturer's maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of executed warranties and bonds and lists of circumstances and conditions that would affect validity of warranties and bonds.

1. Include procedures to follow and required notifications for warranty claims.
2. Include all model, serial numbers and information required on table at end of section. Table is available in Excel upon request from Professional.

NOTE: Where manuals contain manufacturer's standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data includes more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

2.6 CLOSEOUT DOCUMENTATION

A. Seven days prior to requesting a final inspection, the Contractor shall submit all O&M and closeout documentation to the Architect, to be submitted to the Owner at the end of the project.

B. The checklist herein shall be utilized for compiling documentation and shall be included behind front cover of O&M manuals.

C. Contractor shall initial and date each line item once completed and shall email a copy of the completed checklist to the Architect prior to final inspection request.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.

B. Assemble a complete set of the following manuals indicating procedures for each.

1. Emergency manual.
2. Product maintenance manual.
3. Operations and maintenance manual.

C. Manufacturer's Data: When manuals contain manufacturer's standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data includes more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

D. Drawings: Prepare drawings supplementing manufacturer's printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequences and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation. Do not use original Project Record Drawings.

1. Do not use original Project Record Drawings as part of operation and maintenance manuals.

3.2 CLOSEOUT DOCUMENTATION CHECKLIST

A. Closeout Documentation Checklists included:

1. Division 15 – Plumbing.
2. Division 15 – HVAC.

CLOSEOUT DOCUMENTATION CHECKLIST DIVISION 15 – FIRE PROTECTION		
Project Name:		
Initials of person completing task	Date task completed	Description of Contractor's Submittal
		Signed Letter Record of Owners Personnel O & M Training.
		DVD Record of Owners Personnel O & M Training (3 each).
		Valve tag and floor plan location charts.
		Pipe pressure test log. Pipe pressure tests per NFPA 13.
		Provide copy of Installation and Material Certificate per NFPA 13.

CLOSEOUT DOCUMENTATION CHECKLIST DIVISION 15 – PLUMBING		
Project Name:		
Initials of person completing task	Date task completed	Description of Contractor's Submittal
		Final TAB Report.
		Signed Letter Record of Owners Personnel O & M Training.
		DVD Record of Owners Personnel O & M Training (3 each).
		Operation & Maintenance Manuals.
		As-Built Drawings with Contractor's Stamp.
		Warranty Information.
		Potable Water Sanitation Report and Certification.
		Pipe pressure test log. Include narratives of what was tested, description of test methodology and results.
		Valve tag and floor plan location charts.
		Keys to access doors, control panels, etc. (provide written receipts with Owner's acceptance).
		Keys to plumbing stops and hose bibb boxes (provide written receipts with Owner's acceptance).
		Provide spare Circulating Pump seals (provide written receipts with Owner's acceptance).

CLOSEOUT DOCUMENTATION CHECKLIST DIVISION 15 – HVAC		
Project Name:		
Initials of person completing task	Date task completed	Description of Contractor's Submittal
		Final TAB Report (3 each required).
		Signed Letter Record of Owners Personnel O & M Training.
		DVD Record of Owners Personnel O & M Training (3 each).
		Operation & Maintenance Manuals.
		As-Built Drawings with Contractor's Stamp.
		Warranty Information.
		Manufacturer's representative(s) shall provide certification(s) that HVAC equipment has been installed in accordance with manufacturer's recommendations. Typical for Boilers, Chillers, HVAC pumps and Central Station AHU's.
		Provide list of all spare air filter sets. List number, size, type and location/equipment match-up.
		Certification by Contractor that all bearings requiring periodic lubrication, as recommended by equipment manufacturer, have been initially lubricated and have been tagged. Provide a list of all equipment lubricated.
		Pipe Pressure Test Log.
		Duct Pressure Test Log.
		Original issue BAS (EMCS) software & manuals, trend logs, BAS database backup, etc.

		Control sequences of operation.
		Valve tag and floor plan location charts.
		On a reduced floor plan drawing, the CONTRACTOR shall indicate the location of all variable frequency drives, starters, and switches. These devices shall be properly marked to indicate equipment they serve as designated on the Contract Documents.
		Copy of HVAC Water Chemical Treatment Test Results
		Keys to access doors. (Provide written receipts with Owner's acceptance).
		Keys to control panels and sensor/controller covers (provide written receipts with Owner's acceptance).
		Certification of alignment of pumps.
		Provide spare Circulating Pump seals (provide written receipts with Owner's acceptance).
		Certification of hydronic and steam system cleaning.
		Certification of EMCS system calibration and testing.
		Receipt for EMCS system training.
		Receipt acknowledging no EMCS system failures during test period.
		Certification by ION generator technical representative that all units are installed in specified systems are installed properly and functional.
		ION counter

PROJECT NAME									
Equipment Tag	Manufacturer	Model Number	Serial Number	Manufacturer Warranty Description	Start Date	End Date	Contact Information		Remarks
							Name	Phone Number	
RTU-1	NAME OF MANUFACTUER	ABC1234	ABC1234	1-year Parts Only	1/1/2020	1/1/2021	John Doe (Company)	(xxx) xxx-xxxx	
				5-year Compressor Parts Only	1/1/2020	1/1/2021	John Doe (Company)	(xxx) xxx-xxxx	
VAV Terminal Units	NAME OF MANUFACTUER	ABC1234	ABC1234	1-year Parts Only	1/1/2020	1/1/2021	John Doe (Company)	(xxx) xxx-xxxx	
EF-1	NAME OF MANUFACTUER	ABC1234	ABC1234	1-year Parts Only	1/1/2020	1/1/2021	John Doe (Company)	(xxx) xxx-xxxx	
EWH-1	NAME OF MANUFACTUER	ABC1234	ABC1234	5-year Heating Element	1/1/2020	1/1/2025	John Doe (Company)	(xxx) xxx-xxxx	
				10-year Tank	1/1/2020	1/1/2030	John Doe (Company)	(xxx) xxx-xxxx	
ODU-1	NAME OF MANUFACTUER	ABC1234	ABC1234	10-year Parts Only	1/1/2020	1/1/2030	John Doe (Company)	(xxx) xxx-xxxx	
IDU-1.01	NAME OF MANUFACTUER	ABC1234	ABC1234	10-year Parts Only	1/1/2020	1/1/2021	John Doe (Company)	(xxx) xxx-xxxx	
VRF Equipment	NAME OF MANUFACTUER	N/A	N/A	10-year Parts Only	1/1/2020	1/1/2030	John Doe (Company)	(xxx) xxx-xxxx	Includes central controller and thermostats
				2-year Labor	1/1/2020	1/1/2022	John Doe (Company)	(xxx) xxx-xxxx	Includes refrigerant and programming
HVAC Controls Actuators	NAME OF MANUFACTUER	N/A	N/A	5-year Parts Only	1/1/2020	1/1/2025	John Doe (Company)	(xxx) xxx-xxxx	

<CONTRACTOR NAME HERE> warranties and guarantees all materials, equipment and workmanship provided by our company relating to the HVAC system and Plumbing for the above referenced project.
If any parts or materials supplied by our company prove defective, we will repair or replace such items as necessary without expense to the Owner, including costs of services, materials, transportation, parts and labor.
This warranty period begins on <INSERT SUBSTANTIAL SUBMITTAL DATE> and shall run for one year from that date.
Any questions relating to warranty should be directed to our home office at <INSERT PHONE NUMBER>.

END OF SECTION

SECTION 15030 DEMONSTRATION AND TRAINING FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Administrative and Procedural requirements for preparing operation and maintenance manuals, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.

1.3 SUBMITTALS

A. Initial Submittal: Submit draft copy of each manual a minimum of 60 days prior to requesting Substantial Completion inspection. Include a complete operations and maintenance directory. Architect will return draft copy and mark whether general scope and content of manuals are acceptable.

B. Submit manuals according to the following table.

1. “R” means required.

Item	Product Data	O&M Manual	Samples	Documentation
Instruction program				R
Qualification data				R
Attendance record				R
Evaluations				R
DVD				R

C. Instruction Program: Submit to the Architect copies of instructional program outline for demonstration and training, including a schedule of proposed dates, times, length of instruction and instructors’ names for each training module. Include learning objective and outline for each training. Submit to Professional a minimum of seven (7) working days prior to program date coordinated with Owner and Architect.

1. At completion of training, submit two (2) complete training manuals for Owner's use.

D. Qualification Data: Include lists of completed projects with project names and addresses, names, and addresses of Architects and Owner and other information specified.

E. Attendance Record: For each training module, submit list of participants and length of instruction time.

F. Evaluations: For each participant and each training module, submit results and documentation of performance-based test.

G. Demonstration and Training DVD's: Submit two copies of each DVD within seven (7) days of recording.

1. Format: Provide high quality color DVDs.
2. Identification: On each DVD, provide an applied label with the following information:

a. Name of project.
b. Name and address of photographer.
c. Name of Engineer.
d. Name of Contractor.
e. Date DVD was recorded.
f. Description of vantage point, indicating location, direction (by compass point) and elevation or construction story.

H. Transcript: Prepared on 8-1/2 x 11" (A4) paper, punched and bound in heavy-duty, 3-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with the same label information as the corresponding DVD. Include name of Project and date of DVD on each page.

1.4 QUALITY ASSURANCE

A. Instructor Qualifications: A factory-authorized service representative experienced in operation and maintenance procedures and training.

B. Photographer Qualifications: An individual of established reputation who has been regularly engaged as a professional video photographer for not less than five years.

C. Pre-instruction Conference: Contact Architect and review methods and procedures related to demonstration and training including, but not limited to the following:

1. Inspect and discuss locations and other facilities required for instruction.
2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
3. Review required content of instruction.

4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.5 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.

B. Coordinate instructors, including providing notification of dates, times, length of instruction and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections and as follows:

1. Heat generation including boiler, pumps, and heating water distribution piping.
2. Gas-fired heating equipment.
3. Refrigeration systems including chillers, pumps, ice storage tanks and chilled water piping.
4. HVAC systems including air-handling equipment, unit heaters, power ventilators, heat exchangers, piping specialties, etc.
5. Energy Management and Control System.
6. All control end-devices and sensors.
7. Variable Frequency Drives.

B. Training Modules (Basis of System Design, Operational Requirements and Criteria): Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participants are expected to master. For each module, include instruction for the following (this will be provided through the Architect):

1. System, subsystem, and equipment descriptions.
2. Performance and design criteria.
3. Operating standards.
4. Regulatory requirements.
5. Equipment function.
6. Operating characteristics.
7. Limiting conditions.
8. Performance curves.

C. Training Modules (Documentation): Review the following items in detail:

1. Emergency manuals.
2. Operations manuals.
3. Maintenance manuals.
4. Project record documents.
5. Submittal manual.
6. Identification systems.
7. Warranties and bonds.
8. Maintenance service agreements and similar continuing commitments.
9. Owner requirements to uphold extended warranties.

D. Emergencies: Include the following as applicable:

1. Instructions on meaning of warnings, trouble indications and error messages.
2. Instructions on stopping.
3. Shutdown instructions for each type of emergency.
4. Operating instructions for conditions outside of normal operating limits.
5. Sequences for electric or electronic systems.
6. Special operating instructions and procedures.

E. Operations: Include the following as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Control Sequences.
6. Safety procedures.
7. Instructions on stopping.
8. Normal shutdown instructions.
9. Operating procedures for emergencies.
10. Operating procedures for system, subsystem, or equipment failure.
11. Seasonal and weekend operating instructions.
12. Required sequences for electric or electronic systems.
13. Special operating instructions and procedures.

F. Adjustments: Include the following:

1. Alignments.
2. Checking adjustments.
3. Noise and vibration adjustments.
4. Economy and efficiency adjustments.

G. Troubleshooting: Include the following:

1. Diagnostic instructions.
2. Test and inspection procedures.
3. Procedures for Owner’s efforts ahead of a warranty call.

H. Maintenance: Include the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Procedures for routine cleaning.
5. Procedures for preventative maintenance.
6. Procedures for routine maintenance.
7. Instructions on use of special tools.
8. List of all maintenance required to uphold warranties.

I. Repairs: Include the following:

1. Diagnosis instructions.
2. Repair instructions.
3. Disassembly: component removal, repair and replacement and reassembly instructions.
4. Instructions for identifying parts and components.
5. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training modules. Assemble training modules into a combined training manual.

B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

A. Facilitator: The Architect will serve as facilitator to assist the Contractor in preparation of instruction program and training modules, to coordinate instructors and to coordinate between Contractor and Owner for number of participants, instruction times and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate and maintain systems, subsystems, and equipment not part of a system.

1. Contractor will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
2. Owner will furnish an instructor to describe Owner's operational philosophy.
3. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner, through Architect, with at least fifteen (15) days advance notice.

2. Submit training agenda/information to Professional for review and approval at lest seven (7) days prior to meeting.

D. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a written performance-based test.

E. Demonstration and Training DVD: Record each training module separately. Include classroom instructions and demonstrations, board diagrams and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

F. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 DEMONSTRATION AND TRAINING DVDs

A. Demonstration and Training DVDs: Record instruction of Owner's personnel in the operation and maintenance of equipment and systems. Edit DVDs to remove non-instructional conversation. Photographer shall select vantage points to best show equipment, systems and procedures demonstrated. Include instructions and details on maintenance, and operational procedures which are required to uphold quality equipment/system performance, and warranties. Provide information about Owner responsibilities for precheck items ahead od contacting warranty groups, and include warranty contact procedures.

END OF SECTION

SECTION 15050 BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Administrative and Procedural requirements for preparing operation and maintenance manuals, including the following:

1. Temporary operation of mechanical equipment.
2. Wall and ceiling access panels.
3. Roof curbs.
4. Fire, smoke, and sound stopping.
5. Pipe Sleeves.
6. Escutcheons.
7. Dielectric Fittings.
8. Protective drip pans.
9. Non-shrink grout.

1.3 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawings
Wall and ceiling access panels	R			R
Roof curbs	R			R
Fire, smoke and sound stopping	R			R
Pipe sleeves and sleeve seals	R			R
Escutcheons	R			
Dielectric fittings	R			
Protective drain pans	R			R
Non-shrink grout	R			

1.4 QUALITY ASSURANCE

A. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be paid by this Contractor for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must minimum requirements.

1.5 TEMPORARY ENVIRONMENTAL CONDITIONING

A. If the Contractor requires temporary heating, cooling, and dehumidification capability prior to the permanent building HVAC system being ready for operation, it shall be the Contractor's responsibly to provide and maintain in working condition the HVAC equipment and system components necessary to meet the recommended indoor environmental conditions. All cost associated with these temporary HVAC systems shall be the Contractor's responsibility and included in their bid.

B. Additionally, if the contractor requires temporary heating, cooling, and dehumidification capability prior to the Architect approving the use of the building mechanical systems, the Contractor shall be responsible for providing and maintaining temporary HVAC systems. All cost associated with these temporary HVAC systems shall be the Contractor's responsibility and included in their bid.

1. See minimum building condition requirements herein for operation of building mechanical equipment and systems.
2. Temporary HVAC systems and controls shall be capable of providing the recommended indoor environmental conditions.

1.6 OPERATION OF BUILDING MECHANICAL EQUIPMENT AND SYSTEMS

A. Temporary operation of the building mechanical equipment and systems shall be provided for this project beginning a minimum of 60 days (or as approved by Architect) prior to the scheduled substantial completion date and maintained until the Owner's final acceptance of the project, or any phase thereof. The beginning of this temporary HVAC period is intended to align with general industry standard construction practice of providing a minimum suitable indoor environment for the installation and curing of millwork, adhesives, finishes, wall covering(s), tile ceiling/floors, etc. This interior space conditioning includes all areas of the project where the space will be similarly conditioned with heating, cooling, and/or dehumidification capability after the project or any portion/phase thereof is completed.

B. Temporary Operation of Building Mechanical Equipment and Systems Procedure:

1. The Contractor shall notify the Architect in writing fourteen (14) days in advance to request temporary operation of the building permanent HVAC systems.

2. The Architect will schedule a site-visit to observe the site conditions to ensure all the items described below have been met prior to temporary operation.
3. The Contractor shall submit in writing an operation and maintenance plan for temporary use of the building HVAC systems. At a minimum the O&M plan shall address:

    a. Equipment, system, and air filter maintenance.
    b. Temporary filter efficiency and installation locations.
    c. Daily, weekly, monthly, etc. cleaning procedures to ensure indoor cleanliness.
    d. Describe in detail how the system will be controlled, and indoor conditions monitored. Procedures for shutting down equipment or isolation of areas where dust, dirt, or particulate producing activities occur.

4. At a minimum the following building components and activities shall be completed prior to operation of the building HVAC systems:

    a. Dust or particulate generating construction activities completed.
    b. All dirt, dust, and debris have been removed from the building areas being served.
    c. Duct and cooling water piping insulation is fully completed and all seams, openings, etc. have been sealed.
    d. All HVAC system equipment utilized for temporary heating and cooling shall have been started up per specifications. All manufacturer's authorized representative startup and warranty information (including checklists) shall be completed and submitted to the Architect.
    e. All temporary air filters in place of types and installed in locations specified in "Air Cleaning Devices." All return air and exhaust air distribution devices and openings shall be covered and protected with filter material specified in "Air Cleaning Devices." All temporary filters shall be continually monitored and replaced periodically when required.

5. Upon completion of the Architect's site visit, review of site conditions and temporary operation plan, the Architect reserves the right to refuse temporary startup and operation if site conditions and plan do not meet specifications. No additional time will be given to the Contractor due to unapproved startup and temporary operation conditions.
6. Additionally, the Architect reserves the right to order the building HVAC systems shut down if the building condition or indoor environmental conditions are not maintained and found to be unacceptable.

C. The building indoor environmental conditions shall be continuously maintained within the following limits:

1. Maximum indoor temperature: 85 ˚F dry bulb.
2. Minimum indoor temperature: 60 ˚F dry bulb.
3. Maximum indoor relative humidity: 60% RH.

D. Temperature and humidity data loggers provided by the Contractor shall be installed throughout the facility to record indoor environmental conditions. Data logger quantity and locations shall be approved by Architect. Data from data loggers shall be submitted to the Architect every two weeks for review. Data shall be submitted on an hourly basis in .csv format or other, format agreed upon by Architect.

E. Contractor shall have either specified or temporary controls in place and fully operational to maintain the specified indoor environmental conditions above. Contractor shall provide all required temporary building services for temporary operation at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work includes but are not limited to the following listed in this specification.

B. Wall and ceiling access doors.

1. Acudor.
2. Williams Brothers.
3. J.R. Smith.
4. Or equal.

C. Roof curbs.

1. Custom Curb, Inc.
2. Plenums.
3. Thybar.
4. Or equal.

D. Mechanical sleeve seals.

1. Calpico, Inc.
2. Metraflex Co.
3. Thunderline/Link-Seal.
4. Or equal.

2.2 WALL AND CEILING ACCESS DOORS

A. Access panels shall be provided for all concealed valves, controls, dampers, and other mechanical equipment and devices where occasional access for adjustment or repairs will be necessary. Panels shall have cam and cylinder lock with two keys. All locks shall be keyed alike. Label panels as in accordance with Mechanical Identification.

B. Size of panels to be large enough to permit servicing or replacement of devices, controls, valves, etc.; minimum size to be 18"x18". Submit schedule with submittal package indicating location and size.

C. General.

1. Fabricate units of all welded steel construction.
2. The frame and panel assembly for fire rated access panels shall be manufactured under the Factory Inspection Service of Underwriters Laboratories, Inc., and shall bear a label reading: "Frame and Fire Door Assembly, Rating 1-1/2 Hr. (B), Temperature Rise 30 Minutes, 250ºF, Maximum".
3. Access panels used in toilets, kitchens, and other areas expected to experience high relative humidity are to be constructed of stainless steel.

D. Flush Panel Access Panels: Model WB-GP.

1. Frame and door shall be of one-piece unit body construction and 14-gauge steel. Body shall be 18-gauge steel with a return edge around door opening.
2. Flange shall be 1-3/4” wide.
3. Hinges shall be concealed, piano type, opening to 175 degrees. Number of hinges will vary with size of door.
4. Locks shall be flush, key operated cylinder lock. Number of locks will vary with size of door.
5. Finishes shall be factory applied with a rust inhibiting phosphated undercoat; finish to be chemically bonded oven baked white enamel.
6. For installation in masonry openings, units shall be furnished with flexible metal anchor straps welded to the body.

E. Flush Access Panel for Drywall or Plaster: Model WB-DW and WB-PL.

1. Body and flange shall be 16-gauge steel. Door shall be 14-gauge steel.
2. Hinges shall be concealed, piano type, opening to 175 degrees. Number of hinges will vary with size of door.
3. Locks shall be flush, key operated cylinder lock. Number of locks will vary with size of door.
4. Finish shall be factory applied oven baked grey enamel with rust inhibiting phosphated undercoat.
5. Plaster models shall have 2-1/2” of 24 gauge galvanized expanded wing casting surrounding door.
6. Drywall models shall have a 1-1/8” perforated drywall bead on all four sides.

F. Fire Rated “B” Label Access Panel: Model WB-FR.

1. Frame and door shall be of one-piece unit body construction and 14-gauge steel. Door shall be sandwich type filled with 2" thick thermafiber felt insulation and back enclosure of 22-gauge steel. Body shall be 16-gauge steel.
2. Flange shall be 1-3/4” wide.

3. Hinge shall be continuous steel piano type mounted on long side of doors, opening to 180 degrees and equipped with a spring mechanism for automatic closure.
4. Lock assembly shall be self-latching with key operated cylinder lock and shall have a mechanism to release the latch bolt from the inside.
5. Finish shall be factory applied oven baked grey enamel with rust inhibiting phosphated undercoat.
6. For installation in masonry openings, units may be furnished with flexible metal anchor straps welded to the body.

2.3 ROOF CURBS/ADAPTORS/PENETRATIONS

A. Contractor shall provide all curbs, adaptor curbs and supports required for roof penetrations and equipment installation; the Contractor shall install and flash.

B. Roof curbs and equipment supports shall be constructed as required such that the top is level and plumb.

C. Minimum of 18-gauge galvanized steel construction, fully mitered, welded corners, 3-inch cant, internal bulkhead reinforcing, 2x4 wood nailer and 18 gauge counter flashing. Equipment supports shall span a minimum of two joists. No load shall be applied to a cantilever section exceeding 1'-0" in length.

D. All curbs, pipe supports, etc. shall be a minimum of 14" high (shall be higher if required such that top of curbs are minimum 8" above roof surface) from top of roof insulation (curb heights shall be coordinated with final roof installation and insulation thickness). [Adaptable horizontal dimensions as required for existing roof openings.] It shall be the Contractor’s responsibility to coordinate the curb and/or support height with roof construction.

E. All exposed roof curbs, equipment supports, and flashing shall be factory or field painted to match roof color. Coordinate color with Architect.

F. Installation shall be in strict accordance with manufacturer’s printed instructions and as detailed on drawings. Curb manufacturer shall coordinate fabrication with Contractor.

G. All curbs of any type, and the equipment associated shall be constructed and include wind resistance rating for 160 MPH per newest code.

2.4 FIRE, SMOKE, AND SOUND STOPPING

A. UL listed penetration sleeve assembly and/or firestop that meets ASTM E-814 E119, and E84, as "3M" systems or equal for the intended applications.

B. All fire, smoke and sound stopping to be done by a licensed and certified Contractor as approved by Architect.

2.5 PIPE SLEEVES AND SLEEVE SEALS

A. Pipe Sleeves.

1. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
2. PVC Pipe Sleeves: Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
3. Galvanized-Steel Sheet Metal Sleeves: Galvanized sheet metal sleeves with lock seam joints and comply with the following minimum thickness:

    a. 24 gauge for 3 inches and smaller.
    b. 22 gauge for 4 inches to 6 inches inclusive.
    c. 20 gauge for sizes over 6 inches.

B. Sleeve Seals: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.
4. Link-Seal or equal.

2.6 ESCUTCHEONS (WALL, FLOOR, AND CEILING PLATES)

A. Description.

1. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener in exposed applications.
2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
3. Split-Casting Brass Type: With polished, chrome-plated rough-brass finish and with concealed hinge and setscrew in exposed applications.
4. Escutcheon thickness: For wall and ceiling plates, not less than 0.025-inches for up to 3-inch pipe and 0.035-inches for larger pipe.
5. Escutcheon thickness: For floor plates, not less than 0.094-inches.

2.7 DIELECTRIC FITTINGS

A. Provide where copper and ferrous metal are joined.

1. 2 inch and less: Threaded dielectric union.
2. 2-1/2 inch and larger: Flange union with dielectric gasket and bolt sleeves.
3. Temperature Rating: 210 ˚F for water systems.

2.8 PROTECTIVE DRAIN PANS

A. Required at following locations:

1. Fan-coil and all air handling units, dehumidifiers, and such with cooling located horizontally in attics or above ceilings and where required by IMC. Not required if main drain pan includes secondary drain connection for this purpose.

    a. Size to capture any overflow from unit condensate drain pan.

2. Fan-coil and all air handling units with cooling located within rooms housing electrical equipment such as power panels, control panels, transformers, and computer equipment.

    a. Size to capture any overflow from unit condensate drain pan and extended to capture drips from control valves, strainers, and unions.

    b. All central station air handling units shall include drip pans to cover the entire footprint of each unit and extend minimum 4" past unit extents of unit housing on all sides, except coil piping side(s), where pan shall extend minimum 18".

B. Construction:

1. Fabricate pans of 20-gauge galvanized sheet metal or stainless steel, minimum two inches deep with rolled top edges on units with capacities no greater than 2000 CFM. Drain pan depth on larger units shall be minimum 3 inches and minimum 16-gauge galvanized metal.
2. Solder all seams watertight, and cross brace pans to prevent sagging and warping.
3. Provide dielectric union at copper pipe/galvanized pan connection point. Water heater and smaller drain pans shall have minimum one inch (1 inch) drain outlet routed to an approved location.
4. Drip pans under HVAC cooling equipment/coils shall be comprehensively insulated with minimum 1/2" Armaflex.
5. Provide 3/4" outlet drain on pans of units smaller than 2000 cfm and route to nearby suitable receptor. Larger units shall include minimum 1" outlet drain.

2.9 NON-SHRINK GROUT

A. Non-shrink, Nonmetallic Grout: ASTM C 1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psig, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 WALL AND CEILING ACCESS PANEL

A. Coordinate size requirements and exact location with Contractor who will install access doors.

B. Minimum Sizes: 18 inches by 18 inches unless otherwise shown on Drawings or approved by Architect.

C. Provide where shown or required for access of all concealed equipment such as terminal units, valves, fire/smoke dampers, etc., for Mechanical Work. Where ceiling is constructed with removable tiles or sections, access panels are not required.

1. Equipment shall be located wherever practical over accessible ceilings or rooms to avoid access doors.
2. Access doors shall not be used solely for access to balancing dampers; use instead remote control, devices specified under Air Duct Accessories.

D. Contractor shall provide substantial metal angle frame and support at all ceiling access panels.

3.2 ROOF CURB/SUPPORTS/PENETRATIONS

A. All roof mounted equipment shall be furnished with a roof curb compatible with both the equipment configuration and roofing system. Top-off curbs/supports shall be installed level, and curbs may be leveled by either shimming (no more than 1") or sloped curb construction. See detail on Drawings for more information on curb construction requirements.

B. Provide auxiliary steel support under all roof mounted equipment and under perimeter curb base and at all ductwork penetrations as approved by Architect.

3.3 FIRE, SMOKE, AND SOUND STOPPING

A. Fire and smoke stopping shall be provided and installed at all locations where new and existing mechanical work passes through rated assemblies. This includes all ductwork, piping, and controls related conduit.

B. Penetrations in “sound-rated” walls shall be similarly acoustically sealed, both sides of wall with caulk or other approved material. New and existing walls extending to the roof/floor structure above are considered sound walls.

3.4 PIPE SLEEVES AND SLEEVE SEALS

A. Install sleeves for pipes passing through exterior walls, concrete beams, foundations, footings, floors and roof decks.

1. Cut sleeves to length for mounting flush with both surfaces.

    a. Exceptions:

        1) In areas where pipes are exposed, extend sleeves 1/4-inch above finished floor.
        2) Extend sleeves installed in floors of mechanical equipment areas or other wet areas (kitchens, toilets, etc.) 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Build sleeves into new walls, beams, foundations, footings, floors, roof decks and slabs as work progresses.
3. Install sleeves large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Pipe shall be capable of free movement within the sleeve.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Contractor shall coordinate specific sealing requirements to ensure fire, smoke or sound ratings are maintained through pipe penetration/sleeve assembly.

    a. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.

B. Interior wall pipe penetrations.

1. Galvanized-steel sheet metal sleeves.
2. Interior openings shall be caulked tight with fire, smoke or sound stopping material and sealant to prevent the spread of fire, smoke, and sound. Contractor shall coordinate specific requirements to ensure fire, smoke or sound ratings are maintained.

C. Above grade exterior wall, concrete beams, foundations, footings, waterproofed floors and where sleeve is extended above finished floor pipe penetrations: Seal penetrations using silicone sealant specified above.

1. Install galvanized steel or Schedule 40 PVC pipe sleeve.

D. Below grade exterior wall pipe penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install galvanized steel or Schedule 40 PVC pipe sleeve.
2. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.

E. Sleeves that extend into return air plenums shall be of non-combustible material, either galvanized steel or Schedule 40 steel pipe sleeves.

F. For drilled penetrations in existing floors provide one-inch angle ring flange set in silicone sealant and bolted to the floor in lieu of pipe sleeves with one-inch extension above floor.

3.5 ESCUTCHEONS

A. Install pipe escutcheons for exposed pipe penetrations of concrete and masonry walls, wall board partitions, suspended ceilings, etc.

B. Inside diameter shall fit around insulation or around pipe when not insulated; outside diameter shall cover sleeve and penetration.

C. Use plates that fit tight around insulation or pipes when not insulated.

D. Plates shall cover openings around pipes/insulation and cover the entire pipe sleeve projection. Use deep pattern escutcheons where required to completely conceal protruding fittings and sleeves.

3.6 DIELECTRIC FITTINGS

A. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

B. Wet Piping Systems: Install dielectric coupling, unions, and nipple fittings to connect piping materials of dissimilar metals.

3.7 PROTECTIVE DRAIN PANS

A. Provide minimum 2" deep pitched insulated drain pans, where shown and required under all concealed fan-coil and air handling units with cooling, new and existing storage tank type water heaters, and boilers, and all fluid conducting piping that is over electric switchgear, elevator controllers, busways or electric motor starters or as indicated. Pans shall extend minimum two inches beyond each side of the mechanical equipment, pipe or group of pipes being contained. Pans shall extend six inches beyond electrical equipment below.

B. Pitch pans above ceiling and route drain 3/4-inch or larger copper piping to the nearest available open drain or outside as directed by Professional. Separate unit drain and drain pan unless otherwise indicated.

3.8 GROUTING

A. Install nonmetallic, non-shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, pipe support base plates, and anchors. Mix grout according to manufacturer's written instructions.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Place grout, completely filling equipment bases and pipe support base plates.

E. Place grout around anchors.

F. Cure placed grout according to manufacturer's written instructions.

3.9 CUTTING AND PATCHING

A. Do not cut into any major structural element without written approval of the Architect.

B. Cut required openings through existing masonry or reinforced concrete with diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Architect. Locate openings that will least affect structural slabs, columns, ribs, or beams. Refer to the Architect for determination of proper design for openings through structural sections and opening layouts for approval prior to cutting or drilling into structure. After Architect’s approval, carefully cut openings through construction no larger than absolutely necessary for the required installation.

C. Patching:

1. Shall be of quality and appearance matching the existing construction.
2. Contractor shall restore all services and construction that remains in use, to its condition prior to Work performed as part of this contract.

3.10 PROTECTION/TEMPORARY PARTITIONS/DUST BARRIERS

A. Contractor shall be responsible for protecting Owner’s building, occupants, furniture, finishes, ceilings/walls/floors, roof, etc. during all construction activities.

B. The protection shall include temporary rigid partitions, flexible dust barriers, protective covering, relocation of furniture, etc. Contractor to provide:

1. Temporary rigid partitions shall be provided around work areas in Owner occupied facilities for
   noise, safety, and security provisions.
2. Temporary flexible barriers, as vis queen/plastic tarps, etc. shall be provided for dust control
   around work areas.

END OF SECTION

SECTION 15055 MOTORS AND CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors, motor controllers (starters) and Variable Speed Drives (VSD) for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1. Motors.
2. Motor controllers.
3. Variable speed drives.

1.3 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Draw-ing
Motors	R	R		R
Belts and Drives		R		
Variable Speed Drives	R	R		R
Motor Controllers/Starters	R	R		R

B. Submittals shall include certification from the motor manufacturer certifying compliance with NEMA MG-1, part 31 for motors that are driven by variable speed drives.

C. Submit a site-specific harmonic analysis showing total voltage harmonic distortion and total current harmonic distortion is in compliance with IEEE 519. If the analysis indicates that additional external devices or filters are required to meet the power quality requirements of the VSD, provide the devices or filters at no additional cost to the Owner.

1.4 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

1.5 WARRANTY

A. Special Warranty: VSD warranty shall be 60 months from date of start-up certification including all parts, labor, travel time, and expenses.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Motors.

1. General Electric
2. Gould, Inc.
3. Baldor.
4. Or equal.

C. Variable Speed Drives.

1. Yaskawa.
2. Trane.
3. ABB.
4. Or equal.

D. Motor Controllers/starters.

1. ABB.
2. Cerus.
3. Square D.
4. Or equal.

2.2 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.3 MOTORS

A. General.

1. In accordance with NEMA, IEEE, and ANSI C50 standards.
2. Capacity.
    a. Minimum horsepower indicated.
    b. To operate driven devices under all conditions without overload.
3. Squirrel-cage induction type, NEMA Type "B: insulation class, continuous duty.
4. Speed.
    a. 1750 RPM, unless otherwise indicated.
    b. See schedules on drawings for other speeds.
5. NEMA KVA locked rotor CODE LETTER: "G" or better.
6. Service factor: 1.15.
7. Type unless otherwise scheduled on Drawings.
    a. Voltage: As scheduled on Drawings. Contractor shall verify actual site voltage prior to procurement.
    b. 1/2 horsepower and smaller.
        1) Single-phase, 60 hertz.
        2) With built-in auto-reset thermal overload protection.
    c. 3/4 horsepower and larger.
        1) Three-phase, 60 hertz.
        2) Motors 50 horsepower and over: Reduced voltage start, suitable for star-delta starting or as scheduled on Drawings.
    d. EC Motors.

1) Where scheduled on Drawings or equipment Specifications.
2) Equal to GE ECM version 2.2 or greater.
3) Programmed with fan curve for “constant airflow”.

8. Bearings, unless otherwise scheduled on Drawings or equipment Specifications.

a. Provide motors with double shielded, grease lubricated, ball bearings, with grease pockets on each side for re-greasing in service. Provide inlet and outlet grease connections in motor housings for each bearing. Provide factory sealed permanently lubricated ball bearings on roof mounted equipment. Similar bearing may be provided on fractional horsepower motors. Provide sleeve bearings where so specified.
b. Ball type, unless otherwise noted.
c. Sealed, permanently lubricated, unless otherwise noted or not available in motor size.

B. Enclosure.

1. Open drip-proof (ODP).

a. Provide ODP motors unless otherwise indicated.

2. Totally enclosed (TEFC).

a. Motors outside the building or otherwise exposed to the weather.
b. Non-ventilated: under 1/2 horsepower.
c. Fan-cooled: 1/2 horsepower and larger.

3. See schedules on drawings for other enclosures.

C. Belt-connected motors.

1. Foundation slide base.
2. Shaft as required for aligning pulleys.

D. Motors 1 horsepower and larger shall be NEMA Premium labeled and have guaranteed efficiencies equal to or exceeding NEMA Table 12-6D.

E. Multi-speed motors.

1. Two speed motors shall be single winding 1800/900 rpm unless otherwise specified or indicated.
2. Provide 1800/1200 rpm multi-speed motors of separate winding, variable torque type, unless otherwise specified or indicated.

F. Motors driven by variable speed drives.

1. Shall meet the requirements of NEMA MG-1 part 31.40.4.2.
2. Where used for pumps or fans shall be capable of operating at 10 percent speed indefinitely.

G. Electrically Commutated Motors (EC Motors).

1. Brushless DC type with electronic commutation from 115 volt or 277-volt single phase power to a DC signal.
2. Speed controllable from a minimum of 20% or less to 100% of full speed.
3. Minimum 80% efficiency at all speeds.
4. Provide the following.

    a. Potentiometer dial mounted on the exterior of the motor housing.
    b. 0-10 VDC control signal input and 0-10 VDC speed feedback output with pre-wired contacts. Motor shall shut off when speed signal is below minimum.

2.4 VARIABLE SPEED DRIVES

A. All variable speed drives other than those that are factory packaged with equipment shall be supplied by one manufacturer.

B. Electrical Characteristics.

1. Efficiency shall be not less than 97 percent at rated voltage, current, and frequency and fundamental power factor shall not be less than 98 percent at all speeds and loads.
2. VSD shall maintain line noise (voltage harmonics) on the input electrical system at or below levels specified in IEEE 519 for a “General System.” Manufacturer shall include in submittals a harmonic distortion analysis (IEEE 519, 3 percent) for this particular jobsite. Provide as a minimum 5% impedance line reactors. The 5% impedance may be from dual (positive and negative DC bus) reactors or 5% AC line reactors. VSDs with only one DC reactor shall include AC line reactors.
3. VSD shall include EMI/RFI filters that allow the VSD assembly to be CE Marked and meet product standard EN 61800-3 for the First Environment restricted level.

C. Features and Accessories.

1. Plain language LCD display (code numbers not acceptable); all set-up parameters, indications, faults, warnings, and other information shall be displayed in words, not codes.
2. Displays and meters for the following: Output voltage, output frequency, motor rpm, motor current, motor watts, speed signal input, last three faults.

3. Hand-Off-Auto keyboard function with manual speed control, including bump-less transfer of speed reference when switching between Hand and Auto modes.
4. Input line fuses.
5. Adjustable or multiple carrier frequencies up to 12 kHz. Include a carrier frequency control circuit that reduces the carrier frequency based on actual VSD temperature that allows the highest carrier frequency without derating the VSD or operating at high carrier frequency only at low speeds.
6. Isolated 4-20 mA or 0-10 Vdc speed signal input. If the input reference is lost the VSD shall, based on user selectable option, either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the speed based on the last good reference received, or (4) cause a warning to be issued.
7. Analog outputs for kW and speed; kW shall be accurate to ±3%.
8. Digital outputs for alarm and motor on/off status; latter shall be based on field adjustable motor current that can indicate broken belt or coupling.
9. Ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable for each fault type.
10. Controls.

    a. Provide a minimum of two digital outputs that can be programmed for multiple purposes and also controlled through the DDC network interface device by the DDC system independent of other VSD functions or status. Control sequence possibilities shall include:

        1) Contact to open fan discharge damper either with fan start or independent of fan operation, controlled via the DDC system and wait for the damper end switch to make before starting the drive; this shall function in the normal drive mode, bypass mode, and life safety mode (if part of smoke control system).

    b. For fans used as part of IBC smoke control system, include:

        1) Programmable digital input that, when external contact is closed by life safety control system, causes VSD to start and operate at a preset adjustable speed, overriding automatic speed and on/off controls, manual speed settings and all keypad and HOA commands.
        2) “Run to destruct” option so that when the digital input is closed, all internal and external safeties that might prevent the VSD from operating at the preset speed will be ignored or overridden.

    c. Provide built-in PID control loop, allowing connection of a pressure or flow signal to the VSD for closed loop control.

d. Provide factory installed BACnet/MSTP network interface that allows all VSD control points to be communicated to EMCS. See Section "Energy Management & Control Systems." At a minimum, the following points shall be provided:

1) Read only: Speed feedback, output speed, current, % torque, kW power, kilowatt hours (resettable), operating hours (resettable), drive temperature, digital input status, analog input values, all diagnostic warning and fault information, keypad "Hand" or "Auto" selected, deceleration rate, and acceleration rate.
2) Read/write: On/off, output speed, digital output open/close, analog output values, remote fault reset, PID setpoint and gains, force the unit to bypass, maximum speed, and minimum speed.

11. Enclosure.

a. NEMA 3R enclosure for outdoor installation or unconditioned space.
b. NEMA 1 enclosure for indoor installation in conditioned space or indirectly conditioned space such as return air plenum.
c. UL Type 12 for wet mechanical rooms.
d. UL listed as plenum rated where located in supply, return, or outdoor air stream.

12. Thermostatically controlled cooling fans shall be provided where required to meet ambient operating conditions. Fans shall be designed for replacement without requiring removal of the VSD from wall mount or removal of circuit boards. Fan sound power shall be no greater than local noise sources where VSD is installed.
13. 3-contactor, constant speed bypass shall be provided to allow the motor to run across the line in the event of VFD shutdown. The transfer from the VFD to the line shall be accomplished manually by means of a selector switch. The bypass circuitry shall be enclosed in a separate well-mounted NEMA 1 cabinet. The bypass cabinet shall include a door interlocked input circuit breaker, a VFD output contactor, and a full voltage starting contactor (both contactors electrically interlocked), a thermal overload relay to provide motor protection, and a control power transformer. Mounted on the cabinet door shall be the bypass selector switch, motor fault light, power ON light, motor on VFD light, and motor online light.

D. Equipment Protection and Safeties.

1. VSDs short-circuit interrupting rating shall equal or exceed that fault current available at the drive.
2. VSD shall protect itself against all normal transients and surges in incoming power line, any grounding or disconnecting of its output power, and any interruption or run away of incoming speed signal without time delay

considerations. Protection is defined as normal shutdown with no component damage.

3. The VSD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The VSD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay output shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.
4. VSD shall protect itself against all phase-to-phase or phase-to-ground faults.
5. VSD shall be able to start into a rotating load at all speeds (forward or reverse) without trip.
6. Anti-regeneration circuit shall match the deceleration rate of the drive to that of the motor to prevent high bus voltage shutdown common to high inertia loads, such as fans.
7. VSD shall ride through an input power dip of 3 cycles without trip.
8. VSD shall operate properly at a -35% +30% voltage fluctuation from rated voltage.
9. VSD shall operate properly at a 10 percent frequency variation from rated frequency.
10. VSD shall employ three current limit circuits to provide trip-free operation: slow current regulation, rapid current regulation, and current limit switch-off limit. VSD shall be designed so that overcurrent trip shall be at least 315 percent of the drive's current rating.
11. VSD shall have the ability to set a maximum current available to the motor.
12. VSD shall withstand unlimited switching of the output under full load, without damage to the VSD. Operation of a disconnect switch between the motor and VSD shall not have an adverse effect on the VSD, whether the motor is operating or not. Controls conductors between the disconnect and the VSD shall not be required for the safe and reliable operation of the VSD.
13. The VSD shall withstand switching of the input line power up to 20 times per hour without damage to the VSD.
14. The VSD shall be capable of operating continuously at full load in the following service conditions

    a. Ambient temp: 30 to 104 degrees Fahrenheit.
    b. Relative humidity: 0 to 95 percent, non-condensing.

E. Warranty shall be 24 months from date of start-up certification including all parts, labor, travel time, and expenses.

2.5 MOTOR CONTROLLERS/STARTERS

A. General.

1. Manual reset, Class 20, thermal type overload protection for each phase, in accordance with NEMA ICS 2-2000 (R2005).
2. NEMA 3R enclosures for exterior application.
3. Equipment furnished with factory-installed starters shall also be equipped with individual motor disconnect and thermal magnetic circuit breakers or fuses as specified herein with lugs sized to receive a feeder as indicated on the Electrical Drawings.
4. 120 V secondary control power transformer with fused primary and secondary circuit in the enclosure.
5. Unused auxiliary contacts (installed on each contactor): 1 normally open, and 1 normally closed.

B. Motor starters shall be provided with provisions for interfacing with the Energy Management and Control System (EMCS) or other control and interlocking requirements.

1. For all magnetic starters, a minimum of one set of field reversible auxiliary contacts shall be provided with the starter.

C. For 3-phase motors, unless otherwise specified herein:

1. Combination magnetic type and thermal magnetic circuit breaker with:

a. Circuit breakers having minimum AIC rating as specified in Division 26.
b. External operating handle capable of being locked in the off or open position.
c. Hand-off-automatic switch, except those manually controlled.
d. Starters for motors 50 hp and larger shall be solid-state, reduced-voltage type.

D. For 1-phase, unless otherwise specified herein:

1. Manual starting switch with thermal overload protection and pilot light.

2. Hand-off-automatic switch.
3. Magnetic across-the-line starters with overload protection and Hand-Off-Automatic switch, except for manually controlled equipment.

E. Provide control transformers for equipment with voltage above 240 volts, or as required for complete, operable systems.

F. Coordinate with DIVISION 26: ELECTRICAL.

G. Refer to individual equipment sections for factory-provided controllers.

1. Installed on equipment by manufacturer.
2. Supplied with equipment by manufacturer for field installation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with work of other trades.

B. Install in accordance with manufacturer's written installation instructions.

C. Drives for packaged equipment shall be mounted and wired by equipment manufacturer.

D. Mounting and power wiring of field mounted variable speed drives and other motor controllers is specified under Division 26 Electrical:

1. Where wall space is not available for mounting VSDs or other motor controllers, provide mounting struts securely mounted to the floor, roof, or adjacent structure.
2. Where VSD has disconnect switch, locate VSD within sight of equipment served so that switch complies with NEC requirements.

E. Set overload devices to suit motors provided in accordance with NEC.

3.2 INSTALLATION

A. Verify that adequate clearance between motor, controllers and adjacent walls or equipment is available to permit maintenance and repairs.

B. Check that motor and controller are properly supported and allows for proper alignment and tension adjustments as necessary for application.

3.3 PRE-OPERATING CHECKS

A. Before operating motors and controllers.

1. Check for proper and sufficient lubrication.
2. Check for correct rotation.
3. Confirm alignment and re-align if required.
4. Check for proper adjustment of vibration isolation.

3.4 STARTUP, TESTING AND ADJUSTING

A. Start and test motors and controllers in accordance with manufacturers written installation instructions.

B. After starting motors.

1. Check for high bearing temperatures.
2. Check for motor overload by taking ampere reading at maximum operating conditions, with all valves open and individual motor running.
3. Check for objectionable noise or vibration; correct as needed at no additional cost to the Owner.

C. Variable speed drives.

1. Certified factory start-up shall be provided. A certified start-up form shall be filled out for each VSD with a copy to the Architect and a copy kept on file by the manufacturer.
2. See Section “Energy Management and Control Systems” for points to be mapped from the drive controller to the EMCS; coordinate information addresses and other information required with the Section “Energy Management and Control Systems” contractor.
3. Set variable speed ramp-up rates on variable air volume systems slow enough to prevent high pressure trips and/or damage to duct systems. Coordinate with Section EMCS contractor.
4. Set minimum speed for all applications in accordance with procedure indicated in Section “Energy Management and Control Systems.”
5. Set maximum current limit setpoint to the motor to the motor's full load amps.
6. Set voltage to speed ratio (V/f) to “squared”.
7. For fans such as relief fans and cooling tower fans: Run fan through entire speed range and program out speeds that cause fan vibration.
8. After VSD is fully configured and programmed, all settings shall be documented and included with commissioning documentation in electronic format per Section Mechanical General Provisions. The intent is to allow replacement drive electronics to be readily configured.

D. Motor Controllers/Starters.

1. Provide starters, push buttons, thermal overload switches, and contactors for equipment covered in Division 23 unless otherwise specified herein. Installation of starters, push buttons, and thermal overload switches, not factory installed, is specified under Division 23.
2. Provide 120 V secondary control power transformers for control circuits where equipment is served at 208 V or higher.

E. See Section “Testing, Adjusting, and Balancing for HVAC.”

3.5 TRAINING

A. See Section “Mechanical General Provisions.”

B. VSD manufacturer to provide one of the following:

1. 8-hours of customer training.
2. Interactive Computer based training on VSD installation, start-up, programming, and trouble shooting.
3. Professionally produced video cassette on VSD installation, start-up, programming, and trouble shooting in digital format.

END OF SECTION

SECTION 15060 HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Engineers: ASME Section VIII – Boiler and Pressure Vessel Code – Pressure Vessels.

B. Pipe Supports: ANSI B31.1, Power Piping.

C. Duct Hangers: SMACNA Duct Manuals.

1.4 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, “Guidelines on Terminology for Pipe Hangers and Supports”.

1.5 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Pipe hangers and supports	R	R		R
Structural attachments	R			R
Pipe protection and thermal hanger shields	R	R		R
Equipment supports	R			R
Expansion shields	R			
Welding certificates	R			

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Hangers, Inserts and Supports.

1. Unistrut.
2. Superstrut.
3. B-Line Systems.
4. Or equal.

C. Pipe Protection and Thermal Hanger Shields.

1. Pipe Shields, Inc.
2. Elcen Metal Products Company
3. Superstrut.
4. Or equal.

D. Expansion Shields.

1. Hilti Fastening Systems.
2. ITT Phillips Drill Co.: Red Head.
3. Omark Industries, Inc.
4. Or equal.

E. Pipe Stand Supports.

1. B-Line Systems, Inc.
2. Grinnell Corp.

3. PHD Manufacturing, Inc.
4. Or equal.

F. Powder-Actuated Fastener Systems.

1. Hilti Fastening Systems.
2. ITW Ramset/Red Head.
3. MasterSet Fastening Systems, Inc.
4. Or equal.

G. Insulation Protectors.

1. B-Line Systems, Inc.
2. ITT Grinnell Corporation.
3. PHD Manufacturing, Inc.
4. Or equal.

H. Roof Pipe Supports.

1. MiFab.
2. B-Line Systems, Inc.
3. Miro.
4. Or equal

I. Miscellaneous Devices.

1. Kopty.
2. Wejit.
3. Or equal.

2.2 PIPE HANGERS AND SUPPORTS

A. Model numbers are Superstrut, unless otherwise indicated.

B. Provide electro-chromate, galvanized or factory painted finish; no plain, "black" hangers allowed.

C. Dielectric Isolators: All uninsulated copper tubing systems; Superstrut isolators or equal, Cush-A-Strip or Cush-A-Clamp on all pipe clamps; for individual hangers, use felt lined hangers.

D. Individual Pipe Hangers.

1. Cold pipe all sizes: Clevis hanger, No. C710.
2. Hot pipe sizes up to 4 in: Clevis hanger, No. C710.
3. Hot pipe sizes above 6 in: Adjustable steel yoke and cast iron, roll No. C729.

E. Multiple or Trapeze Hangers.

1. Factory channel.

   a. 12-gauge thick steel.
   b. Single or double section.
   c. Electro-chromate finish.
   d. Strutnuts: Series A-100 or CM-100.
   e. Straps: Series 702.
   f. No. A-1200 or A-1202.

2. Hot pipe sizes 6 in and larger: cast iron roll and stand; C728 or CR728.

F. Wall Supports.

1. Pipe sizes up to 3 in: Steel bracket No. C738.
2. Pipe sizes 4 in and larger: Welded steel bracket C-735.
3. Hot pipe sizes 6 inches and larger.

   a. Welded steel bracket No. C739.
   b. Adjustable steel yoke and cast iron, roller No.C729.

G. Vertical Support.

1. Riser clamp Series C-720.

H. Floor Support.

1. Hot pipe sizes up to 4 inch; cold pipe, all sizes.

   a. Adjustable cast iron saddle No. R786.
   b. Locknut nipple.
   c. Floor flange.

2. Hot pipe sizes 6 in and larger: Adjustable cast iron roll and stand No. R-730-C.

I. Thermal Hanger Shields (for insulated pipe supports).

1. 180-degree high density insert.

   a. 100 psi waterproofed cellular glass, asbestos-free, K=0.38, encased in a 360-degree galvanized sheet metal shield, ASTM A653.
   b. See Section Piping Insulation.
   c. Same thickness as adjoining pipe insulation.

2. 180-degree galvanized sheet metal shield (inverted saddle).

   a. Shield length and gauges.

Pipe Size	Shield Length	Minimum Gauge
1/2-1 1/2	4	26
2 - 6	6	20
8 - 10	9	16

3. Insert to extend one inch beyond metal shield ends on insulated piping.
4. Use double layer shield on bearing surface for:

    a. Roller hangers.
    b. Support spacing exceeding 10 feet.

J. Pipe Isolators.

1. Hanger with felt padding.
2. Tolco Fig. 3F or equal felt lined hangers.

K. Anchors and Guides: Provide anchors and guides where indicated on the Drawings and as required. Structural inserts shall be high density cellular glass. Guide slide pads shall be Teflon. Ensure that slide accommodates pipe movement over full range of service and out-of-service temperatures. Guides shall be Pipe Shields, Inc. Model #B3000 or equal. Anchors shall be Pipe Shields, Inc. Model #C4000 or equal. See Section Piping and Equipment Insulation.

L. Insulated Pipe Strap.

1. 1/2 in to 1 in plumbing piping in wood frame construction.
2. Felt insulated.
3. Kopty or equal.

M. Escutcheons: See Section– Basic Mechanical Materials and Methods.

N. Flashing and Sleeves.

1. Flashings.

    a. See Division 7 – Thermal and Moisture Protection.
    b. Flash and counter flash watertight all pipe and duct penetrations of roofs and exterior walls.
    c. Flash pipes through roofs with ITWBuildex Dektite or equal.
    d. Flash vents through roofs with.

        1) Minimum 24-gauge soldered roof jack for flat surface roofs.
        2) Minimum 4-pound lead soldered roof jack for roofs other than flat surface roofs.
        3) Vandal caps.
        4) Provide counter-flashing sleeves and storm collars.

5) Caulk counterflashing and storm collar weather tight.
6) Other flashings shall be minimum 24-gauge galvanized sheet metal.

2. Sleeves.

a. See Basic Mechanical Materials and Methods.

b. For insulated piping, sleeve diameter shall not be less than diameter of insulation.

c. Terminate sleeves flush with walls, and ceiling.

d. For exposed vertical pipe, extend sleeves 1 inch above finished floor except where escutcheons are required.

e. Packing through fire rated partitions one of following.

1) 3M Penetration Sealing Systems (PSS 7909) and 3M Fire Barrier Caulk and Putty.
2) Dow-Corning LTV Silicone foam.
3) Or equal.

3. Separate piping through walls, other than concrete walls, from contact with wall construction materials; use non-hardening caulking.

4. Install insulation on piping in walls which require insulation at time of installation.

2.3 DUCT HANGERS AND SUPPORTS

A. See Section– Metal Ducts.

2.4 DUCT AND PIPE SUPPORT AT ROOF LEVEL

A. The Contractor shall coordinate pipe work and ductwork to provide access to all equipment. The services at roof level indicated on the details provide the minimum clearance required for pipe work and ductwork for maintenance of the roof. The plans indicate higher elevations where necessary for access. Where pipe work and ductwork cross over at the same point, the pipe work shall run underneath the ductwork. The Contractor may propose a combined structure, for approval, to support the pipes and ducts at roof level. The contractor shall provide calculations by a certified licensed engineer in the state of Mississippi once the conceptual support has been approved. The main path of egress shall be maintained clear at 7’-6”.

2.5 STRUCTURAL ATTACHMENTS

A. Model Numbers are Superstrut, unless otherwise indicated.

B. All components shall have galvanized or equal finish.

C. Anchor Bolts: Size as specified for hanger rods.

D. Concrete Inserts.

1. Malleable iron.
2. Place reinforcing steel through insert as recommended by manufacturer for recommended loads.
3. No. 452 or equal.

E. Beam Clamps.

1. All with U-568 safety strap.
2. All with locknuts on.

    a. Set Screw.
    b. Hanger rod.

3. Bottom flange attachment.

    a. Loading 150-pound and less: U-563.
    b. Loading 150-pound to 300-pound: U-562.
    c. Loading more than 300-pound: U-560.

4. Top flange attachment.

    a. Permitted only when bottom flange attachment cannot be used.
    b. Loading 400-pound and less: M-777.
    c. Loading more than 400-pound: M-778.

F. Welded Beam Attachments: No. C-780 or equal.

G. Side Beam Attachments: No. 542 or equal.

H. Hanger Rods.

1. ASTM A575 Hot rolled steel, galvanized.
2. ANSI B1.1 Unified Inch Screw Treads.
3. Threaded both ends, threaded one end, or continuous threaded.

I. Hanger Rod Fixtures.

1. Turnbuckles: No. F-112 or equal.
2. Linked Eye Rod.

a. Rod swivel.
b. No. E-131 or equal.

3. Clevis: No. F-111 or equal.

J. Powder or Gas Actuated Anchors.

1. Not allowed on initial building construction; allowed only for revisions made after initial construction and with approval of Owner.
2. Hardened steel stud with threaded shank; size of shank to match hanger rod size.
3. Use only with non-shock loads.
4. Maximum load safety factors:

a. Maximum anchor load: 100 pounds.
b. Static loads – 5.
c. Vibratory loads - 8-10.

5. For concrete and steel, not to be used for light weight concrete, brick or concrete block.
6. 10% testing rate required, testing by contractor.
7. Omark Drivit or equal.

K. Expansion Shields.

1. Carbon-steel anchors, zinc coated.
2. Stainless steel for corrosive atmospheres.
3. For normal concrete use.

a. Self-drilling anchor.
b. Sleeve anchor.
c. Stud anchor.

4. For thin concrete use: wedge anchor.
5. For brick or concrete block use: sleeve anchor.
6. Maximum load safety factors.

a. Static loads – 4.
b. Vibratory loads - 8 – 10.
c. Shock loads - 8 – 10.

7. Size to suit hanger rods.
8. ITT Phillips Red Head or equal.

L. Steel Deck Inserts.

1. Factory stud with.

a. Clip.
b. Spring.
c. Coupling.

2. ITT Phillips Red-Head or equal.

M. Miscellaneous Metal.

1. Steel plate, shapes, and bars: ASTM A36.
2. Steel pipe columns: ASTM A53, Schedule 40, black.
3. Bolts and nuts: regular hexagon-head type, ASTM A307, Grade A.
4. Lag bolts: square head type, Fed. Spec. FF-B-561.
5. Plain washers: round, carbon steel, Fed. Spec. FF-W.92.

2.6 ROOF PIPE SUPPORTS

A. All piping HVAC, plumbing, gas, etc. located above the roof (and supported by the roof) shall be supported utilizing the following roof supports.

B. Widebody rubber support base.

C. Materials:

1. Base: 100% recycled rubber, UV resistant.
2. Channel: 14-gauge galvanized steel (1-5/8-inch-wide x 1-5/8-inch high).
3. Rods: Two 1/2-inch electro zinc plated all threaded rod risers.

D. Maximum load: 800 lbs. for each 9.6-inch-long support.

E. Include strut clamp on condensate drain piping.

F. Include roller provisions on gas piping.

G. Sized appropriately for the quantity of piping being supported.

H. Gas Piping Supports: Mifab CR10/CRE10, Miro Model #4-RAH or approved equal.

I. Condensate Pipe Supports: Erico/Caddy Pyramid 50/TCC cushion clamp, or similar by Mifab, or approved equal.

2.7 MISCELLANEOUS MATERIALS

A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

C. Structural Steel: ASTM A36/A36M, steel plates, shapes, and bars, black and galvanized.

D. Concrete: Normal weight concrete (145 pcf) using Type I Portland Cement, 1" maximum size coarse aggregate to provide a minimum 28-day compressive strength of 3000 psi.

E. Grout: ASTM C1107, Grade B, factory-mixed and -packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.

1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
2. Properties: Non-staining, noncorrosive, and nongaseous.
3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 PIPE HANGERS, SUPPORTS AND GUIDES

A. General.

1. Assure adequate support for pipe and contents.
2. Provide adjustable hangers for all pipes complete with inserts, adjusters, bolts, nuts, swivels, all-thread rods, etc., except where specified otherwise.
3. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping.
4. Except as otherwise indicated for exposed continuous pipe runs, install hangers, and supports of same type and style as installed for adjacent similar piping.
5. Install all cast iron piping in accordance with Cast Iron Soil Pipe Industry (CISPI) Standards.
6. Support all piping within 2 feet of each change of direction on both sides of fitting.
7. Thermal hanger shields shall be provided at hangers and supports where piping is insulated.
8. Prevent vibration or swaying.
9. Provide for expansion and contraction.

10. Supports of wire, rope, wood, chain, strap perforated bar or any other makeshift device not permitted.
11. Comply with applicable requirements at ANSI B31.1 and B31.2 for piping.
12. Support piping independently so that equipment is not stressed by piping weight or expansion.
13. Hangers and supports shall have minimum safety factor of five (5), based on ultimate tensile or compressive strength, as applicable, of material used, base calculations on equipment's heaviest operating weight and pipes full of water.
14. Install additional supports or braces if, during normal operation, piping should sway, crawl or vibrate. Piping shall be immobile.
15. Install thrust blocks as required to prevent sway.

B. Horizontal piping, except as noted.

1. Adjustable clevis type and rod; all services at or below 250 degrees F.
2. Rollers or slide bases: not required.
3. Trapeze hangers; guide individual pipes on trapezes with 1/4-inch U-bolt or Superstrut 702 pipe clamp.

    a. Install thermal hanger shield at each support point.

4. Galvanized sheet metal shields between hangers and PVC piping.
5. Threaded steel rods.

    a. 2-inch vertical adjustment with 2 nuts each end for positioning and locking.
    b. Size to 12-inch inside pipe size (IPS).

Pipe, IPS	Rod
to 2 inch	3/8 inch
2-1/2 inch and 3 inch	1/2 inch
4 inch	5/8 inch
6 inch and 8 inch	3/4 inch
10 inch and 12 inch	7/8 inch
14 inch and 18 inch	1 inch
20 inch and 30 inch	1-1/4 inch

    c. Size above 12-inch IPS and multiple pipe standards: safety factor of 5 on ultimate strength on area.
    d. For double rod hangers: 1 size smaller than above.

C. Vertical piping.

1. Base support.

    a. Base elbow or welded equivalent.
    b. Bearing plate on structural support.

2. Guides.

    a. At every third floor but not to exceed.

        1) 25 feet for piping to 2-inch.
        2) 36 feet for piping 2-1/2 inch to 12-inch.
        3) 50 feet for piping 14 inch and larger.

    b. Or as otherwise designed by the Vibration Isolation vendor.

3. Top support.

    a. Special hanger or saddle in horizontal connection.
    b. Provisions for expansion.

4. Intermediate supports: steel pipe clamp at floor.

    a. Bolted and welded to pipe.
    b. Extension ends bearing on structural steel or bearing plates.

5. For multiple pipes: coordinate guides, bearing plates and accessory steel.

D. Horizontal insulated piping.

1. Install saddles for rollers or slide bases.
2. Install thermal hanger shields for all other types of supports.
3. See Section Piping and Equipment Insulation for insulation connection to shields.

E. Vertical insulated piping.

1. Install thermal hanger shields at guides.
2. See Section Piping and Equipment Insulation for insulation connection to shields.

F. Install Pipe Isolators between hangers and piping for all uninsulated copper tubing.

G. Miscellaneous Steel.

1. Provide miscellaneous steel members, beams, brackets, etc., for support of work in this division unless specifically included in other divisions.

H. Fire-stopping.

1. At pipe penetrations through rated assemblies.
2. Commercial pipe sleeve assemblies that are UL listed and that have been approved by the fire marshal for this purpose.

I. Roof pipe supports shall be installed per manufacturer's recommendations in coordination with the roofing system and company holding the roof warranty.

3.2 PIPE SUPPORT SPACING

A. Maximum spacing for horizontal piping.

Type of Pipe	Size	MAXIMUM SPACING
Steel	1-1/2 inch and smaller	7 feet
	2 inch and larger	10 feet
Copper	3/4 inch and smaller	5 feet
	1- 1-1/4 inch	6 feet
	1-1/2 - 3 inch	8 feet
	4 inch and larger	10 feet
Plastic	3/4 inch and smaller	3 feet
	1" – 1-1/2"	6 feet
	1-1-1/4 inches	6 feet
	1½″-3″	8 feet
	4 inch and larger	10 feet

B. Spacing Notes: Additional supports at:

1. Changes in direction.
2. Branch piping and runouts over 5 feet.
3. Concentrated loads due to valves, strainers, and other similar items.
4. At valves 4 inch and larger in horizontal piping, support piping on each side of valve.

C. Parallel piping on trapezes.

1. Maximum spacing to be that of pipe requiring closest spacing.

3.3 ATTACHMENT TO STRUCTURE

A. Concrete.

1. Use inserts for suspending hangers from reinforced concrete slabs, walls, and sides of reinforced concrete beams wherever practicable.
2. Set inserts in position in advance of concrete work.

3. Provide reinforcement rod in concrete for inserts carrying.

    a. Pipe over 4-inch.
    b. Ducts over 60 inches wide.

4. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
5. Where inserts are omitted, install hangers with expansion shields.
6. Through-deck support.

    a. Drill through concrete slab from below.
    b. Provide rod with recessed square steel plate and nut above slab.

7. Where permitted by Owner and only for revisions made after initial construction, powder actuated anchors or expansion shields may be used in lieu of inserts.

    a. In bottom of thick slabs.
    b. In thin slab construction, only in sides of beams.

8. Pre-Cast Concrete.

    a. Use pre-set inserts.
    b. Where inserts are not available, field drill through beam or joists at locations as directed by Architect.
    c. Through bolt side beam bracket to beam or joist.

9. Poured-In-Place Concrete.

    a. With metal form or underdeck.
    b. Before concrete is poured.

        1) Field drill hole through metal deck.
        2) Provide bearing plate, nut, and locknut on rod; or install factory-made steel deck inserts specified hereinbefore.

    c. After concrete is poured.

        1) Install hangers with expansion shields.

B. Steel Beam Anchors.

1. Beam or channel clamps.
2. Do not cut or weld to structural steel without permission of structural engineer.

C. Steel Deck Anchors.

1. Concrete filled: as specified above.

2. Decking without concrete.

    a. Through rod Support.

        1) Weld to square plate, 1/4 in thick.
        2) Plate to distribute load over minimum of two full cells.
        3) Coordinate with floor layouts to clear cells with wiring.

D. Side Wall Supports.

1. Concrete walls: As specified for hangers.
2. Stud Walls.

    a. Toggle bolts.
    b. Stud welded to structural studs.

E. Support Spreaders.

1. Install spreaders spanning between structural members when hangers fall between them, and hanger load is too great for slab or deck attachment.
2. Spreaders may be one of methods listed below, or combination of both as required.

    a. Fabricated from structural channel.

        1) End fittings bolted or welded.
        2) Secure to structural members.

            a) As required by construction.
            b) As reviewed by Structural Engineer.

    b. Formed channels with fittings, Superstrut or equal.

        1) Submit manufacturer's calculations for installation.

3.4 DUCT HANGERS AND SUPPORTS

1. See Section Metal Ducts.

3.5 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and floor pipe supports. Finish shall provide a smooth bearing surface.

3.6 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes 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.

3.7 ADJUSTING

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

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

3.8 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 15070 MECHANICAL SOUND AND VIBRATION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes Materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Vibration isolators for equipment.
2. Vibration isolators for piping systems.
3. Equipment bases.
4. Inertia bases.
5. Wind Restraints

1.3 REFERENCE STANDARDS

A. ASHRAE – American Society of Heating, Refrigerating and Air Conditioning Engineers.

B. NEMA – National Electrical Manufacturer's Association.

C. Published specifications standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this section where cited below.

1. FEMA Installation Manuals

    a. FEMA 412: Installing Seismic Restraints for Mechanical Equipment
    b. FEMA 413: Installing Seismic Restraints for Electrical Equipment
    c. FEMA 414: Installing Seismic Restraints for Duct and Pipe

2. SMACNA and PPIC “Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems”.

1.4 QUALITY ASSURANCE

A. Qualifications.

1. Manufacturer.

a. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture for not less than five years. Manufacturer shall be an active member of VISCMA - Vibration Isolation & Seismic Controls Manufacturers Association.

B. Manufacturer or manufacturer's representative of vibration isolation and restraint equipment shall have the following responsibilities.

1. Determine vibration isolator and/or restraint sizes and locations.
2. Provide piping and equipment isolation and/or restraint systems as scheduled or specified.
3. Guarantee specified isolation system static deflection under installed actual load.
4. Provide installation instructions, drawings and field supervision to assure proper installation, adjustment and performance.

C. The installation of all vibration isolation units and associated hangers and bases shall be as directed by the vibration isolation manufacturer's representative.

D. It is the objective of this Specification to provide the necessary design for the control of excessive noise and vibration in the building due to the operation of machinery or equipment, and due to interconnected piping, ductwork or conduit.

1. All vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
2. All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and shall be linear over a deflection range of not less than 50 percent greater than the design deflection.
3. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than ±10 percent.
4. All neoprene mountings shall have a Shore hardness of 30 to 60 ±5, after minimum aging of 20 days or corresponding oven-aging.

E. Acoustical Testing.

1. The contractor shall cooperate with regard to sound tests (ARI 575, ANSI S1.13) which may be conducted by Professional to verify that noise criteria are met.
2. The contractor shall notify the Professional of any changes which will affect the acoustical performance.

F. Seismic load calculations for piping, ductwork, and equipment.

1. Fp, the total design lateral seismic force, shall be calculated by a licensed structural or mechanical engineer, unless it is explicitly stated in the plans or specifications. The engineer shall be hired by the contractor responsible for this Section of work.
2. Shall meet International Mechanical Code requirements.
3. Calculations required for supports and bracing for situations not covered by referenced Guidelines.

    a. Hired by contractor under this Section of work.
    b. Cost of calculations borne by contractor under this Section.

4. Calculations made and signed by registered structural engineer knowledgeable in seismic design.
5. Include horizontal and vertical reaction loads at connections to building structures for all seismic restraints, including those covered by Referenced Standards.

    a. Coordinate reaction loads and attachment details with structural engineer for building.

G. Wind load calculations for rooftop equipment

1. Fw, design wind force applied to rooftop equipment, shall be calculated by a licensed structural or mechanical engineer, unless it is explicitly stated in the plans or specifications. The engineer shall be hired by the contractor responsible for this Section of work.
2. Shall meet International Mechanical Code requirements.
3. Calculations required for supports and bracing for situations not covered by referenced Guidelines.

    a. Hired by contractor under this Section of work.
    b. Cost of calculations borne by contractor under this Section.

4. Calculations made and signed by registered structural or mechanical engineer knowledgeable in wind restraint design.
5. Include horizontal and vertical reaction loads at connections to building structures for all wind restraints, including those covered by Referenced Standards.
6. Coordinate reaction loads and attachment details with structural engineer for building.

1.5 SUBMITTALS

A. See Section– Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. "R" means required.
2. "R2" means required only for products and equipment differing for the specified manufacturer and model and for "or equals" where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Vibration isolation devices: catalog cuts, static deflections, quantity, load per isolator, mounting details, etc.	R	R		R
Concrete and steel details for equipment pads				R
Weld or anchor bolt locations				R
Reinforcing and template steel locations and details				R
Seismic calculations for each seismic restraint sized and signed by registered structural engineer	R	R		
Seismic restraints	R	R		R
Seismic bracing and restraint mounting details	R	R		R
Wind calculations for each seismic restraint sized and signed by registered structural engineer	R	R		
Wind restraints	R	R		R
Wind bracing and restraint mounting details	R	R		R
Inertia and equipment bases	R	R		R
Anchors, inserts and fasteners and fastening details	R	R		R
Flexible pipe connectors	R	R		R
Flexible duct connectors	R	R		R

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Vibration Isolation and Roof Curbs.

1. Vibro-Acoustics.
2. Mason Industries, Inc.
3. Kinetics Noise Control, Inc.
4. Or equal.

C. Flexible Duct Connections.

1. Ventfabrics.
2. Duro Dyne.
3. Or equal.

D. Seismic Restraints.

1. Hangers and snubbers: Any manufacturer who can verify compliance with SMACNA standards.
2. Strut – Channel Framing: Any manufacturer who can verify compliance with the ICBO standards.
3. Anchors – Drill in, wedge type: Any manufacturer within the ICBO standards approved for seismic.
4. Snubbers: Any manufacturer within the ICBO standards.

2.2 VIBRATION ISOLATOR TYPES

A. Spring type.

1. Spring isolators shall incorporate the following:

a. All springs to have minimum spring coil outer diameter 0.8 of loaded operating height.
b. Horizontal spring stiffness within 0.8 to 1.25 times rated vertical spring stiffness.
c. Corrosion resistance

1) Where exposed to corrosive environment including but not limited to:

a) Outdoors.
b) Exposed to outdoor air within 5 feet of outdoor air intake.

2) Corrosion protection:

a) Housings: hot dip galvanized.
b) Springs: powder coated, or neoprene coated.
c) Hardware: zinc or cadmium plated.
d) All other metal parts hot dip galvanized or stainless steel.

d. Reserve deflection (from loaded to solid height) of 50 percent of rated deflection.

e. Designed and installed so that ends of springs remain parallel.
f. Noise pads/cups of 1/4 inch or 1-inch thickness below the spring base to reduce the chance that the springs shall be resonant with equipment forcing frequencies or support structure natural frequencies. See Table herein.
g. Where operating weight differs from installed weight provide built-in adjustable limit stops to prevent equipment rising when weight is removed. Stops shall not be in contact during normal operation.

2. Type "A-1": Open Floor Springs shall incorporate the following.

a. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the base plate and the support.
b. Equal to Vibro-Acoustics type FS.

3. Type “A-2”: Restrained Floor Springs shall incorporate the following:

a. Restrained spring mountings shall have a “Type A-1” spring isolator within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/4" shall be maintained around restraining bolts and internal neoprene deceleration bushings so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Housing shall be designed to resist all seismic and/or wind forces.
b. Equal to Vibro-Acoustics type CSR or SFS

4. Type "B": Spring Hangers shall incorporate the following:

a. Hangers shall consist of rigid steel frames containing a steel spring with general characteristics as described herein. Spring shall be seated within a neoprene cup/bushing.
b. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degrees arc from side to side before contacting the rod and short circuiting the spring.
c. Hanger locations requiring pre-compression for holding piping at fixed elevation shall be pre-compressed type for all manufacturers.
d. Equal to Vibro-Acoustics type SHB

5. Type "C": Spring Hanger with Neoprene Element shall incorporate the following:

a. Similar to “Type B” with the addition of a neoprene element (as described by Type E) within the top of the hanger box.
b. Equal to Vibro-Acoustics type SHRB

B. Elastomer mounting types.

1. Type "D": Neoprene Floor Mount incorporating the following:

a. Bolt holes for bolting to equipment base.
b. Bottom steel plates for bolting to sub-base as required.
c. Unit type design molded in colored oil-resistant neoprene.
d. Neoprene compounded to meet following:

1) Not greater than 50-durometer.
2) Minimum tensile strength 2000 pounds per square inch.
3) Minimum elongation 300 percent.
4) Maximum compression set of 25 percent of the original deflection.

e. Equal to Vibro-Acoustics Type RD.

2. Type "E": Elastomer hanger rod isolators shall incorporate following:

a. Hangers shall consist of rigid steel frames containing molded (minimum 1-1/4” thick) type neoprene element.
b. Element to have projecting bushing lining the rod clearance hole.
c. Static deflection at rated load shall be a minimum of 0.35".
d. Equal to Vibro-Acoustics type NH.

3. Type "F": pad type elastomer mountings to incorporate following:

a. 3/4-inch minimum thickness per layer.
b. 50 psi maximum loading.
c. Ribbed or waffled design.
d. 1/16-inch galvanized steel plate between multiple layers of pad thickness.
e. Suitable bearing plate to distribute load.
f. Bolts through equipment and pad shall be oversized and provided with resilient washers, bushings and lock nuts.
g. Equal to Vibro-Acoustics type Neo+.

4. Type "G": Pad type elastomer mountings to incorporate following:

a. High quality bridge bearing neoprene.
b. Maximum loading 800 psi.
c. Suitable bearing plate to distribute load.
d. Minimum thickness 2 inch.
Mason Type BBP or equal.

5. Type "H": See Type “C”.

6. Type "J": Restrained Neoprene Mount

    a. Similar to Type “D” with the addition of a rigid steel housing to provide restraint against seismic/wind loads.
    b. Equal to Vibro-Acoustics type SRD

2.3 EQUIPMENT BASES

A. Integral structural steel bases, Type "B-1".

1. Reinforced as required to prevent base flexure at start-up and misalignment of drive and driven units.
2. Fan bases complete with motor slide rails.
3. Drilled for drive and driven unit mounting template.
4. Bases to be primer coated for indoor applications and hot dip galvanized for outdoor applications
5. Base depths need not exceed 12" provided that the deflection and misalignment is kept within acceptable limits as determined by the equipment manufacturer.
6. Vibro-Acoustics type IFB/CTB or equal.

B. Concrete inertia base, Type "B-2".

1. Formed in structural steel frame.
2. Structural base reinforced as required to prevent flexure, misalignment of drive and driven unit or stress transferal into equipment.
3. Minimum thickness of the inertia base shall be 6 inches or greater if required to meet weight ratio specified below.
4. Fan bases complete with motor slide rails.
5. Pump bases shall be large enough to support suction and discharge elbows and suction diffusers.
6. Bases complete with:

    a. Height saving brackets.
    b. Reinforcing.
    c. Equipment bolting provisions.
    d. Isolators provided by vibration control supplier, type as scheduled.

7. Base ready for concrete pour.
8. Inertia Base Weights.

    a. Centrifugal Fans, except as noted: Minimum 1.0 times weight of fan, motor and drive.
    b. Air handling Units, except as noted: Minimum 1.0 times weight of fan and coil cabinet, coils, fan, motor and drive.

c. Pumps: Minimum 1.5 times weight of pump, motor and base.

1) Base to be sized to support suction diffuser when used.

d. Air compressors.

1) Minimum 2 times weight of compressor, motor and base.
2) Weight can be reduced by weight of tank when tank mounted unit is provided.

9. Vibro-Acoustics type CIB or equal.

2.4 ANCHORS, INSERTS AND FASTENERS

A. All anchors and inserts shall be installed according to the ICBO or ICC-ES standards.

B. Do not use any anchor or insert in concrete which does not have a signed structurally engineered design value based on its installed application and one of the following:

1. ICBO or ICC-ES evaluation report.
2. Lab test report verifying compliance.

C. Do not use powder driven and power driven (Shoot-In) fasteners, expansion nails or friction spring clips.

D. All over-head concrete anchors or inserts shall be selected to comply with the ICBO report table for the anchor or insert.

E. Torque testing of anchors shall be allowed to verify compliance of anchor installation. However, torque testing shall not justify usability of anchor. Only load or pull testing shall be allowed to justify usability of anchors. Failure of torque shall constitute failure of anchor.

F. Bolts and nuts.

1. Bolts and heavy hexagon nuts: ANSI B18.2.1 and ASTM A307 or A576.
2. Bolts, underground: ASTM A325.
3. Expansion anchors: Federal Specification A-A-1922.

2.5 FLEXIBLE PIPE CONNECTORS

A. Piping Connections for Vibration Isolation.

1. Molded twin-sphere type connectors made of peroxide cured EPDM.
2. Connectors up to 2-inch diameter may have threaded ends.

3. Connectors 2-1/2-inch diameter and larger to have floating steel flanges recessed to lock the connector's neoprene flanges.
4. Connectors rated a minimum of 150 pounds per square inch at 220 degrees Fahrenheit without control rods or cables.
5. Vibro-Acoustics Type EJE2 or equal.

B. Hose Connections for Vibration Isolation.

1. Stainless steel braid over an EPDM liner.
2. Rated for -40 to 230 ˚F and a minimum working pressure of 300 psig.

C. Piping Connections at Seismic Joints.

1. Flexible hose configuration capable of the following seismic motion in all planes:

a. At seismic joints: 4-inches.

2. 304 stainless steel hose and braid.
3. 250 psi rated.
4. Connectors up to 2-inch diameter may have threaded ends.
5. Connectors 2 inch and larger shall have free floating flange connection.
6. Vibro-Acoustics Type SSV or equal.

2.6 FLEXIBLE DUCT CONNECTORS

A. See Section– Metal Ducts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install isolators in accordance with manufacturer's written instructions.

B. Install seismic restraints in accordance with manufacturer’s written instructions.

C. Install wind restraints for all outdoor components in accordance with the manufacturer’s written instructions.

D. Make no rigid connections between equipment and building structure that degrade noise and vibration isolation system herein specified.

1. Electrical conduit connections to isolated equipment shall be flexible liquid tight conduit of sufficient length to incorporate a right-angle bend, an offset of not less than 8 inches or a loop to allow free motion of isolated equipment.

2. The HVAC Contractor shall not install any equipment, piping or conduit which makes rigid contact with the building unless permitted in this Specification; building includes, but is not limited to, slabs, beams, columns, studs and walls.
3. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.

E. Do not use isolator leveling bolts as jacking screws.

F. Verify that all installed isolators and mounting systems permit equipment motion in all directions.

3.2 FLOOR MOUNTED EQUIPMENT

A. Concrete housekeeping pads:

1. Isolation supplier to determine dimensions and thickness required.

    a. Minimum thickness: 5.5 inches.

2. Support all vibration isolation devices and bases.
3. Key with stirrups as required, integral with structural slab.
4. Incorporate seismic restraint anchor plates flush with top of housekeeping pad.

3.3 EQUIPMENT ISOLATION

A. General.

1. Provide 1-inch operating clearance minimum between equipment or structural bases and housekeeping pad.

    a. 1-inch minimum clearance for inertia bases over 96 inches in any dimension.

2. Position equipment, structural base and concrete bases on blocks or wedges at proper operating height.
3. Provide operating load conditions prior to transferring base isolator loads to springs and removing wedges.
4. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 1/4 inch.
5. Prior to start-up, clean out all foreign matter between bases and equipment.
6. Verify that there are no isolation short circuits in the base, isolators, or conduit, pipe and duct connections.

7. Position all corner or side seismic restraints with equipment in operation for proper operating clearance. Weld or bolt seismic restraints to seismic anchor plates in housekeeping pad.
8. Locate spring hanger boxes directly adjacent to the structural support element above, as opposed to down at the location of the supported equipment.
9. Where isolator base pad is called for in Vibration Isolator Schedule, install pad between the isolator base and structure.
10. For isolator pads penetrated by anchors to the structure, to prevent short-circuiting, provide neoprene grommet between the anchor and isolator. Hand-tighten nut so that grommet is not compressed then secure with lock nut.

B. Vibration Isolator Schedule.

Equipment	Basement/Slab On Grade			Upper Floor		
	Base Type	Isolator Type	Min. Defl. (in.)	Base Type	Isolator Type	Min. Defl. (in.)
Chillers						
Air-cooled	--	J	0.25	--	A-2	1.50
Water-cooled	--	F	0.15	--	A-2	1.50
Air Compressors/Vacuum Pumps						
Tank Mounted	--	F	0.15	--	D or F	0.30
Base Mounted	B-2	A-1	0.75	B-2	A-1	1.50
Pumps						
Inline - suspended (1 hp to 3 hp)	--	--	--	--	C	0.75
Inline - suspended (5 hp and up)	--	--	--	--	C	1.50
Inline - floor (up to 3 hp)	--	F	0.15	V	D or F	0.30
Inline - floor (5 hp and up)	--	D	0.30	V/B-2	A-1	1.50
End Suction/Split Case	B-2	A-1	0.75	B-2	A-1	1.50
Cooling Towers						
Up to 500 rpm	--	--	--	B-1	A-2	2.50
501 rpm and up	--	--	--	B-1	A-2	1.50
Boilers						
All	--	--	--	--	F	0.15
Fans						
Small suspended (1/4 hp to 1/2 hp)	--	--	--	--	E	0.30
Inline/Axial - Suspended (up to 22 in. dia.)	--	--	--	--	C	0.75
Inline/Axial - Suspended (24 in. dia. and up)	--	--	--	--	C	1.50
Centrifugal (up to 22 in. dia.)	B-1	D	0.30	B-1	A-1	0.75
Centrifugal (24 in. dia. and up)	B-2	A-1	0.75	B-1	A-1	1.50
Heat Pumps, Fan Coils, CRACs, Fan Powered Boxes						

Equipment	Basement/Slab On Grade			Upper Floor		
	Base Type	Isolator Type	Min. Defl. (in.)	Base Type	Isolator Type	Min. Defl. (in.)
Suspended	--	--	--	--	C	0.75
Floor	--	F	0.15	N/A	D or F	0.30
Packaged AHUs - indoor						
with internal spring isolation (up to 10 hp)	--	--	--	--	F	0.15
with internal spring isolation (> 15 hp)	--	F	0.15	--	D or F	0.30
without internal spring isolation (up to 10 hp)	--	F	0.15	B-1	A-1	0.75
without internal spring isolation (> 15 hp)	--	D or F	0.30	B-1	A-1	1.50
Packaged Rooftop Equipment						
with internal spring isolation (up to 10 tons)	--	--	--	--	--	--
with internal spring isolation (> 10 tons)	--	--	--	VCR/ARTR	A-2	1.50
without internal spring isolation (up to 10 tons)	--	--	--	VCR/ARTR	A-2	0.75
without internal spring isolation (> 10 tons)	--	--	--	VCR/ARTR	A-2	1.50

3.4 PIPING ISOLATION

A. See Section Hydronic Piping.

~~B.~~ Piping connected to vibration isolated equipment and larger than 1" dia. shall be spring isolated as follows:

1. All piping in mechanical rooms or 50' to/from equipment, whichever is greater.
2. First 3 supports points to/from equipment shall have the same rated deflection as the connected equipment.
3. Suspended spring hanger supports shall be type "B" or equal. Floor mounted spring supports shall be type "A-2".
4. Pre-compressed spring hangers shall be provided upon request.
5. Flexible connectors shall be provided at piping connections to equipment

C. Vertical Pipe Risers.

1. Riser Support.

a. Applies to all pipe risers that experience thermal movement greater than 1/4"
b. Riser supports shall be engineered by the vibration isolation vendor.
c. All vertical risers shall be supported by spring isolators designed to support the riser filled with water. Assigned loads shall be within the building design limits at the support points.
d. Neutral central resilient anchors close to the center of the run shall direct movement up and down. The anchors shall be capable of

holding an upward force equal to the water weight when the system is drained. If one level cannot accommodate this force, anchors can be located on 2 or 3 adjacent floors. Anchors shall be Vibro-Acoustics Type CSR or equal.

e. Resilient guides shall be spaced and sized properly depending on the pipe diameter. Guides shall be Mason VSG Vertical Sliding Guides or equal.

f. Support spring mountings shall be Type A-1. The initial spring deflection shall be a minimum of 0.75 inches or four times the thermal movement at the isolator location, whichever is greater.

g. Submittals shall include the initial load, initial deflection, change in deflection, final load and change in load at all spring and anchor locations, as well as guide spacing. Calculations shall include pipe stress at end conditions and branch off locations and the manufacturer shall include installation instructions.

3.5 DUCTWORK ISOLATION

A. See Section Metal Ducts.

B. Ductwork.

1. No vibration isolation required other than flexible connections at fans.

C. Flexible Connections.

1. Install at all connections to fans and air handling units and as indicated on Drawings.

   a. Not required at fan powered VAV boxes.

2. 2-inch slack in fabric; install to allow minimum movement of 1 inch in both tension and compression.
3. Outdoor installations.

   a. Protect from direct solar and rain exposure with sheet metal shroud.
   b. Install shroud on top and both sides; not required on bottom.
   c. Shroud shall be fastened to fan and cantilevered over and extending a minimum of 2 inches beyond the flexible connection.

3.6 WALL AND FLOOR PENETRATIONS

A. All piping and ductwork to be vibration isolated, and all piping and ductwork passing through acoustically rated partitions, shall freely pass through walls and floors without rigid contacts or connections. Penetration points shall be sleeved or otherwise formed to allow passage of piping or ductwork and maintain 0.75

inches to 1.25 inches clearance around the pipe or duct outside surfaces. For installations through air plenum partitions and through acoustically rated partitions, clearance space shall be tightly packed with fiberglass, and caulked airtight after installation of piping or ductwork.

B. For installation in rated walls, see Section Hydronic Piping and Section Metal Ducts.

C. Provide sleeves and escutcheons as specified.

3.7 FIELD QUALITY CONTROL

A. Inspection by manufacturer's representative of all vibration isolating devices.

1. After installation of all devices.
2. Provide written report by manufacturer regarding:

    a. Installation errors.
    b. Improper selection of devices.
    c. Other fault that could affect performance of system.

B. Submit written report to Architect.

1. Include manufacturer's report indicating required corrections.
2. Include report on steps to properly complete isolation work.

END OF SECTION

SECTION 15075 MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment nameplates.
2. Access panel and door markers.
3. Pipe markers.
4. Duct markers.
5. Valve tags.
6. Valve schedules.
7. Warning tags.

1.3 REFERENCE STANDARDS

A. Pipe marker shall comply with ANSI A13-1.

1.4 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Pipe markers	R		R	
Duct markers	R		R	
Equipment tags	R		R	
Valve tags	R		R	
Concealed equipment markers	R		R	
Equipment label and valve tag schedule		R		

Item	Product Data	O&M Manual	Samples	Shop Drawing
Valve numbering scheme		R		
Valve schedules	R	R	R	

1.5 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.6 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

1. Brimar Industries, Inc.
2. Seton Identification Products.
3. Marking Services, Inc.

2.2 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Labels:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.

4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: Principal lettering shall be 1/2 inch. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
9. Label Content: Include equipment's Drawing designation or unique equipment number, serial number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

B. Warranty Label:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg. F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: Principal lettering shall be 1/2 inch. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
9. Label Content: Include warranty information including start date, end of parts and labor warranty date, contact name and contact number. Coordinate information with professional and end user before making labels.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3 ACCESS PANEL AND DOOR MARKERS

A. Access panel and access door markers:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Red.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: Principal lettering shall be 1/2 inch. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label access panels and access doors identifying “Fire Damper, Fire/Smoke Damper”, etc.

2.4 WARNING SIGNS AND LABELS

A. Warning signs and labels:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Red.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: Principal lettering shall be 1/2 inch. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include caution and warning information plus emergency notification instructions.

C. Laundry, kitchen and other similar equipment and fixture installations utilizing water with temperatures in excess of 125 deg F., shall have warning sign, mounted adjacent to and easily visible to users, indicating “CAUTION: EXTREMELY HOT TEMPERATURES UTILIZED”.

D. Identify front cover of laboratory safety valve enclosure with warning sign, with 1” tall lettering as “NOTICE: Gas/Water Safety Shutoff Valves”. Identify valves inside with valve tags, with service indicated.

E. Provide OSHA and ANSI required safety warning signage at all emergency eye/shower stations, kitchen hood fire protection pull stations, safety and critical operating controls, etc.

2.5 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or shaped pipe markers at least three times letter height and of length required for label.

B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.6 DUCT LABELS

A. Not required.

2.7 VALVE TAGS

A. Valve Tags: Numbering scheme approved by Architect.

1. General: Identify valves with metal tags, legends to be stamped or embossed. It shall indicate the function of the valve and its normal operating position, such as:

a. “56 HW” (NUMBER AND CONTENT OF PIPE)
b. “ISOLATION” (VALVE FUNCTION)
c. “NC” (NORMALLY CLOSED)

B. Description: 2-inch diameter, stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass beaded chain or S-hook.
3. Automatic Valves and Regulating Valves: Use 1/16-inch thick laminated 3-ply plastic, center ply white, outer ply red, “lamicoid” or equal. Form letters by exposing center ply.
4. Valve Tag Directory: Include tag number, location, exposed or concealed, service, valve size, valve manufacturer, valve model number, tag material, and normal operating position of valve.

C. Valve Schedules: For each piping system, on plastic laminated, 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. Include floor plan location drawing with all valves indicated with the valve tag assigned to each valve. Mark valves for emergency shutoff and similar special uses.

1. Valve-Schedule and Valve Floor Plan 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.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment (including motor starters, VFDs, control panels, etc.)

B. Locate equipment labels where accessible and visible.

C. Install access panel markers with screws on equipment access panels.

3.4 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 18” of each valve, valve assembly and control device.
2. Within 3’ of each 90-degree elbow, connection to equipment or vessel and where pipe enters shafts and penetrates outside walls, floors, ceilings, and non-accessible enclosures.
3. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
4. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
5. At access doors, manholes, and similar access points that permit view of concealed piping.
6. Near major equipment items and other points of origination and termination.
7. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
8. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule:

Service	Pipe marker	Background color	Lettering
Chilled water	Chilled water supply	Green	White
	Chilled water return	Green	White
Heating water	Heating water supply	Yellow	Black
	Heating water return	Yellow	Black
Refrigerant Gas	RG	Orange	Black
Natural gas	Natural gas	Yellow	Black
Cold water	Domestic cold water	Green	White
Hot water	Domestic hot water supply	Yellow	White
	Domestic hot water return	Yellow	White
Sanitary waste	Sanitary waste	Green	White
Storm drain	Storm drain	Green	White
Condensate drain	Condensate drain	Green	White
Vent	Vent	Green	White

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape: 1-1/2 inches, round.
2. Valve-Tag Colors:

    a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
    b. Flammable Fluids: Black letters on a safety-yellow background.
    c. Combustible Fluids: White letters on a safety-brown background.
    d. Potable and Chilled Water: White letters on a safety-green background.
    e. Hot and Heating Water: White letters on a safety-orange background.
    f. Compressed Air: White letters on a safety-blue background.

g. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

3.6 VALVE SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.7 EQUIPMENT LOCATOR STICKERS

A. Install color-coded stickers on the grid, access panel, or insulation at the closest access point to the device.

B. Install color-coded stickers to locate above ceiling equipment and devices as follows:

1. Fire dampers (red).
2. Manual volume dampers (orange).
3. Motorized control dampers (yellow).
4. HVAC equipment (black).
5. Hydronic system valves (green).
6. Control system devices (light blue).
7. Cold water (blue).
8. Hot water (red).

3.8 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.9 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.10 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION

SECTION 15.080 DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Ducts and plenums, thermal insulation.
2. Ducts and plenums, acoustic insulation.
3. Ducts and plenums, fire rated insulation.
4. Duct liner.

1.3 REFERENCE STANDARDS

A. ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C177 – Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

C. ASTM C335 – Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.

D. ASTM C585 – Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe.

E. ASTM C921 – Properties of Jacketing Materials for Thermal Insulation.

F. ASTM E84 – Surface Burning Characteristics of Building Materials.

G. ASTM E96 – Water Vapor Transmission of Materials.

H. NFPA 255 – Surface Burning Characteristics of Building Materials.

I. SMACNA – HVAC Duct Construction Standards - Metal and Flexible.

J. UL 723 – Surface Burning Characteristics of Building Materials.

K. ASTM E 814 – Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

1.4 DEFINITIONS

A. Duct Dimensions.

1. Duct sizes indicated on Drawings shall be clear inside dimensions unless duct size is specifically indicated as outside dimensions (OD).

1.5 QUALITY ASSURANCE

A. Source Quality Control.

1. Service: Use insulation specifically manufactured for service specified.
2. Labeling: Insulation labeled or stamped with brand name and number.

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

1.6 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Duct insulation, wrap and liner	R			
Jackets	R			
Adhesives and coatings	R			
Mechanical fasteners	R			
Installer qualifications	R			

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Insulation: fiberglass.

1. Owens-Corning Fiberglass Corporation.
2. Johns Manville.
3. Certainteed Corporation.
4. Knauf.
5. Or equal.

C. Adhesives.

1. Childers Brand; H. B. Fuller Construction Products.
2. Foster Brand; H. B. Fuller Construction Products.
3. Mon-Eco Industries, Inc.
4. Or equal.

D. Mechanical Fasteners.

1. AGM Industries, Inc.
2. Miracle Adhesives Corporation.
3. Grip-Nail.
4. Or equal.

2.2 GENERAL

A. Energy Codes: The current versions of ASHRAE 90.1 shall govern where requirements for thickness exceeds thickness specified.

B. All insulation materials, including jackets, facings, adhesives, coatings, and accessories are to be fire hazard rated and listed by Underwriters' Laboratories, Inc., using Standard UL 723 (ASTM E-84), (NFPA-255), (ASA A2.5-1963).

1. Flamespread: maximum 25.
2. Fuel contributed, and smoke developed: maximum 50.
3. Flameproofing treatments subject to deterioration from moisture or humidity are not acceptable.

C. Insulation and accessories shall not provide any nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, shall not react corrosively

with equipment, piping or ductwork, and shall be asbestos free: Duct lining shall meet ASTM C1136 and ASTM C665 for biological growth in insulation

2.3 MATERIALS

A. Duct Wrap with Vapor Barrier, Type DW-V.

1. Insulation: ASTM C553 and C612; flexible, noncombustible blanket.

a. Installed 'K' ('Ksi') value: ASTM C518, 0.27 at 75 degrees Fahrenheit.
b. Maximum service temperature: ASTM C411, 250 degrees Fahrenheit.
c. Maximum moisture absorption: 0.20 percent by volume.

2. Vapor Barrier Jacket - factory installed. (FSK).

a. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
b. Moisture vapor transmission: ASTM E96 Procedure E; 0.02 perm.
c. Secure with pressure sensitive tape.

3. Vapor Barrier Tape: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based, adhesive.

a. Flexible fiberglass wrap

1) Supply Air: 2.2” Nominal Thickness with Installed R-Value 6.0 (0.75 pcf)
2) Return/Outside/Exhaust Air: 1.5” Nominal Thickness with Installed R-Value 4.2 (0.75 pcf)

b. Installed conductance: 0.27 BTU-inch/hr./square foot/degree Fahrenheit.
c. Factory applied jacket.

1) Foil-scrim-kraft laminate: Aluminum foil facing.
2) Glass scrim reinforcing.
3) Kraft paper backing.

d. Maximum vapor permeance: 0.02 perms,

4. Owens-Corning All Service Faced Duct-Wrap or equal.

B. Duct Board with Vapor Barrier, Type DB-V

1. Insulation: ASTM C612; rigid, noncombustible board.

a. 'K' ('Ksi') value: ASTM C518, 0.23 at 75 degrees Fahrenheit.
b. Maximum service temperature: 350 degrees Fahrenheit.
c. Maximum moisture absorption: 0.20 percent by volume.

2. Vapor Barrier Jacket - factory installed (FSK).

a. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
b. Moisture vapor transmission: ASTM E96 Procedure E; 0.02 perm.
c. Secure with pressure sensitive tape.

3. Vapor Barrier Tape: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based, adhesive.
4. Installed conductance: 0.23 BTU-inch/hr./square foot/degree Fahrenheit.
5. Thickness per Duct Insulation Type and Thickness Schedule.
6. Factory applied jacket.

a. Foil-scrim-kraft laminate.

1) Aluminum foil facing.
2) Glass scrim reinforcing.

C. Rectangular Duct Liner, Type AL.

1. Material.

a. Insulation: ASTM C423.
b. 'K': ASTM C518, 0.23 at 75 degrees Fahrenheit.
c. Maximum service temperature: 350 degrees Fahrenheit.
d. Maximum moisture absorption: 0.20 percent by volume.
e. Thickness per Duct Insulation Type and Thickness Schedule.
f. 1-1/2 pounds per cubic foot unless shown otherwise to be 3 pounds per cubic foot.
g. Installed conductance: 0.25 BTU-inch/hr./square foot/degree Fahrenheit.

2. Interior air side surface.

a. Smooth black neoprene or matte facing overlay on air side. Coating shall conform to NFPA 90A, ASTM C665, ASTM G21.
b. Suitable for velocity up to 4000 feet per minute.
c. Meet erosion test method described in UL publication No. 181.
d. Durable and mechanically cleanable.
e. EPA registered anti-microbial agent.
f. Certainteed Toughgard Duct Liner or equal.
g. Adhesives.

1) Duct Insulation, Internal: Foster 85-60 or equal.
2) Weld Pins: Duro-Dyne CP or equal.

D. Round Duct Liner, Type RAL.

1. Same material as Type AL.
2. Interior air-side surfaces same as Type AL.
3. Self-supporting, slide-in installation.
4. Schuller Permacote Spiracoustic or equal.
5. Small diameter ducts which cannot be insulated internally using duct lining materials shall be prefabricated. Insulation material shall be fixed between outer duct metal and a perforated metal liner. United McGill k27 series or equal. Fittings shall be insulated to same standard and shall be by same manufacturer.

E. Plenum Liner, Type PL

1. Material.

a. Heavy-density mat-faced Plenum Liner: Comply with ASTM C 1071.
b. 'K': ASTM C518, 0.23 at 75 degrees Fahrenheit.
c. Maximum service temperature: 350 degrees Fahrenheit.
d. Maximum moisture absorption: 0.20 percent by volume.
e. Thickness per Duct Insulation Type and Thickness Schedule.
f. 1-1/2 pounds per cubic foot unless shown otherwise to be 3 pounds per cubic foot.
g. Installed conductance: 0.25 BTU-inch/hr./square foot/degree Fahrenheit.

2. Interior air side surface.

a. Smooth black neoprene or matte facing overlay on air side. Coating shall conform to NFPA 90A, ASTM C665, ASTM G21.
b. Suitable for velocity up to 4000 feet per minute.
c. Meet erosion test method described in UL publication No. 181.
d. Durable and mechanically cleanable.
e. EPA registered anti-microbial agent.
f. Knauf Insulation Rigid Plenum Liner or equal.
g. Adhesives.

1) Duct Insulation, Internal: Foster 85-60 or equal.
2) Weld Pins: Duro-Dyne CP or equal.

PART 3 - EXECUTION

3.1 DUCT & PLENUM INSULATION

A. Duct Insulation Type and Thickness Schedule.

Location	Cooling or Heat/Cool Supply	Re-turn/Outdoor Air	Exhaust
Supply/return ductwork con-cealed in ceiling or return air plenum	2.2 inches DW-V	1-1/2 inches DW-V	1-1/2 inches DW-V
Concealed in unconditioned spaces	2.2 inches DW-V	1-1/2 inches DW-V	1-1/2 inches DW-V
Lined duct on first 6' pf R/A and S/A ductwork from HVAC equipment	2 inches 1.5 pounds per Cubic foot AL	2 inches 1.5 pounds per Cubic foot AL	-
Exposed to view duct	1 inch 1.5 pounds per Cubic foot AL or AL	1 inch 1.5 pounds per Cubic foot AL or AL	-
Flex duct	By manufacturer	By manufacturer	-
Double wall duct	1 inch 1-1/2 pounds Per cubic foot DW	-	-
Air distribution devices, not fac-tory insulated (backpans of grilles, registers, and diffusers)	2.2 inches DW-V	-	-

3.2 DUCT INSULATION INSTALLATION

A. General.

1. Ensure that insulation is continuous through all walls.
2. Finish insulation neatly at hangers, supports and other protrusions.
3. Locate insulation joints or cover seams in least visible locations.
4. Where ducts run in groups too close to be individually insulated and finished.

a. Completely fill all spaces between ducts with rigid or flexible insulating material.
b. Insulate and finish exterior surfaces of group as specified for particular service.

5. Where ducts cannot be insulated after erection, insulate prior to installation.
6. Where specified thickness of insulation and/or lining exceeds available thickness in single layer, provide insulation and/or lining in 2 or more layers with joints staggered.
7. Preparation:

a. Do not install covering before ductwork and equipment has been tested and reviewed.
b. Ensure surface is clean and dry prior to installation.
c. Ensure insulation is dry before and during application.

8. Mechanical fasteners:

a. Use spot weld anchors in all shop fabricated internally lined ducts.
b. Adhered anchors.
c. Clip off pin penetrations flush with insulation surface or facing.
d. Seal pins and washers where pins penetrate vapor barriers.

1) With 4-inch square pieces of vapor barrier material to match facing.
2) Adhere with vapor-seal adhesive.

e. Spacing on rectangular ducts.

1) Typical of horizontal and vertical, unless otherwise specified.
2) Duct board.

a) 3 inches in from edges.
b) Intermediate fasteners: 12 inches on center maximum spacing all directions.
c) Not less than four pins per surface.

3) Duct Wrap.

Side Dimension	Maximum Spacing
24 inches and under	None required.
25 to 32 inches	Horizontal - none. Vertical: 1 row centered, 12 inches on center
33 to 48 inches	2 rows, 12 inches on center.

Side Dimension	Maximum Spacing
49 to 60 inches	3 rows, 12 inches on center.
61 inches and over	16 inches on center, all directions.

4) Duct wrap spacing applicable to flat surfaces of flat oval ducts.

9. Provide 24-gauge sheet metal Z section frames over edges of duct and plenum lining.

   a. At access openings and doors.
   b. Along edges exposed to air flow.

B. Rectangular Duct Wrap.

1. Vapor barrier and sealing continuous without breaks. Vapor proof seal around supports and bracing.
2. 2 inches lap strip at one end.
3. Peel insulation for 2-inch lap strip along longitudinal joints.
4. Seal lap strips with vapor-seal adhesive; Foster's 85-60 or equal.

C. Round Duct Wrap.

1. Adhere flexible insulation to ductwork with adhesive applied in 6-inch-wide strips on 16-inch centers.
2. Provide 16-gauge annealed tie wire tied, spiral wound or half hitched at 16-inch centers.
3. Overlap insulation 2 inches and seal joints and breaks with 2-inch lap of foil adhered over joint.
4. Apply duct wrap with vapor barrier as specified above for rectangular ducts.

D. Duct Board.

1. Comply with published recommendations of manufacturer.
2. Secure on top, sides, and bottom of duct with mechanical fasteners, spacing as scheduled.
3. Secure with 4-inch strips of adhesive, 8-inch on center.

E. Rectangular Duct and Plenum Lining.

1. Comply with SMACNA Duct Liner Application Standard, published recommendations of manufacturer, and following:
2. Apply adhesive over 100 percent of surfaces to be lined.
3. The coated surface shall face air stream.
4. Surface adjacent to air flow, including at joints, to be uniformly flat.

5. Insulation on floors of plenums and large ducts where access is required shall be protected by wire mesh so that lining is not damaged when walked or crawled on.
6. Blank-Off Panels: Insulation, enclosed with sheet metal on all sides; all joints with vapor barrier mastic and taped.
7. Volume Dampers: Where volume dampers do not allow for continuous insulation, terminate insulation clear of handle sweep and finish edges to maintain vapor barrier and to prevent damage to the insulation.
8. Seal butt joints and exposed edges of liner to prevent erosion.
9. Edges at terminal points shall be provided with metal beading and heavily coated with adhesive.
10. Damaged areas replaced or heavily coated with adhesive.
11. Mechanical fasteners.

    a. Use weld pins.
    b. Install mechanical fasteners.

        1) Weld pins flush with liner surface. Weld pins spaced maximum of 12-inch on center in both directions and within 2 inches of all corners and joints, except where SMACNA Standard requires closer spacing.
        2) Within 2 inches of all edges.
        3) Minimum 4 pins per side.
        4) For field alterations of lined ducts, install adhesive and glued pins with washers. Clip-off pins after washers installed. Field installed pins shall be used for unusual conditions only and shall not exceed 1 percent of total pins.

3.3 PENETRATION THROUGH RATED WALLS

A. Refer to drawings for penetrations of rated assemblies.

B. Install per manufacturer’s installation and listing requirements.

3.4 FIELD QUALITY CONTROL

A. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

B. All vapor barriers shall be continuous; tears, holes, staples, etc. shall be coated with vapor barrier mastic and patch with facing or tape.

C. See Section– Metal Ducts for protection of lined duct during construction.

END OF SECTION

SECTION 15.081 PIPING AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work Included in This Section: Materials, equipment, fabrication, installation, and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Piping insulation.
2. Pipe insulation jacket.
3. Equipment insulation.

1.3 REFERENCE STANDARDS

A. ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C177 – Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

C. ASTM C335 – Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.

D. ASTM C585 – Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe.

E. ASTM C921 – Properties of Jacketing Materials for Thermal Insulation.

F. ASTM E84 – Surface Burning Characteristics of Building Materials.

G. ASTM E96 – Water Vapor Transmission of Materials.

H. NFPA 255 – Surface Burning Characteristics of Building Materials.

I. SMACNA – HVAC Duct Construction Standards - Metal and Flexible.

J. UL 723 – Surface Burning Characteristics of Building Materials.

K. ASTM E 814 – Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

1.4 QUALITY ASSURANCE

A. Source Quality Control.

1. Service: Use insulation specifically manufactured for service specified.
2. Labeling: Insulation labeled or stamped with brand name and number.

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

1.5 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Piping insulation	R			
Jackets	R			
Adhesives and coatings	R			
Mechanical fasteners	R			
Installer qualifications	R			

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Insulation: Cellular glass.

1. Pittsburg-Corning
2. Or equal.

C. Insulation: fiberglass.

1. Owens-Corning Fiberglass Corporation.
2. Manville.
3. Certainteed Corporation.
4. Knauf.
5. Or equal.

D. Insulation: Elastomeric Closed Cell.

1. Armstrong World Industries, Inc.
2. Rubatex Corporation.
3. Or equal.

E. Weatherproof Aluminum Jacket.

1. Childers Products Company.
2. Insul-Coustic/Birma Corporation.
3. Or equal.

F. Pre-molded pipe fitting covers and Jacketing.

1. Manville: Zeston.
2. Childers Products Company.
3. Proto Corporation.
4. Insul-Coustic/Birma Corporation.
5. Or equal.

G. Adhesives.

1. Foster Div. Amchem Products Inc.
2. Childers Products Company.
3. Epolux Mfg. Corporation.
4. Insul-Coustic/Birma Corporation.
5. Armstrong 520 Adhesive.
6. Or equal.

H. Mechanical Fasteners.

1. AGM Industries, Inc.
2. Miracle Adhesives Corporation.
3. Grip-Nail.
4. Or equal.

2.2 GENERAL

A. Energy Codes: The current versions of ASHRAE 90.1 shall govern where requirements for thickness exceeds thickness specified.

B. All insulation materials, including jackets, facings, adhesives, coatings, and accessories are to be fire hazard rated and listed by Underwriters' Laboratories, Inc., using Standard UL 723 (ASTM E-84), (NFPA-255), (ASA A2.5-1963).

1. Flamespread: maximum 25.
2. Fuel contributed, and smoke developed: maximum 50.
3. Flameproofing treatments subject to deterioration from moisture or humidity are not acceptable.

C. Insulation and accessories shall not provide any nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, shall not react corrosively with equipment, piping or ductwork, and shall be asbestos free: Duct lining shall meet ASTM C1136 and ASTM C665 for biological growth in insulation.

D. Provide a continuous vapor seal for any service piping that carries liquid below 60 degrees Fahrenheit.

2.3 PIPE INSULATION

A. Cellular Glass.

1. Insulation (without jacket) ASTM C 552, Type II, Class 1.
2. Insulation (with jacket) ASTM C552, Class 2.
3. Sectional.
4. 0.32 maximum K-factor at 75 degrees Fahrenheit mean temperature.
5. Pittsburg-Corning or equal.

B. Fiberglass.

1. Molded: one piece, with factory-applied, all purpose, vapor retarder jacket, maximum 0.26 K factor at 75 degrees Fahrenheit mean temperature: Owens-Corning ASJ/SSL-II Pipe Insulation or equal.

C. Flexible, closed cell elastomeric thermal insulation.

1. Insulation ASTM C534.
2. Service rating of 220 degrees Fahrenheit.
3. Density 6.0 pounds per cubic foot.
4. Closed cell foam: Vapor permeability ASTM E96 0.2 perm.
5. Max moisture absorption: 1.0 percent by volume, 10 percent by weight.
6. Molded pipe insulation.

a. Maximum 0.27 K factor at 75 degrees Fahrenheit mean temperature
b. Maximum water vapor transmission rating of 0.17 perm-inches,

7. Sheet insulation.

a. Maximum 0.28 K factor at 75 degrees Fahrenheit mean temperature.
b. Maximum water vapor transmission rating of 0.17 perm-inches.

8. Seal with Rubatex adhesive or equal: Armstrong Armaflex II or equal.

D. Underground pipe insulation: See Section – Hydronic Piping.

2.4 EQUIPMENT INSULATION

A. Flexible, closed cell elastomeric thermal insulation.

1. Insulation ASTM C534, Type II sheet material.
2. Service rating of 220 degrees Fahrenheit.
3. Density 6.0 pounds per cubic foot.
4. Closed cell foam: Vapor permeability ASTM E96 0.2 perm.
5. Max moisture absorption: 1.0 percent by volume, 10 percent by weight.
6. Sheet insulation.

a. Maximum 0.28 K factor at 75 degrees Fahrenheit mean temperature.
b. Maximum water vapor transmission rating of 0.17 perm-inches.

7. Seal with Rubatex adhesive or equal: Armstrong Armaflex II or equal.

2.5 JACKETS

A. Factory Applied Vapor Barrier All Service Jacket (ASJ).

1. ASTM C921, White kraft paper bonded to aluminum foil and reinforced with glass fiber yarn.
2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
3. Secure with self-sealing longitudinal laps and butt strips.
4. Secure vapor barrier mastic.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.
6. Vapor Barrier Lap Adhesive: Compatible with insulation.

B. Aluminum Jacket: ASTM B209.

1. Use for weatherproof jacket.
2. Thickness: 0.016 inch sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2 inch laps.

5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.

C. Preformed PVC.

1. Polyvinylchloride covers similar to Manville Zeston.
2. Colors:

    a. Chilled Water: Blue.
    b. Condenser Water: Light blue.
    c. Heating Water: Red.
    d. Domestic Cold Water: Green.
    e. Domestic Hot Water: Orange.

D. Equipment insulation facings: Foil-scrim-kraft laminate of aluminum foil facing, glass scrim reinforcing, kraft paper backing.

E. Preformed Pipe Fitting Covers:

1. Aluminum.

    a. Factory fabricated formed covers.
    b. General Aluminum Supply Corporation GASCO or equal.

2. PVC.

    a. Factory fabricated formed covers.
    b. Manville Zeston or equal.

2.6 ADHESIVES AND COATINGS

A. Foster product names and figure numbers or equal.

1. Lagging adhesive: 30-36.
2. Fiberglass: Zeston Z-Glu.
3. Vapor barrier coating: Tite-fit 30-80, UP Label, comply with MIL-C-19565C, Type II; fire and water resistant.
4. Vaporseal adhesive: 85-60.
5. Cellular glass bedding and sealing compound adhesive: Foamseal 30-45.
6. Outdoor mastic: 30-90.
7. Asphalt mastic: C.I. Mastic 60-25.
8. For elastomeric insulation: 520 contact, adhesive.

2.7 WIRE, BANDING AND FASTENING DEVICES

A. Wire: minimum 16 gauge copper clad annealed steel wire

B. Bands: 3/4 inches nominal width with wing seals, of minimum thickness as follows:

1. Aluminum: 0.007 inches. Except where exposed to weather, 0.020 inches.
2. Stainless steel: 0.010 inches.

C. Staples: outward clinching type of corrosion resistant steel.

2.8 MECHANICAL FASTENERS

A. Mild steel, copper plated.

B. AGM Industries Power Base insulation pins or equal.

C. Insulation washers:

1. Galvanized steel.
2. 1-1/2 inch diameter.
3. AGM Industries SLW-1 or equal.

2.9 PRE-INSULATED PIPE SUPPORT AND SHIELDS

A. Provide insulated pipe supports for all insulated pipe and tubing. Insulated pipe supports shall be Pipe Shields, Inc. or equal.

B. All insulated pipe supports shall be load rated. Load ratings shall be established by pipe support manufacturer based upon testing and analysis in conformance with the latest edition of the following codes: ASME B31.1, MSS SP-58, MSS SP-69, and MSS SP-89.

C. All insulated pipe supports shall have cellular glass insulation and galvanized steel jackets. Pipe supports for use on flat surfaces shall have integral load distribution plates coated with zinc primer minimum 3 mils thick.

D. See Section 230529 – Hangers and Supports.

E. Hangers and supports shall fit outside of all pipe insulation and insulation inserts. Provide pre-insulated pipe supports as specified and install per manufacturer's installation instructions. Shield lengths and gauges shall also be per manufacturer's recommendations.

F. Tape all butt joints where pipe insulation butts up against hanger shield.

1. On hot pipe, apply three inch wide vapor barrier tape or band over the butt joint.
2. On chilled water piping, apply a wet coat vapor barrier lap cement on all butt joints and seal the joints with a minimum of three inch wide vapor tape or band.

2.10 FIRESTOPPING

A. At pipe penetrations through rated assemblies.

B. Commercial pipe sleeve assemblies that are UL listed and that have been approved by the fire marshal for this purpose.

C. Insulation shall be continuous through penetration.

2.11 ACCESSORIES

A. Insulation Protection Saddles: 12-inch long, 16 gauge steel.

B. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the fitting covers, elastomeric, aluminum facing, Kraft paper, tapes, and adhesives.

PART 3 - EXECUTION

3.1 PIPE & EQUIPMENT INSULATION SCHEDULE

A. Type P-1.

1. Molded fiberglass.
2. All-service jacket (ASJ).
3. Vapor sealed.

B. Type P-1A.

1. Molded fiberglass.
2. All-service jacket (ASJ).
3. Vapor sealed.
4. PVC jacket.

C. Type P-1B.

1. Molded fiberglass.
2. All-service jacket (ASJ).
3. Vapor sealed.
4. Metal jacket.

D. Type P-1C

1. Molded fiberglass
2. All-service jacket with a polymer film exterior surface (ASJ-MAX)
3. Vapor sealed
4. Temperature Rating 0-1000°F
5. ASTM E84 tested as an assembly

E. Type P-2.

1. Flexible elastomeric insulation.

F. Type P-3.

1. Cellular glass insulation.
2. All service jacket (ASJ).
3. Vapor sealed.

G. Type P-3A.

1. Cellular glass insulation.
2. All service jacket (ASJ).
3. Vapor sealed.
4. PVC jacket.

H. Type P-3B.

1. Cellular glass insulation.
2. All service jacket (ASJ).
3. Vapor sealed.
4. Metal jacket.

I. Type E-1.

1. Flexible elastomeric insulation.

J. Application Schedule.

Piping Systems	Location	Type	Pipe Size	Insulation Thickness	Freeze Protection
Floor Drain Bodies and related horizontal and vertical Sanitary Drain Lines above floor that receive cold condensate drainage.	Interior	P-2	4” and smaller	3/4"	-

Piping Systems	Location	Type	Pipe Size	Insulation Thickness	Freeze Protection
Cold Condensate Drain Lines	Interior	P-2	All Sizes	3/4"	-
Condensate, and sanitary sewer waste/vent piping receiving condensate (horizontal piping and vertical piping, Underside of floor drain bodies receiving condensate)	Interior	P-2	All Sizes	3/4"	
Combustible piping (PVC, PEX, etc.) installed in return air plenum	Return Air Plenum	P-1C	All Sizes	3/4"	
Domestic cold water	Interior concealed	P-1	1-1/2” and smaller	1/2"	-
			2” and larger	3/4"	-
	Interior exposed	P-1A	1-1/2” and smaller	1/2"	-
			2” and larger	3/4"	-
	Exterior exposed	P-1B	All Sizes	3/4"	Yes
Domestic hot water (includes recirculation piping)	Interior concealed	P-1	1-1/2” and smaller	3/4"	-
			2” and larger	1"	-
	Interior exposed	P-1A	1-1/2” and smaller	3/4"	-
			2” and larger	1"	-
	Exterior exposed	P-1B	All Sizes	1”	Yes
Roof drains (horizontal and vertical piping)	All	P-1	All Sizes	3/4"	-
		P-2	All Sizes	1”	-
Roof drains (underside of roof drain bodies/bowl)	All	E-1	All Sizes	3/4"	-
Chilled Water	Interior concealed	P-3	4" and Smaller	1-1/2”	-
			6" and Larger	2"	-
	Interior exposed	P-3A	4” and Smaller	1-1/2”	-
			6” and Larger	2"	-
	Exterior	P-3B	4” and Smaller	2”	Yes
			6” and Larger	2”	Yes
Chilled water pumps	All	E-1	-	1-1/2”	-

Piping Systems	Location	Type	Pipe Size	Insulation Thickness	Freeze Protection
Chilled water air separators, expansion tanks, and storage tanks, equipment supports as required	All	E-1	-	1-1/2”	-
Chillers (evaporators, evaporator heads, all cold services)	All	E-1	-	1-1/2”	-
Heating Water (Max 180 ˚F)	Interior concealed	P-1	2-1/2” and Smaller	1-1/2”	-
			3" and Larger	2-1/2”	-
	Interior exposed	P-1A	2-1/2” and Smaller	1-1/2”	-
			3" and Larger	2-1/2”	-
	Exterior	P-1B	2-1/2” and Smaller	2”	Yes
			3" and Larger	3-1/2”	Yes
Hot water pumps	All	E-1	-	1-1/2”	-
Hot water air separators and storage tanks	All	E-1	-	1-1/2”	-
Hot water coil frame and tube bends	All	E-1 or DW-V	-	1-1/2”	-

L. Non-insulated piping and equipment.

1. Pneumatic tubing.
2. Condenser water piping and condenser water pumps (indoors).
3. Hot water expansion tanks and piping to them other than the first 3 feet from the point of connection at piping mains.
4. Pot feeders and piping to them other than the first 3 feet from the point of connection at piping mains.
5. Vent, overflow, drain and relief, except as noted otherwise.
6. Hot water control valves. (Note: this exclusion applies only to the valves themselves; all other hot water piping and accessories, including that between isolation valves and coils, shall be insulated.)

3.2 INSTALLATION

A. Install materials in accordance with manufacturer’s instructions.

B. Coordinate with work of other trades.

C. Deliver material to job site in original non-broken factory packaging, labeled with manufacturer's density and thickness.

D. Install insulation where it cannot become wet. If insulation becomes wet, remove, and dispose of properly and replace with new, dry insulation. Wetted insulation is not acceptable. Ensure insulation is dry before and during installation.

E. Insulate all piping, valves, fittings, flanges, and accessories.

F. On piping exposed to public view, locate insulation and cover seams in least visible locations.

G. Insulate fittings, joints, and valves with insulation of same material and thickness as adjoining pipe. Use pre-molded fiberglass fittings. For strainers, expansion joints, fittings and accessories requiring servicing or inspection insulation shall be removable and replaceable without damage. Enclose within two-piece no. 15 gauge aluminum covers fastened with cadmium-plated bolts and nuts.

H. Insulate flanges with insulation sleeve of same material as pipe insulation to cover flange and overlap insulation on adjacent piping.

I. Continue insulation through walls, sleeves, pipe hangers and other pipe penetrations.

J. Finish insulation at supports, protrusions, and interruptions. No hangers or supports shall be embedded in insulation. Do not insulate expansion bellows.

K. Fiberglass insulation.

1. Provide insulation with factory applied vapor barrier jackets.
2. Butt edges neatly. ASJ with 3 inch minimum butt strips.
3. Longitudinal overlaps: Minimum 2 inch self-sealing, double adhesive.
4. Apply additional jacket as specified.
5. For insulation with factory-applied jackets, secure laps with aluminum or stainless steel, bands at 18 inches o.c.
6. For piping conveying fluids below, ambient temperature finish with vapor barrier adhesive.

L. Cellular glass insulation.

1. Provide insulation with factory applied vapor barrier jackets.
2. Butt edges neatly. Seal longitudinal and transverse joints with adhesive to maintain minimum vapor permeance. Adhesive shall be selected and applied in accordance with insulation manufacturer's recommendations.

3. Secure insulation sections with bands without deforming insulation materials.
4. Build up coating of insulating and finishing cement.
5. For insulation with factory-applied jackets, secure laps with aluminum or stainless steel, bands at 18 inches o.c.
6. For piping conveying fluids below, ambient temperature finish with vapor barrier adhesive.
7. Apply additional jacket as specified. If no additional jacket specified apply skim coat of finishing cement to smooth out surface of fitting insulation.

M. Elastomeric Tubing.

1. Butt edges neatly. Seal longitudinal and transverse joints with adhesive to maintain minimum vapor permeance. Adhesive shall be selected and applied in accordance with insulation manufacturer's recommendations.
2. Apply additional jacket as specified.

N. For all pipe systems exposed in the mechanical equipment rooms, finish with an all service PVC jacket.

O. For exterior applications, provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

P. For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

Q. Perform work at ambient and equipment temperatures as recommended by adhesive manufacturer.

R. Protection: Protect against dirt, water, chemical, or mechanical damage before, during, and after installation. Repair or replace damaged insulation at no additional cost.

S. Paint all insulation exposed to ultraviolet light (sunlight).

T. All vapor barriers shall be continuous. Tears, holes, staples, etc. shall be coated with vapor barrier mastic and patch with facing or tape.

U. Joints between insulation and access shall be sealed with vapor barrier mastic.

3.3 PIPE INSULATION APPLICATION

A. General.

1. Before applying insulation.

    a. Test piping for tightness and obtain approval.
    b. Dry pipe thoroughly.
    c. Clean surfaces to be insulated of dust, grease, and foreign matter.

2. Butt edges neatly.
3. Fill voids with insulating cement.
4. Longitudinal overlaps.

    a. 2 inches minimum.
    b. For exposed work: toward ceiling or wall.
    c. For weatherproof aluminum jackets: on side to shed water.

5. Circumferential overlaps on weatherproof aluminum jackets: 2 inches minimum.
6. Continuous insulation passing through sleeves or other openings.
7. Oversize insulation to accommodate heat tracing on piping.

B. Valves, fittings, flanges, and accessory insulation.

1. Unless otherwise noted, insulate:

    a. Valves including bonnets.
    b. Flanges.
    c. Fittings.
    d. Strainers.
    e. Expansion joints.
    f. Specialties.

2. Insulation for strainers, expansion joints, fittings and accessories requiring servicing or inspection.

    a. Insulation removable and replaceable without damage.
    b. Enclosed within two-piece, No. 18 gauge aluminum covers fastened with cadmium plated bolts and nuts.

3. Insulation of same thickness as adjacent piping insulation.
4. For piping systems insulated with fiberglass.

    a. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
    b. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

5. For piping systems insulated with cellular glass.

    a. Apply pre-molded insulation sections of the same material as straight segments of pipe when available. Secure according to manufacturer's written instructions.
    b. When pre-molded insulation elbows and fittings are not available, apply mitered sections of pipe insulation (blanket insulation is not acceptable) to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
    c. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

6. For piping systems insulated with elastomeric thermal insulation.

    a. Apply mitered sections of pipe insulation.
    b. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
    c. Prime and paint exterior installations for UV protection.

7. Flanges.

    a. Apply preformed pipe insulation to outer diameter of pipe flange.
    b. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
    c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with the same insulation material as adjacent piping insulation.
    d. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.

8. Finish for outdoor locations only: weatherproof aluminum jacket compatible with weatherproof jacket on adjoining pipe insulation.

C. At pipe hangers.

1. Insulation protection shields specified in Section – Hangers and Supports.
2. Butt insulation to shields.
3. Cold piping: Wet coat of vapor barrier lap cement on all butt joints.

D. Jackets and facings.

1. Vapor-sealed types: continuous; staples not permitted.
2. Adhere longitudinal laps: Adhere 3 inches wide joint strip, of same material as facing, at center of each butt joint.

3. Adhesives.

    a. Vapor-sealed insulation: vapor-seal adhesive.
    b. Heating service insulation: vapor-seal adhesive.
    c. Weatherproof aluminum jacket: sealing compound.
    d. PVC jacket: welding compound.
    e. Underground asphalt felt jacket: asphalt mastic

E. Wiring, banding, and fastening devices: Secure insulation to piping and equipment in accordance with following minimum requirements.

1. Piping insulation section 3 foot long.

    a. Concealed vapor-sealed insulation banded at ends and center.
    b. Other concealed insulation banded at ends and center.

2. Pipe fitting insulation.

    a. Loops of wire to secure mitered segments of insulation.
    b. Wire spiraled on from end to end on blanket insulation

3. Outdoor piping weatherproof aluminum jackets banded at circumferential joints and center of each section: Lap joint at bottom.

4. Provide aluminum banding near ends of unicellular piping valve and accessory insulation where unicellular is allowed by Professional.

3.4 EQUIPMENT INSULATION

A. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Secure insulation to equipment with bands, welded-on anchors, ties or adhesive. Where access to equipment is required for testing or maintenance the insulation shall be installed so that it is removable and so that the vapor barrier can be remade after access.

B. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

C. For cold equipment or equipment containing fluids below ambient temperature.

1. Insulate entire system.
2. Provide vapor barrier jackets, factory applied, or field applied.
3. Finish with glass cloth and vapor barrier adhesive.
4. Cover with aluminum jacket where specified.

D. For equipment containing fluids above ambient temperature.

1. Insulate entire system.

2. Provide standard jackets, with or without vapor barrier, factory applied, or field applied.
3. Finish with glass cloth and adhesive.
4. Cover with aluminum jacket where specified.
5. For hot equipment containing fluids 140 degrees Fahrenheit or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
6. For hot equipment containing fluids over 140 degrees Fahrenheit, insulate flanges and unions with removable sections and jackets.

E. Finish insulation at supports, protrusions, and interruptions.

F. For equipment in mechanical equipment rooms or in finished spaces, finish with aluminum jacket.

G. Do not insulate over nameplate or ASME stamps; bevel and seal insulation around such.

H. General.
1. Apply insulation with edges tightly butted. Seal with 520, adhesive.

a. Joints staggered and secured in place by steel bands.
b. Where necessary weld on suitable anchors.

I. Special considerations.

1. Chiller heads: removable and replaceable covers to allow tube removal.
2. Strainers and suction diffusers: removable and replaceable covers to allow strainer removal.
3. Pumps: removable and replaceable covers to allow impeller replacement.
4. Provide sufficient clearance around openings for normal operation of equipment.

3.5 PENETRATION THROUGH RATED WALLS

A. Refer to drawings for penetrations of rated assemblies. Install per manufacturer’s installation and listing requirements.

3.6 FIELD QUALITY CONTROL

A. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

B. All vapor barriers shall be continuous; tears, holes, staples, etc. shall be coated with vapor barrier mastic and patch with facing or tape.

END OF SECTION

SECTION 15.110 VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work Included in This Section: Materials, equipment, fabrication, installation, and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Service valves in hydronic and plumbing systems (other than gas and fire sprinkler).
2. Balancing valves.
3. Check valves.
4. Pressure reducing valves.
5. Safety and relief valves.
6. Vent and gas cocks.
7. Manual and automatic air vents.
8. Miscellaneous valves.

1.3 QUALITY ASSURANCE

A. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

1.4 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop and coordination drawings according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Valves, all types	R	R		R

Valve accessories (handle extensions, operators, etc.)	R			
Manual and automatic air vents	R	R		
Pressure/temperature test plug	R	R		

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Ball, gate, and check valves.

1. Nibco Inc.
2. Crane Company.
3. De Zurik Corporation.
4. Or equal.

C. Gate valves – buried.

1. Mueller Company.
2. Kennedy Valve Mfg. Company.
3. Clow Corporation.
4. Or equal.

D. Butterfly valves.

1. Nibco Inc.
2. Crane Company.
3. De Zurik Corporation.
4. Or equal.

E. Balancing valves.

1. ITT Bell and Gossett.
2. Taco Inc.
3. Watts.
4. Or equal.

F. Silent check valves.

1. Nibco Inc.
2. Grinnell.
3. Mueller Steam Specialty.

4. Or equal.

G. Combination check and shut-off valves and Triple duty valves: Not allowed.

H. Pressure reducing valves-air and water. Safety and relief valves.

1. Watts.
2. Consolidated.
3. ITT Bell and Gossett.
4. Or equal.

I. Vent cocks.

1. Weiss.
2. Weksler.
3. Crane Company.
4. Or equal.

J. Automatic air vents.

1. Amtrol.
2. ITT Bell and Gossett.
3. Dole Valve Company.
4. Or equal.

2.2 GENERAL

A. Where possible, provide valves of same manufacturer for all Mechanical Sections per products in this Section.

B. For copper tubing provide solder-joint valves, flare fittings, or IPS-to-copper adaptor, sized for use with tubing and respective valve.

C. For flanged valves, provide streamline companion flanges, ANSI B16.5, 1988 150 class pounds per square inch.

1. 255 pounds per square inch water on gage (WOG) at 150-degree Fahrenheit.
2. 225 pounds per square inch water on gage (WOG) at 250-degree Fahrenheit unless indicated otherwise.

D. Provide valves rated not less than 125 pounds per square inch steam working pressure, unless indicated otherwise.

E. Provide valve materials suitable for service and temperature of respective systems, especially with respect to discs, plugs, balls, linings, gaskets, and lubricants of globe valves, plug cocks, ball valves, etc.

F. Provide chain-operated hand wheels, rustproof chain, and chain guide for following valves.

1. Provide chain-operated hand wheels, rustproof chain, and chain guide for following valves.
2. As noted.

G. Valves in Insulated Piping: With 2-inch (minimum, greater if insulation thickness is greater than 1 inches) stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied. Nibco Nib-seal handle extension or equal.
2. Butterfly Valves: With extended neck.

2.3 BALL VALVES

A. 2-1/2 inches and smaller.

1. Two-piece body, bronze ASTM B584 C84400.
2. 316 stainless steel stem and ball.
3. PTFE Seat.
4. Full Port 1/2 to 1 inch; Standard Port 1-1/4 and larger.
5. 600 pounds per square inch at 100-degree F, 125 pounds per square inch saturated steam.
6. Infinite throttling handle with memory stop.
7. Nibco 585-70-66 or equal. Nibco 580-70-66 or equal may be used for 1-1/4 inch and larger.

2.4 GATE VALVES

A. General.

1. 2 inches and smaller, Bronze.

a. Class 125 (125 psi steam, 200 psi water).
b. Solid wedge.
c. Union bonnet.
d. Inside screw.
e. Rising screw.
f. Rising stem.
g. Equal to Nibco.

1) Threaded: T-124.

2) Soldered: S-134.

2. 2-1/2 inches and larger.

a. Iron body.
b. Bronze trim.
c. Class 125 (125 psi steam, 200 psi water).
d. Solid wedge.
e. Outside screw and yoke (OS&Y).
f. Flanged.
g. Equal to Nibco

1) 125 pounds per square inch: F-617-O.
2) 250 pounds per square inch: F-667-O.

B. Gate Valves – Hose.

1. Cast Bronze.
2. 200 pounds per square inch water working pressure.
3. Rising stem.
4. Polished chrome plated.
5. Satin chrome.
6. Rough bronze.
7. Polished bronze.
8. NFPA approved.
9. Cap chained to valve body.
10. With escutcheon.
11. Hose threads per requirements of Fire Authority having jurisdiction.
12. Equal to Potter-Roemer.

a. 2-1/2 x 2-1/2 = 4315.
b. 2-1/2 x 3 = 4335.

C. Gate Valves – Direct Buried.

1. AWWA C500.
2. Federal Specification WW-V-586, Type II, Class1.
3. Cast iron.
4. Pressure ratings: 2-12 inches - 200 pounds per square inch working, 400 pounds per square inch test; 14 inch and larger - 150 pounds per square inch working, 300 pounds per square inch test.
5. Double disc, parallel seat.
6. Non-rising stem.
7. Joint ends to match piping.
8. Equal to Clow Series F-5062 through F-5085.

D. Valve Indicator Posts.

1. U.L. listed.
2. Two-piece.
3. Non-rising stem.
4. Equal to Nibco NIP-1AJ.

E. Lockshield Gate Valves: Same as gate valves, except key operated.

2.5 BUTTERFLY VALVES

A. Flange Type:

1. Iron body.
2. 316 or 416 stainless steel stem, continuous with pinned disc.
3. Disk shall be either:

    a. 316 stainless-steel.
    b. Aluminum bronze.
    c. Nickel encapsulated ductile iron.
    d. EPDM encapsulated ductile iron.
    e. Nylon encapsulated ductile iron.

4. Steel seat or cast-iron support ring.
5. EPDM body and stem seal.
6. Bronze or copper bushings.
7. Factory tested bubble-tight at 150 pounds per square inch.

B. Type:

1. Lug Type:

    a. Equal to Nibco Series LD-2000.
    b. Lugs drilled and tapped to match ANSI 150 flanges.
    c. Recommended by manufacturer or dead-end service at full pressure without the need for downstream flanges.
    d. Use cap screws both sides.

C. Operator:

1. Infinite throttling handle with memory stop: smaller than 8 inches.
2. Gear operators: 8 inches and larger.

2.6 BALANCING VALVES

A. Calibrated Balancing Valves.

1. Combination balancing and shut-off valves.
2. Calibrated name plate and adjustable memory stop.

3. Capped read-out valves.
4. Pre-formed insulation for chilled water valves.
5. Provide one differential pressure read-out meter for all valves in system.
6. 2-1/2 inches and smaller:

    a. Brass body.
    b. 304 stainless steel ball.
    c. Soldered or threaded ends.
    a. Teflon or TFE seats.
    b. 250 pounds per square inch at 250 degrees Fahrenheit.

7. 3 inches and larger.

    a. Ductile or cast-iron body.
    b. Flanged.
    c. 175 pounds per square inch at 250 degrees Fahrenheit.

8. Devices using venture type flow meter not acceptable (due to propensity for clogging and ease of putting valve with limited flow range in wrong direction).
9. Devices using Pitot tube or Annubar type flow meter not acceptable (due to propensity for clogging).
10. Devices using other than ball or butterfly valves shall not be used for coil isolation – a separate ball valve or butterfly valve shall be added for isolation (to ensure positive shut-off and to allow 90˚ open-close with memory stop) whether shown on schematics or not.
11. Bell & Gossett Circuit-Setter Plus, or equal.

B. Combination shut-off, balancing, and check valve: Not allowed.

2.7 CHECK VALVES

A. Check Valves, General Service.

1. 2 inches and smaller.

    a. Brass body.
    b. Swing check.
    c. Class 125 (125 psi steam, 200 psi water).
    d. Bronze disc.
    e. Screw-in cap.
    f. Soldered ends.
    g. Equal to Nibco S-413-W.

2. 2-1/2 inches and larger.
    a. Ductile or cast-iron body.
    b. Swing Check.

c. Class 125 (125 psi steam, 200 psi water).
d. Bronze disc and seat ring.
e. Bolted cap.
f. Flanged body.
g. Equal to Nibco F-918-8.

B. Silent Check Valves.

1. For pump discharges:

a. Except sump pumps and sewage ejectors.
b. Variable speed pumps. Check valve pressure drop shall vary roughly as the square of flow rate to near zero flow. Valves that use hydrodynamic profiles (e.g. Victaulic 716 check valve) resulting in high or erratic pressure drop at low flow rates are not acceptable.

2. 2 inches or smaller.

a. Brass body.
b. Center-guided, silent check.
c. Class 125 (125 psi steam, 200 psi water).
d. Bronze trim.
e. Equal to Nibco 480.

3. 2-1/2 inches or larger.

a. Ductile or cast-iron body.
b. Globe body silent check.
c. Class 125 (125 psi steam, 200 psi water).
d. Bronze trim.
e. Center-guided.
f. Flanged body.
g. Equal to Nibco F-910.

2.8 PRESSURE REDUCING VALVES

A. 2 inches and Smaller.

1. Bronze body, solder or threaded.
2. Equal to Watts Series 223.

B. 2-1/2 inches and Larger.

1. Iron body, flanged.
2. Equal to Watts No. 2300.

2.9 SAFETY AND RELIEF VALVES

A. General.

1. Constructed, rated, and stamped in accordance with Section IV of the ASME Boiler and Pressure Vessel Code.
2. Direct spring-loaded type.
3. Adjustable discharge pressure setting.
4. Bronze body and all wetted parts shall be non-ferrous.
5. Suitable and rated for system pressure and temperature.

B. Set pressures.

1. Set pressure as indicated on Drawings: Not to exceed pressure rating of protected equipment.
2. Valves to open, under test, at set pressure with following tolerance:

    a. Set pressure up to 70 pounds per square inch gage: plus, or minus 2 pounds per square inch.
    b. Set pressure, above 70 pounds per square inch gage: plus, or minus 3 percent.

C. Capacities.

1. Valves shall have capacity to relieve maximum possible generated energy while maintaining pressure in protected equipment at no more than 10 percent above vessel working pressure.
2. Greater than make-up pressure reducing valve capacity.
3. Equipment relief valve capacity to exceed rating of connected equipment.
4. For boiler relief valves, the valve shall have a BTU/h rating in excess of the BTU/h rating of the boiler’s heating output.
5. Provide multiple valves if required for capacity even though only one valve may be shown on Drawings.

D. Maintain pressure in protected equipment at not more than the following:

1. Low pressure Boilers: 5 pounds per square inch above boiler working pressure.
2. High pressure Boilers: 6 percent above boiler working pressure.
3. Unfired Pressure Vessels: 10 percent above vessel working pressure.

E. Safety and Relief Valves: Equal to Consolidated.

F. Relief Valves, Water: Equal to Watts.

2.10 VENT AND GAUGE COCKS

A. Bronze body, 1/4-inch size.

B. Lever handle.

C. 125 pounds per square inch steam working pressure.

D. Equal to Weiss LC-14.

2.11 MANUAL AIR VENTS

A. Construction.

1. Vertical.
2. Provide 1/4-inch brass needle valve at top of chamber.
3. To 3-inch pipe: Line size air chamber, 12 inch long.
4. 4 inch to 8 inch: Line size air chamber, 6 inch long.
5. 10 inch and larger: Line size pipe cap.

2.12 AUTOMATIC AIR VENTS

A. Float type.

1. With isolating valve.
2. Brass or semi-steel body.
3. Float copper or stainless steel.
4. Stainless steel valve and valve seat.
5. Suitable for system operating temperature and pressure.
6. Non-opening on negative pressure.
7. Equal to Thrush/Amtrol No. 720.

B. Disc type.

1. All brass with hydroscopic fiber discs.
2. Vent ports.
3. Adjustable cap for manual shut-off.
4. Integral spring-loaded ball check valve.
5. Equal to Dole.

C. Threaded vent connection for piping vent to drain.

D. Upstream ball valve for isolation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with work of other trades.

B. Install valves in accordance with manufacturer's written installation instructions.

C. Provide valves as shown on drawings and provide shutoff valves around all equipment whether shown with valves on drawings or not.

D. Provide all valves (except control valves), strainers, and check valves of same size as the pipes in which they are installed unless otherwise indicated.

E. Pressure rating of valves same as piping in which installed.

F. Install valves with stems upright or horizontal, not inverted.

G. Install valves with cast directional arrows in direction of flow.

H. Support line valves at the valve in addition to regularly spaced pipe supports shown and specified.

I. Check valves:

1. Provide silent check valves at discharge of pumps. Triple duty valves shall not be used as a substitution for check and shut-off valve.
2. Install swing checks and gravity closing lift checks in horizontal position.

J. Butterfly valves:

1. Piping adjacent to lug type shall be flange removable while valve is in use.

K. Control valves:

1. See Section– EMCS Basic Materials and Devices for valve specifications.
2. Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where the actuator top and position indicator are below 5 feet above the floor, install with valve stem axis vertical with actuator side up. Otherwise, valves shall be installed with stem horizontal so that the position indicator is visible from the floor. Do not install valves with stem below horizontal or down.

L. Provide blow-down ball valves and hose adaptors with caps at strainers, air separators, tanks, pipe traps, equipment drains, etc. of same size as strainer blow-off connection.

M. Provide drain valves at main shut-off valves, low points of piping and apparatus.

N. Provide extended valve stems to clear insulation on insulated valves.

O. Locate wheel handles to clear obstructions with hand.

P. Install valves only in accessible locations.

Q. Wherever possible, install valves accessible from floor level. Provide guided chain operators on valves over 7 feet above floor in equipment areas. Extend chains to within 6 feet 6 inches of floor.

R. Locate equipment shut-off valves to be accessible without climbing over equipment.

S. Provide operating handles for all valves and cocks without integral operators, unless otherwise noted. Provide adequate clearance for easy operation.

T. Provide discharge pipe to atmosphere from all relief and safety valves, sized with area equal to sum of outlet areas of all valves connected thereto, unless indicated larger. Extend to over code compliant drain receptacle with airgap.

U. Provide ball valves to isolate shock absorbers/water hammer arrestors.

V. Provide open-ended line valves with plugs or blind flanges.

3.2 VALVE APPLICATIONS

A. Valves shall be limited to the applications listed below. Where this section disagrees with drawings, obtain clarification from Architect, and provide as directed by the Architect at no additional cost to the Owner.

B. Ball valves:

1. Throttling and shut-off: water.
2. Use in HVAC, domestic water, and general fire protection piping 2-1/2 inches and smaller.

C. Butterfly valves:

1. Throttling and shut-off: water.
2. Use in HVAC, domestic water, and general fire protection piping 3 inches and larger.

D. Gate Valves:

1. Hose drains.
2. Direct buried.
3. Not used for general shut-off (ball or butterfly only for general shut-off).

3.3 AIR VENTS

A. Manual air vents.

1. Locate:

   a. As shown on drawings.
   b. At all high points in closed piping systems.
   c. At equipment with vents, such as coils.

2. 1/4-inch copper tube discharged into nearest drain or with 180-degree bend to discharge into portable container.
3. Extend tubing or piping as required to make valve accessible.

B. Automatic air vents.

1. Locate: As shown on drawings.

2. Provide manual cock at automatic air vents. Shut after system is free of air.
3. 1/4-inch copper tube discharged into nearest drain.

3.4 FIELD QUALITY CONTROL

A. Test operate valves from closed-to-open-to-closed position while valve is under test pressure.

B. Test automatic valves including solenoid valves, expansion valves, water regulating valves, pressure reducing valves, pressure relief valves, safety valves and temperature and pressure relief valves for proper operation at settings indicated.

C. Ensure that valves are field checked for packing and lubricant and that disc is for service intended. Replace leaking packing at no additional cost to the Owner. Service valves which do not operate smoothly and properly with suitable lubricant before placing in operation at no additional cost to the Owner.

3.5 INSPECTION & COMPLETION

A. Verify that adequate clearance between valves and adjacent walls or equipment is available to permit maintenance and repairs.

B. Verify valve set for normal operation.

END OF SECTION

SECTION 15.120 METERS AND GAUGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Duct-thermometer mounting brackets.
3. Thermowells.
4. Dial-type pressure gauges.
5. Gauge attachments.
6. Test plugs.

1.3 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Thermometers	R	R		
Thermowells	R			
Pressure gauges	R	R		
Gauge attachments	R			
Test plugs	R			

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models are acceptable.

B. Thermometers:

1. Weksler.
2. Weiss.
3. Trerice.
4. Or equal.

C. Pressure gauges:

1. Weksler.
2. Weiss.
3. Trerice.
4. Or equal.

D. Pressure-temperature test plugs:

1. Peterson Engineering Company.
2. Taco.
3. Watts.
4. Or equal.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
6. Window: Glass.
7. Stem: Aluminum and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.

9. Accuracy: Plus, or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
10. Weiss 9VU or equal.

2.3 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.4 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.5 PRESSURE GAUGES

A. Pipe or equipment mounted type.

1. Standard: ASME B40.100.
2. Diameter: 4 1/2 inch, except as noted.
3. Case: black finished cast aluminum with flangeless back.
4. Threaded black cast aluminum ring with gasketed glass face.
5. Type 316 stainless steel spring tube.
6. Stainless steel precision movement: Micrometer adjustment on needle.
7. Accuracy: 0.5 of 1 percent full scale range.
8. With calibration adjustment.
9. Quarter turn stop cock: Materials compatible with service.
10. Pressure snubbers.

a. Filter type.
b. For liquid, air, and gas.

11. Weksler Type AA44 or equal.

2.6 GAUGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, 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 stainless-steel pipe with NPS 1/4 or NPS 1/2 pipe threads.

C. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.7 TEST PLUGS

A. Description: Test-station fitting made for insertion in piping tee fitting.

B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

C. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

D. Minimum Pressure and Temperature Rating: 500 psig at 275 deg F.

E. Core Inserts: Nordel self-sealing rubber.

F. Pete’s Plug: No. 110 with yellow cap or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions at the most readable position.

F. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

H. Install valve and syphon fitting in piping for each pressure gauge for steam.

I. Install test plugs in piping tees.

J. Install test plugs at all temperature, pressure, and flow sensors for calibration. See Section Energy Management and Control Systems.

3.2 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

Installation Location	Thermometer Type	
	Industrial (Metal) Liquid-in-Glass	Test Plug w/Nordel Core
Hydronic Zone	X	X
Boiler Inlet and Outlet	X	X
Chiller Inlet and Outlet (Evapora-tor and Condenser)	X	X
AHU Coil Inlet and Outlet	X	X
Hydronic Heat Exchager Inlet and Outlet	X	X

Heat Recovery Unit Inlet and Outlet	X	X
Thermal Storage Tank Inlet and Outlet	X	X
Where indicated on Drawings	X	X

A. Thermometer stems shall be of length to match thermowell insertion length.

B. Test plug with Nordel core self-sealing rubber inserts, where shown on Construction Drawings. Also locate adjacent to all EMCS temperature/pressure wells for calibration.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

Application	Scale Range
Chilled Water	0 – 100 deg F
Condenser Water	0 – 150 deg F
Heating Water	0 – 250 deg F
Steam and Steam Condensate	0 – 250 deg F
Domestic Hot Water	0 – 240 deg F
Domestic Cold Water	0 – 110 deg F

3.6 PRESSURE-GAUGE SCHEDULE

Installation Location	Pressure Gauge Type	
	Liquid-filled (Metal) Direct-Mounted	Test Plug w/Nordel Core
Pressure-Reducing Valve	X	X
Boiler Inlet and Outlet	X	X
Chiller (Evaporator & Condenser) Inlet and Outlet	X	X
AHU Coil Inlet and Outlet	X	X
Pump Suction and Discharge	X	X
Domestic Cold Water Building Entrance	X	X

Installation Location	Pressure Gauge Type	
	Liquid-filled (Metal) Direct-Mounted	Test Plug w/Nordel Core
Gas Regulator Inlet and Outlet	X	

3.7 PRESSURE-GAUGE SCALE-RANGE SCHEDULE

Application	Scale Range
Chilled Water	0 – 200 psig
Condenser Water	0 – 100 psig
Heating Water	0 – 160 psig
AHU Coil	0 – 100 psig
Condensate pump set	0 – 60 psig
Diesel oil pump	0 – 160 psig
Emergency generator jacket water pump	0 – 50 psig
Domestic cold water building entrance	0 – 100 psig
Pressure gauges indicated on drawings or specifications, not indicated herein	Submit with appropriate range for review
BAS regulator	0-20 psig

END OF SECTION

SECTION 15.140 DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
2. Encasement for piping.

1.3 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Piping and fitting materials	R			R
Solder	R			
Couplings	R			
System purging and disinfecting activities report.		R		

1.4 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

G. Other fitting types not allowed.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.4 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105/A21.5.

B. Form: tube.

C. Color: Blue (domestic cold water), Red (domestic hot water).

2.5 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cascade Waterworks Mfg. Co.
b. Dresser, Inc.
c. Jay R. Smith Mfg. Co.
d. Viking Johnson.
e. Or equal.

D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Charlotte Pipe and Foundry Company.
b. Spears Manufacturing Company.
c. Uponor.
d. Or equal.

2. Description:

a. PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
b. One end with threaded brass insert and one solvent-cement-socket end.

E. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Colonial Engineering, Inc.
b. NIBCO INC.
c. Spears Manufacturing Company.
d. Or equal.

2. Description:

a. PVC four-part union.
b. Brass or stainless-steel threaded end.
c. Solvent-cement-joint plastic end.
d. Rubber O-ring.
e. Union nut.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105/A21.5.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gauge, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gauges in Section 230519 – Meters and Gauges and with requirements for drain valves and strainers in Section – Domestic Water Piping Specialties.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section – Valves.

G. Install domestic water piping level and plumb.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

J. 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.

K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections. Other piping connection types not allowed.

P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Section – Vibration and Seismic Controls for Piping and Equipment.

B. Comply with requirements for pipe hanger, support products, and installation in Section 230529 – Hangers and Supports.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.7 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 – Mechanical Identification.

B. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections, and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials (minimum of 150 psig). Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.

b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application, where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

Service	Type of Pipe	Fittings	Joints
Under-building slab Domestic water	Soft copper, Type K	None	None
Above slab	Hard copper, Type L	Cast or wrought copper	Soldered

3.12 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping 2-1/2 inch and smaller. Use gate valves with flanged ends for piping 3 inch and larger.
2. Throttling Duty: Use ball valves for piping 2 inch and smaller. Use butterfly or ball valves with flanged ends for piping 2-1/2 inch and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

Domestic Water Piping Test Log						
Date	System	Description of Piping Section Tested	Test Press. (psig)	Test Duration (hours)	Results Pass/ Fail	Witness (Contractor) Initials
This form stall be completed and submitted with the project closeout documents. Contractor shall copy this form if more sheets are required. Piping pressure test log shall be kept at project site and shall be made available to the Architect upon request.						

END OF SECTION

SECTION 15.141 DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Check Valves.
6. Mixing valves.
7. Strainers.
8. Drain valves.
9. Water-hammer arresters.
10. Air vents.
11. Specialty valves.
12. Flexible connectors.

1.3 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Domestic water piping specialties (for each item)	R	R		R

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models are acceptable.

1. Vacuum Breakers.

    a. Ames Co.
    b. Conbraco Industries, Inc.
    c. Watts; a Watts Water Technologies company.
    d. Zurn Industries, LLC.
    e. Or equal.

2. Backflow Preventers.

    a. Ames Co.
    b. Conbraco Industries, Inc.
    c. Watts; a Watts Water Technologies company.
    d. Zurn Industries, LLC.
    e. Or equal.

3. Balancing Valves.

    a. Armstrong International, Inc.
    b. ITT Corporation.
    c. NIBCO INC.
    d. Watts; a Watts Water Technologies company.
    e. Or equal.

4. Check Valves

    a. Watts
    b. Nibco
    c. Armstrong International, Inc.
    d. or equal

5. Water Hammer Arrestors.

    a. Precision Plumbing Products.
    b. Watts; a Watts Water Technologies company.
    c. Zurn Industries, LLC.
    d. Or equal.

6. Flexible Connectors.

a. Flex Pression Ltd.
b. Mercer Gasket & Shim, Inc.
c. Metraflex Company (The).
d. Or equal.

2.2 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping, and components shall comply with NSF 61 Annex G.

2.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.4 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Rough bronze.

2.5 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Standard: ASSE 1012.
2. Operation: Continuous-pressure applications.
3. Size: [NPS 1/2] [NPS 3/4].
4. Body: Bronze.
5. End Connections: Union, solder joint.
6. Finish: Chrome plated.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: ASSE 1013.

2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig maximum, through middle third of flow range.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Configuration: Designed for horizontal, straight-through flow.
7. Accessories:

    a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.6 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
2. Body: Brass or bronze.
3. Size: Same as connected piping, but not larger than NPS 2.

B. Cast-Iron Calibrated Balancing Valves:

1. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
2. Size: Same as connected piping, but not smaller than NPS 2-1/2.

C. Memory-Stop Balancing Valves:

1. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 2 or smaller.
4. Body: Copper alloy.
5. Port: Standard or full port.
6. Ball: Chrome-plated brass.
7. Seats and Seals: Replaceable.
8. End Connections: Solder joint or threaded.
9. Handle: Vinyl-covered steel with memory-setting device.

2.7 CHECK VALVES

A. Lead-Free Silent Check Valves:

1. Type: Spring.
2. Body: Lead-Free cast copper silicon alloy.
3. Size: Same as connected piping, 1/4" to 2”

B. Valve shall have a conical Lead-Free check, PTFE seat and silent operation. Pressure rating no less than 400psi WOG non-shock and 15psi WSP.

C. Check valves shall comply with state codes and standards, where applicable, requiring reduced lead content.

D. Valve shall be a Watts Series LF600.

2.8 STRAINERS

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 and Smaller: 0.033 inch.
    b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
    c. Strainers NPS 5 and Larger: 0.125 inch.

6. Drain: Factory-installed, hose-end drain valve.

2.9 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.

8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.10 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Metal bellows or copper tube with piston.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.11 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.

2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.12 FLEXIBLE CONNECTORS

A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Install balancing valves in locations where they can easily be adjusted.

C. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.

D. Install water-hammer arresters in water piping according to PDI-WH 201.

E. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.
2. Intermediate atmospheric-vent backflow preventers.
3. Reduced-pressure-principle backflow preventers.
4. Double-check, backflow-prevention assemblies.
5. Dual-check-valve backflow preventers.
6. Double-check, detector-assembly backflow preventers.
7. Water pressure-reducing valves.
8. Calibrated balancing valves.
9. Primary, thermostatic, water mixing valves.
10. Supply-type, trap-seal primer valves.
11. Trap-seal primer systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section Mechanical Identification.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer double-check, backflow-prevention assembly and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION

SECTION 15.150 SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.3 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Piping and fitting materials	R			R
Couplings	R			

1.4 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Architect's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

1. Soil, Waste, and Vent Piping: 10-foot head of water.

2.2 PIPING MATERIALS

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

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

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Heavy-Duty, Hub-less-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ANACO-Husky.
   b. Charlotte Pipe and Foundry Company.
   c. Or equal.

2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe, stop.

2.5 COPPER TUBE AND FITTINGS

A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.

D. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

E. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

F. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.6 PVC PIPE AND FITTINGS

A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

E. Solvent Cement: ASTM D 2564.

2.7 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
2. Unshielded, Non-pressure Transition Couplings:

    a. Manufacturers: Subject to compliance with requirements, provide products by the following:

        1) Fernco Inc.
        2) Or equal.

    b. Standard: ASTM C 1173.
    c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    d. End Connections: Same size as and compatible with pipes to be joined.
    e. Sleeve Materials:

        1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
        2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
        3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

3. Pressure Transition Couplings:

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Cascade Waterworks Mfg. Co.
        2) Dresser, Inc.
        3) Jay R. Smith Mfg. Co.
        4) Or equal.

    b. Standard: AWWA C219.
    c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
    d. Center-Sleeve Material: Manufacturer's standard.
    e. Gasket Material: Natural or synthetic rubber.
    f. Metal Component Finish: Corrosion-resistant coating or material.

2.8 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105/A 21.5.

B. Material: Linear low-density polyethylene film of 0.008-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

    a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

    a. Reducing size of waste piping in direction of flow is prohibited.

K. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

P. Install aboveground PVC piping according to ASTM D 2665.

Q. Install underground PVC piping according to ASTM D 2321.

R. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Hub-less, Single-Stack Drainage System: Comply with ASME B16.45 and hub-less, single-stack aerator fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

S. Plumbing Specialties:

1. Install backwater valves in sanitary waste gravity-flow piping.

   a. Comply with requirements for backwater valves specified in Section– Sanitary Waste Piping Specialties.

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

3. Install drains in sanitary waste gravity-flow piping.

T. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

U. Install sleeves for piping penetrations of walls, ceilings, and floors.

V. Install sleeve seals for piping penetrations of concrete walls and slabs.

W. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-less, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hub-less-piping coupling joints.

C. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.

D. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

E. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

F. Plastic, Non-Pressure Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Unshielded, non-pressure transition couplings.

3.5 VALVE INSTALLATION

A. Comply with requirements in Section– Valves for general-duty valve installation requirements.

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install gate or full-port ball valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section– Sanitary Waste Piping Specialties.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section– Hangers and Supports.

1. Install galvanized-steel pipe hangers for horizontal piping in noncorrosive environments.

2. Install galvanized-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
4. Vertical Piping: MSS Type 8 or Type 42, clamps.
5. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

6. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
7. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

I. Install hangers for PVC, CPVC and polypropylene piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

J. Install supports for vertical PVC, CPVC and polypropylene piping every 48 inches.

K. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves in pit with pit cover flush with floor.
6. Comply with requirements for backwater valves, cleanouts, and drains specified in Section– Sanitary Waste Piping Specialties.
7. Equipment: Connect waste piping as indicated.

    a. Provide shutoff valve if indicated and union for each connection.
    b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section– Mechanical Identification.

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
c. Air pressure must remain constant without introducing additional air throughout period of inspection.
d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

F. Insulate indoor piping drains.

G. Provide accessible cleanouts at offsets more than 45 degrees and on piping larger than 1" every 20 feet on center. Provide unions at equipment connections.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

Description	Pipe	Fittings	Joints
Below grade, Soil, Waste, and Vent Piping	Solid-wall PVC	PVC socket fittings, DWV pattern	Solvent-cemented
Above grade, Soil, Waste, and Vent Piping (not installed in return air plenum)	Solid-wall PVC	PVC socket fittings, DWV pattern	Solvent-cemented
Above grade, Soil, Waste, and Vent Piping (installed in return air plenum)	Cast-iron, hubless	Hubless, DWV pattern	Heavy-duty, couplings
Condensate drains (except on piping routed above roof from packaged units)	Copper, Type L	Copper, DWV pattern	Soldered
Condensate drains routed above roof from packaged units	Solid wall PVC	PVC socket fittings, DWV pattern	Solvent-cemented

Sanitary Waste and Vent Piping Test Log						
Date	System	Description of Piping Section Tested	Test Press. (psig)	Test Duration (hours)	Results Pass/ Fail	Witness (Contract or) Initials
This form stall be completed and submitted with the project closeout documents. Contractor shall copy this form if more sheets are required. Piping pressure test log shall be kept at project site and shall be made available to the Architect upon request.						

END OF SECTION

SECTION 15.153 SANITARY DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Floor drains.

1.3 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Floor drains	R	R		R

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models are acceptable.

1. Floor Drains:

a. Jay R. Smith.
b. Josam.
c. Watts.
d. Wade.

e. Zurn.
f. Or equal.

2.2 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.3 FLOOR DRAINS

A. General: All floor drains shall be furnished and installed with all options and accessories required for a waterproof installation within the particular construction in which they are to be mounted.

1. Duco coated cast iron body.
2. Polished bronze strainer.
3. Clamping collar.
4. Drain shall have trap primer connections where indicated. Size as indicated.
5. Provide flashing clamp when required with waterproofing membrane.

B. See Construction Drawings for basis of design floor drains.

2.4 TRAPS

A. Provide on all sanitary branch waste connections from fixtures or equipment not provided with traps. Exposed brass shall be polished brass chromium plated with nipple and setscrew escutcheons. Concealed traps may be wrought cast brass. Slip joints not permitted on sewer side of trap. Traps shall correspond to fittings on cast iron soil pipe or steel pipe respectively, and size shall be as required by connected service or fixture, or as scheduled.

B. All drains, overflow, condensate, and relief, to be routed to a trapped hub or floor drain. If plans are not specific, check with Architect regarding routing of such drains.

C. Other required drains, including condensate drain piping, relief and overflow drain piping shall be provided and installed by the Contractor. Drains with outlets outdoors shall include insect screen neatly attached over opening.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

a. Maintain integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. The Contractor shall connect to roof drains and exterior roof downspouts and route new piping to its termination point outside of building as indicated on Construction Drawings.

C. Each AC equipment drip and drain opening which normally or frequently discharges water (such as air conditioning unit drains, pump base and stuffing box drips, overflows, and similar drips and drains) shall be connected to the drain openings or piped down directly over the floor drains which are provided for the purpose, as applicable, whether indicated on the Drawings or not.

D. Each water relief valve discharge shall be piped down to 6" above floor, but not necessarily over a floor drain or connected to a drain opening, unless otherwise indicated. No drain piping is required from the discharges of drain valves, unless otherwise indicated.

E. Drains shall be provided at all coils, receivers, pump suction lines, pump plates where facilities are provided and at all low points of the systems. Such drains shall consist of the necessary pipe, valves and fittings required in the opinion of the Architect to permit servicing of equipment, systems, etc.

F. Install open drain fittings with top of hub 1-inch above floor.

G. The top of all floor, roof, deck, and trench drain strainer covers shall be cleaned and polished prior to final inspection by the Architect.

3.2 CONNECTIONS

A. Comply with requirements in Section – Sanitary Waste and Vent Piping for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section– Sanitary Waste Piping Specialties for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Install piping adjacent to equipment to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section– Mechanical Identification.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 15165 STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Backwater valves.
5. Trench drains.
6. Channel drainage systems.
7. Through-penetration firestop assemblies.
8. Flashing materials.

1.3 SUBMITTALS

A. See Section 15010– Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Sanitary waste piping specialties (for each item)	R	R		R

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

A. Cast-Iron, 12-inch Diameter, Combination Main Roof and Overflow Drains (RD-1):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Jay R. Smith Mfg. Co.
    b. Watts; a Watts Water Technologies company.
    c. Zurn Industries, LLC.
    d. Or equal.

2. Standard: ASME A112.6.4, for general-purpose roof drains.
3. Body Material: Cast iron, Dura-coated.
4. Dimension of Body: Nominal 12-inch diameter.
5. Combination Flashing Ring and Gravel Stop: Required.
6. Flow-Control Weirs: Required.
7. Outlet: Bottom.
8. Double deck plate.
9. Dome Material: Cast iron, low silhouette.
10. Perforated Gravel Guard: Stainless steel.
11. Zurn 164 or equal.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Nozzle (RD-2):

1. Description: Manufactured, all nickel bronze body, threaded or no-hub inlet and decorative face of wall flange and outlet nozzle.
2. Zurn Z199 or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.

2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install downspout nozzles at exposed bottom of conductors where they spill onto grade.

C. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.

D. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 15154 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 15180 HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes special-duty valves and specialties for the following:

1. Hot-water heating piping.
2. Chilled water piping.
3. Auxiliary and intermediate drain pan piping.

1.3 REFERENCE STANDARDS

A. ASME B31.1 or B31.9 as applicable for shop and project site welding of piping work.

B. ASTM A53 – Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

C. ASTM A120 – Pipe, Steel, Black, Welded and Seamless, for Ordinary Uses.

D. ASTM A234 – Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

E. ANSI/ASME SEC 9 – Welding and Brazing Qualifications.

F. ANSI/ASME B16.3 – Malleable Iron Threaded Fittings Class 150 and 300.

G. ANSI/ASME B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

H. ANSI/ASME B16.26 – Cast Copper Alloy Fittings for Flared Copper Tubes.

I. ANSI/ASTM B32 – Solder Metal.

J. ANSI/ASTM B88 – Seamless Copper Water Tube.

K. ASTM B280 – Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

L. ANSI/AWS A5.8 – Brazing Filler Metal.

M. ANSI/AWS D1.1 – Structural Welding Code.

1.4 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. "R" means required.
2. "R2" means required only for products and equipment differing for the specified manufacturer and model and for "or equals" where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Piping materials	R			R
Pipe fittings	R			
Solder	R2			

1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

B. Welding materials and labor to conform to ASME Code and applicable state Labor Regulations.

C. Use welders fully qualified and licensed by state authorities.

D. Each length of pipe, fitting, trap, fixture, or device used in any piping system shall be stamped or indelibly marked with.

1. Weight or quality.
2. Maker's name or mark.

E. Examine piping layouts and determine requirements for piping offsets, loops or expansion joints to adequately protect systems.

1. Determine locations and design of anchors and pipe guides to maintain proper piping alignment.
2. Determine anchor reaction forces and coordinate locations of anchors with Architect.

F. Conform to ANSI/ASME B31.1

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Welding Fittings.

1. Babcock and Wilcox Tubular Products Division.
2. Bonney Forge Foundry, Inc.
3. Landish Company.
4. Or equal.

C. Flange Gaskets.

1. John Crane Company.
2. Garlock Mechanical Packing Division.
3. Goodrich.
4. Or equal.

D. Copper Press Fittings.

1. Viega Propress.
2. Apolloxpress.
3. Or equal.

E. Underground Pipe Protection.

1. Wrapping Materials.

a. 3M “Scotchwrap”.
b. Plymouth Corp.
c. Or equal.

2. Factory Insulated Pipe.

a. Thermal Pipe Systems, Inc.
b. Rovanco Corp.
c. Thermacor.

d. Or equal.

F. Solder.

1. Westinghouse.
2. J.W. Harris Co., Inc.
3. Engelhard.
4. Or equal.

G. Pipe Joint Compound.

1. Rectorseal.
2. Permatec.
3. John Crane.
4. Or equal.

2.2 PIPING AND FITTINGS

A. General.

1. Piping shall.

a. Be commercially round and straight.
b. Be of uniform quality and workmanship.
c. Be free from all defects.
d. Be identified.

B. Pressure Piping.

1. Pressure piping shall conform to requirements of ANSI Safety Code for Pressure Piping, B31.1.

2. Type PP-1: Black Steel: Schedule 40 or Standard Weight, ASTM A53 Type E Grade B (electric resistance welded).

a. 2-1/2 inches and larger.
b. Butt-welded joints.
c. Fittings.

1) Steel welding-neck flanges and flanged fittings, ANSI B16.5, Class 150 forged carbon steel.
2) ASTM A234 carbon steel welding type, long radius type elbows unless specified otherwise on the Drawings.

d. 0.375-inch wall for sizes 12 inch and larger.

3. Type PP-2: Copper Tubing.

a. 2 inches and smaller.
b. ASTM B 88; Type L, hard drawn.
c. Wrought-copper, solder joint fittings, ANSI B16.22, in sizes available.
d. Cast-bronze solder-joint fittings, ANSI B16.18, only in sizes not available in wrought copper.
e. Cast-bronze, threaded, ground-joint unions, ANSI B16.15, 2 inches and smaller.
f. Cast bronze, flanged unions, ANSI B16.24, 150 pounds per square inch class, 2-1/2 inches and larger.
g. Joints:

1) ASTM B 32, solder, Grade 95TA (lead free).
2) ASTM B 88 Type L Press Fittings and Joints. Press fittings and joints shall be feature leak before press technology. The O-ring shall be constructed out of EPDM. The fittings shall be rated for working pressure of 200 psi and temperature range from 32°F to 250°F. Press fittings are not acceptable for underground installations.

4. Type PP-3: Polypropylene-Randon (PP-R) Thermoplastic,

a. Pipe shall be manufactured from a PP-R resin (Fusiolen) meeting the short-term properties and long-term strength requirements of ASTM F 2389 or CSA B137.11.
b. All pipe shall be made in an extrusion process.
c. The pipe shall contain a fiber layer (faser) to restrict thermal expansion.
d. All pipe shall be encased in a layer of HDPE for UV protection where piping will be exposed to direct UV light for more than 30 days (factory applied).
e. All pipe shall comply with the rated pressure requirements of ASTM F 2389.
f. All pipe shall be certified by NSF International as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11.
g. Applications

1) Piping less than 4” and <= 65 psi to be SDR11.
2) Piping less than 4” and > 65 psi to be SDR9.
3) Piping 4” and greater to be R17.6
4) SDR ratings above are a minimum. All piping to be based on the required minimum pressure rating and use temperature for the project in accordance with manufacturer’s instructions and ASM F2389.

h. Fittings

1) Fittings shall be manufactured from a PP-R resin (Fusiolen) meeting the short-term properties and long-term strength requirements of ASTM F 2389.
2) All fittings shall be certified by NSF International as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11.

i. Piping and fittings shall be Aquatherm Blue Pipe or equal.

5. Type UPP-1: Underground Pre-Insulated Ductile Iron Pipe and Fittings.

a. General.

1) Piping shall be factory fabricated, pre-insulated pipe units consisting of the fluid carrier pipe, polyurethane foam insulation and moisture barrier outer jacket.

b. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end.

1) Standard-Pattern, Mechanical-Joint Fittings: AWWA C110/A21.10, ductile or gray iron.

c. Insulation: The insulation shall be rigid polyurethane foam, conforming to ASTM C-591, with a minimum density of two (2) pounds per cubic foot, 90 -95 percent closed cell content and initial thermal conductivity K = .13. The insulation shall completely fill the annular space between the pipe and the jacket. Support guides shall be factory installed, to assure equal thickness of insulation around the pipe. Insulation thickness: 2 inches.

d. Protective Jacket: The outer casing protective jacket shall be high density polyethylene. The jacket shall be manufactured to a minimum thickness of SDR 32.5. Jackets made from PVC, tape materials, or thin-walled polyethylene shall not be allowed. Fittings shall be insulated and jacketed. Both ends of each length of piping shall have a polyethylene disk between the service pipe and the jacket. The disk shall be recessed approximately 1/2" from the end of the pipe. End seals shall not be mastic, rubber, shrink end caps or other non-polyethylene materials.

e. Expansion Joints: Install expansion joints per manufacturer’s guidelines to account for expansion and contraction.

f. Install, insulate and test per manufacturers guidelines. Test at 150 psi for four hours minimum before any backfilling over pipe.

6. UPP-3 Underground Polypropylene-Randon (PP-R) Thermoplastic.

a. Pipe: PP-R resin, meeting all strength requirements of ASTM F 2389 or CSA B137.11.

1) All pipe shall be manufactured with a 0.039-inch HDPE layer to protect the pipe from UV exposure.
2) NSF International certified: NSF 14 and ASTM F2389.
3) SDR 11.

b. Pipe Fittings: PP-R resin, meeting all strength requirements of ASTM F 2389 or CSA B137.11.
c. Heat-fused joints.
d. Pipe Manufacturer:

1) Aquatherm Blue Pipe or equal.

e. Insulation: The insulation shall be rigid polyurethane foam, conforming to ASTM C-591, with a minimum density of two (2) pounds per cubic foot, 90 -95 percent closed cell content and initial thermal conductivity K = .13. The insulation shall completely fill the annular space between the pipe and the jacket. Support guides shall be factory installed, to assure equal thickness of insulation around the pipe. Insulation thickness: Per ASHRAE 90.1-2010.
f. Protective Jacket: The outer casing protective jacket shall be high density polyethylene. The jacket shall be manufactured to a minimum thickness of SDR 32.5. Jackets made from PVC, tape materials, or thin-walled polyethylene shall not be allowed. Fittings shall be insulated and jacketed. Both ends of each length of piping shall have a polyethylene disk between the service pipe and the jacket. The disk shall be recessed approximately 1/2" from the end of the pipe. End seals shall not be mastic, rubber, shrink end caps or other non-polyethylene materials.
g. Expansion Joints: Install expansion joints per manufacturer's guidelines to account for expansion and contraction.
h. Install, insulate and test per manufacturers guidelines. Test at 150 psi for four hours minimum before any backfilling over pipe.

C. Fittings and Flanges: Standard products of respective manufacturer of piping as hereinbefore specified.

D. Flange Gaskets.

1. Full faced or flat ring type to suit flange facings, selected from one of following materials.
2. Gaskets for flanged joints shall comply with ANSI B16.21.
3. Full faced for cast iron flanges.
4. Raised face for steel flanges.

a. Red rubber, ASTM D1330.
b. 1/16 inch thick.
c. Equal to Crane Style 555.

5. Gaskets coated with thread lubricant when being installed.

E. Flange Bolts: Open-hearth bolt steel.

F. Unions.

1. Steel Piping 2 inches and smaller.

a. 250 pounds per square inch: ground joint.
b. Equal to Grinnell Fig. 554.

2. Steel Piping Larger than 2 inches: Welding flanges.
3. Copper Piping: Equal to Nibco No. 633.

G. Dielectric Connections.

1. Unions.

a. Only allowed where union is required elsewhere in specifications or on drawings. Use nipple specified below otherwise.
b. 2 inches and smaller.

1) 250 pounds per square inch water on gage (WOG).
2) Standard gaskets for plumbing.
3) High temperature gaskets for heating.
4) Equal to EPCO Model FX.

c. 2-1/2 inches and larger.

1) Brass.

a) Brass half-union, ANSI B16.1, 1989, 175 pounds per square inch water on gage (WOG).
b) To welding flange as hereinbefore specified.
c) Equal to EPCO Model X.

2) Copper.

a) Half union with EPDM insulator gasket.
b) 150 pounds per square inch water on gage (WOG).
c) The Copper component of the flange adapter shall be Third Party Classified by Underwriters Laboratories Inc.

2. Nipples.

a. Applicable to all hydronic systems.

1) Minimum 4-inch-long stainless steel, brass, or copper nipple with non-conducting thermo-plastic internal lining.

2) ASTM Standard F-492 for continuous use at temperatures up to 225°F.
3) ClearFlow or equal.

b. Allowed for closed-circuit hydronic systems only: minimum 6-inch-long brass nipple.

2.3 PIPING SPECIALTIES

A. See Section “Hydronic Piping Specialties”.

2.4 SOLDER

A. S-1: Silfos or Silvaloy 15 silver solder (brazing) with 15 percent silver, 80 percent copper and 5 percent phosphorous.

B. S-1A: Safety Silv 56 cadmium-free silver solder (brazing) with 55 to 57 percent silver, 21 -23 percent copper, 15 to 19 percent zinc, 4 to 6 percent tin, and 0.15 percent other metals.

C. S-2, either.

1. 95 percent tin 5 percent antimony solder, lead free, or.
2. 95.6 percent tin, 4 percent copper, 0.4 percent silver, lead free.

PART 3 - EXECUTION

3.1 PIPE SERVICES

Service	Type of Pipe	Remarks
Above Ground Hydronic (HW, CHW)	PP-1; PP-2 Type L Hard; PP-3	to 250 degrees Fahrenheit
Underground Insulated Hydronic (HW, CHW) - General	UPP-1; UPP-3 Type K Hard	to 250 degrees Fahrenheit
Auxiliary pan drains	PP-2 Type M Hard	
Chemical water treatment and filtration systems	PP-4 Schedule 80	

3.2 INSTALLATION

A. Coordinate with work of other trades.

B. Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leak resistant piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes, where indicated by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerance.

C. Install underground piping per manufacturer's instructions.

D. Arrangement.

1. Except for large scale details piping is diagrammatically indicated. Install generally as shown.
2. Do not scale drawings for exact location of piping.
3. Install piping to best suit field conditions, in coordination with other trades.
4. Piping Arrangement.

    a. Arrange piping neatly along walls.
    b. In neat, horizontal groups.
    c. Each group to be in one plane, insofar as possible.
    d. Maintain required slope.

5. Do not sleeve structural members without consent of the Architect.
6. Maintain maximum 1-inch clearance from adjacent work, including insulation, except as noted.
7. Install piping concealed above ceilings or in walls unless otherwise indicated.
8. Installation of piping shall be made with use of appropriate fittings. Bending of piping will not be allowed.
9. Unions installed shall be accessible.
10. Locate piping runs vertically and horizontally; avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. In finished and occupied spaces, conceal piping from view by locating in column enclosures, in hollow wall construction, or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.
11. Electrical equipment spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless the piping serves equipment in the room.
12. Use tapered reducers where any change in pipe size occurs. Bushings shall not be used.
13. Conceal piping in finished portions of building, above the floor line. Cutting of walls and floors shall be held to the minimum possible to secure the proper installation.
14. Provide concealed high points with air chambers with 1/4-inch copper tube vent line and stop cock carried to accessible point.

15. Install piping subject to expansion or contraction in a manner permitting strains to be evenly distributed and alleviated.
16. Pipe the discharge of each relief valve, air vent, backflow preventer, and similar device to floor sink or drain.

E. Installation of Protective Pipe Wrap.

1. Wrap pipe and fittings with two layers of protective wrap according to manufacturer's instructions. Over-lap each layer of warp minimum 1/2 inch. Extend wrap three feet beyond section underground.
2. Protect all steel pipe buried in ground from corrosion by the application of protective pipe wrap. Clean and prime piping before application of the wrapping material.
3. No rocks or sharp edges shall be backfilled against the wrap. When backfilling with other than sand, protect wrap with an outer wrapping of Kraft paper; leave in place during backfill.
4. Wrap all copper piping below grade or concrete with plastic sleeve.

3.3 EXPANSION CONTROL

A. General.

1. Install piping to permit free expansion and contraction without damaging piping or construction.
2. Provide offsets, expansion loops, anchors, guides, and supports to permit expansion, within stress limits of ANSI 31.1 Pressure Piping for temperature ranges specified.
3. Where pipe loops or changes in direction of piping cannot be employed to absorb expansion and contraction, provide expansion joints.
4. Install pipe guides so that movement takes place along axis of pipe only. Pipe moves laterally at expansion elbows.
5. Make riser offsets in manner to avoid pocket forming due to expansion.

B. Expansion Calculations.

1. Thermal Expansion.

a. Determine thermal linear expansion of each segment of piping systems.
b. Base expansion calculations on following temperatures, plus 30 percent safety factor.

1) Hot Water Heating.

a) Idle temperature: 50 degrees Fahrenheit.
b) Maximum temperature: 210 degrees Fahrenheit.

2) Chilled Water.

a) Operating temperature: 40 degrees Fahrenheit.
b) Maximum temperature: 100 degrees Fahrenheit.

c. Determine effect of linear expansion upon piping layout in building.

1) If resulting stresses exceed maximum allowable limits introduce additional loops and/or offsets.
2) Where space limitations preclude installation of loops and/or offsets provide expansion joints.

2. Structural Considerations

a. Install pipe anchors to provide required restraints on expanding piping systems.
b. Install pipe guides to provide required restraints against lateral action of expanding piping systems.

1) Spacing for expansion joints: per manufacturer's recommendations.
2) Spacing for pipe loops and/or offsets: as required to maintain alignment within allowable stress limits.

c. Locate anchors and guides only at building structural members capable of taking imposed reaction loads.
d. Determine horizontal and vertical reaction loads of anchors and guides to building structure.

1) Coordinate details and reaction loads with structural engineer for building.
2) If necessary, revise location and number of anchors and guides as recommended by structural engineer to result in allowable reaction loads to building.

C. Provision for Expansion.

1. Loops, bends, offsets.

a. As indicated or because of job required relocation of piping and equipment.
b. Design as follows:

1) Use spring type loop U-bend or offset U-bend.
2) Corner radii five to six times pipe diameters.
3) Join bends only by welding.

a) Welding-steel piping.

b) Brazing-copper or bronze piping.

D. Sloping, Air Venting and Draining.

1. Slope piping as indicated, true to line and grade, and free of traps and air pockets.
2. Reducers/increasers.

a. Eccentric.

1) At pump suction where reducer is required.
2) Top side flat.

b. Concentric: All other locations.

3. Connect branch piping to bottom of mains in closed systems.
4. Provide drain valves and hose adapters as indicated on drawings and at the bottom of all risers.
5. Vents: See Section “Hydronic Piping Specialties.”

E. Piping Specialties: See Section “Hydronic Piping Specialties.”

F. Pipe Hanging and Supports: See Section “Hangers and Supports.”

G. Copper.

1. Crimping of copper tubing prohibited.
2. Isolate copper tubing from ferrous materials and hangers with two thicknesses of 1 inch wide 10 mil polyvinyl tape, spiral-wrapped around pipe. Total width shall be a minimum of 3 inches.

H. Coatings: Reapply coal-tar coating on buried piping, after installation, to surfaces from which coating has been removed or scraped.

I. Pipe Identification: See Section “Mechanical Identification.”

J. Care of Floors.

1. Do not set pipe vises or threading machines on unprotected concrete floors.
2. Cover floor when making plumbing connections to avoid staining floors with oil, white or red lead or other substances.
3. Remove any stains at no additional cost to the Owner.

3.4 PIPE JOINTING

A. This section does not apply to refrigerant piping.

B. Fittings.

1. Provide standard, manufacturing fittings in all cases.
2. Prohibited fittings.

    a. Field fabricated.
    b. Bushings on pressure piping.
    c. Clamp-on branch connections.

3. Provide insulating couplings or dielectric unions at all connections of ferrous piping to non-ferrous piping.
4. Branch connections, steel piping.

    a. Equal to main and to two pipe sizes smaller: weld tees, same weight as piping.
    b. Three or more pipe sizes smaller than main, but 2-1/2 inches and larger: Bonney Weld-o-lets.
    c. Two inches and smaller: Bonney Weld-o-lets, Thread-o-lets, threaded Nip-o-lets, or steel couplings.

C. Unions: Provide unions or flanges to render all items in systems easily removable, including.

1. Control valves.
2. Both sides of pumps and equipment.
3. Where indicated on drawings.
4. Exceptions.

    a. Copper water piping 1-inch or less, at Contractor's options, since the copper can be easily cut, and the union is a less secure joint than a soldered joint.
    b. Where unions are not allowed by code: Unions not allowed.

D. Pipe Ends.

1. Perform pipe cutting and end preparation to result in clean ends with full inside diameter.
2. Grind and ream as necessary.

E. Nipples.

1. Close nipples not permitted.
2. Provide extra heavy pipe for nipples where unthreaded portion is less than 1-1/2 inch long.

F. Threaded Joints: not allowed other than unions.

G. Welded Joints.

1. Weld pipe joints in accordance with recognized industry practice and as follows:

    a. Welding shall be done by qualified welders in a first-class, workmanlike manner, conforming to the American Standard Code for Pressure Piping USA B-31.1 and B-31.1A.
    b. Bevel pipe ends at a 37.5-degree angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
    c. Do not weld-out piping system imperfections by tack-welding procedures; re-fabricate to comply with requirements.
    d. Standards: Conform to Section UI, Chapter 4, "Welding of Pipe Joints", ANSI B31.1 and applicable portion of ASME Boiler and Pressure Vessel Code, Section IX.
    e. Operator's qualifications: All welders engaged in work under this Section shall be qualified in accordance with State requirements. Each operator's certificate shall be on file at site and made available to State upon request. Welding of pressure piping shall be done by-welders who have been qualified by recognized agency within 6 months prior to date of Contract.
    f. Preparation for welding: Bevel piping on both ends before welding; both ends shall have 1-1/6-inch land at bottom of bevel. Pipe with a 3/4-inch wall thickness or less shall be beveled to a standard 37.5 degrees.
    g. Use backing rings on all butt-welding joints 6-inches and larger.
    h. State employed Inspector will visually inspect welds. Any weld judged defective by visual inspection shall be cut out and tested in presence of Inspector. If percentage of defective coupons is deemed excessive, contractor shall cut additional coupons as directed by the Architect or the State Inspector. Removal and replacement of test coupons and samplings shall be done at no additional cost to the Owner. At the option of the State Inspector or the Architect, certain welds may be required to be radiographed.

2. Where required, peen and wheel-grind welds.
3. Ends of pipe may be burned for welding.

    a. Grind bevel and remove scale between welding joint.
    b. Ragged edges with metal beads, poor alignment other inferior work will be rejected.

4. Perform welding with oxyacetylene or electric arc process.

H. Soldered and Brazed Joints.

1. Solder.

    a. Use Solder S-1 for underground copper piping.

b. Use Solder S-2 other than above.

2. Clean surfaces to be jointed, of oil, grease, rust, and oxides.

   a. Remove grease from fittings by washing in solution of 1/16 sodium carbonate and three gallons hot water (except as otherwise specified for medical gas piping).
   b. Clean socket of fitting and end of pipe thoroughly with emery cloth to remove rust and oxides.
   c. Wipe excess solder from joint before it hardens.

3. When soldering or brazing materials that could be damaged by heat, remove sensitive parts and protect parts from heat. Joints shall be cool before reassembling valve.
4. Cut tubing square, reamed, and burrs removed.
5. Prevent annealing of fittings and tubing when making connections.

3.5 FLASHING AND SLEEVES

A. See Section “Hangers and Supports.”

3.6 CLEANING

A. General.

   1. During Construction.

      a. Keep openings in piping closed to prevent entrance of foreign matter.
      b. Clean pipe, fittings, and valves internally.
      c. Hammer welds to remove slag and weld beads.

   2. Clean system after pressure test. Do NOT let system sit filled with un-chemically treated water for more than 4-hours.

B. Cleaning Procedure.

   1. Upon start-up fill with clean water.
   2. Add alkaline detergent.

      a. Sodium silicate and/or sodium phosphate with non-foaming wetting agent.
      b. Phenolphthalein alkalinity to 2000 to 5000 parts per million as CaCo/3.
      c. Supplied and supervised by water treatment company.

   3. Install temporary filter bags in line strainers during start-up.
   4. Circulate water of each system at respective design flow rates or greater.

a. Three 8-hour periods.
b. At end of each 8-hour period remove and clean strainers and blow off low points.
c. After third period, completely drain out entire systems of cleaning solution and removed filters at strainers.
d. Refill systems with clean water and circulate for additional 8-hour period at end of which interval, completely drain systems.
e. Drain, refill with clear water; circulate.
f. Test for alkalinity.

1) Not more than 200 parts per million in excess of alkalinity of rinsing water.
2) Repeat flushing of water of each system at respective minimum design flow rate as described above, until 200 parts per million or less.

5. Protect against damage from freeze up or discharge of water.
6. Should any pipe be plugged or should foaming of water systems occur, disconnect piping, clean again, and reconnect at no additional cost to the Owner.

C. Upon completion of cleaning, dose system with chemicals to obtain corrosion inhibition conditions as recommended by water treatment company.

3.7 FIELD QUALITY CONTROL

A. Testing of Water Piping.

1. Test water piping at completion of roughing in, in accordance with the following schedule and show no loss in pressure or visible leaks after a minimum duration of four hours, or time as indicated, at the test pressures indicated.
2. Make connections to existing systems with flanged connection. During testing of the new work, provide a slip-in plate to restrict test pressure to new systems only. Remove plate and complete connection to existing system at completion of testing.
3. Inspect pressure piping in accordance with procedures of ANSI B31.
4. Less than 100 pounds per square inch operating pressure: Test hydrostatically to 150 pounds per square inch.
5. Over 100 pounds per square inch operating pressure.

a. Test hydrostatically to 1-1/2 times operating pressure.
b. Never exceed test pressure ANSI B16.1 basis.

6. Duration: 4 hours.

a. With system valves capped and pressure apparatus disconnected.

1) Pressure change: none.
2) Compensate for temperature change.

7. Leaks and defects.

   a. Repair or replace as directed by the Architect.
   b. At no additional cost to the Owner.

8. Notify Architect in writing one week before test.
9. Furnish written report and certification that tests have been satisfactorily completed to the Architect.
10. Include written report and certification that tests have been satisfactorily completed.
11. Final connection to system shall be witnessed by Architect.

Hydronic Piping Test Log						
Date	System	Description of Piping Section Tested	Test Press. (psig)	Test Duration (hours)	Results Pass/ Fail	Witness (Contract or) Initials
This form stall be completed and submitted with the project closeout documents. Contractor shall copy this form if more sheets are required. Piping pressure test log shall be kept at project site and shall be made available to the Architect upon request.						

END OF SECTION

SECTION 15.181 HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Materials, equipment, fabrication, installation, and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Expansion tanks.
2. Storage/buffer tanks.
3. Air separators.
4. Bypass chemical feeders.
5. Strainers.
6. Suction diffusers.
7. Balancing valves.
8. Pressure reducing valves.
9. Safety valves.
10. Air Vents.
11. Test plugs.
12. Flanges.
13. Flex connectors.

1.3 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Expansion tanks	R	R		R
Storage/buffer tanks	R	R		R
Air separators	R	R		R

Bypass chemical feeders	R	R		R
Strainers	R	R		R
Suction diffusers	R	R		R
Balancing valves	R	R		R
Pressure reducing valves	R	R		R
Safety valves	R	R		R
Air vents (manual and automatic)	R	R		R
Test plugs	R			
Flanges	R			
Flexible connectors	R			R

1.4 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Expansion tanks.

1. Bell & Gossett.
2. John Wood.
3. Wessels
4. Or equal

C. Storage/buffer tanks.

1. Bell & Gossett.
2. John Wood.
3. Wessels
4. Or equal

D. Coalescing air/dirt separators.

1. Spirotherm.

2. Wessels.
3. Wheatley.
4. Or equal.

E. Bypass chemical feeders.

1. J.L Wingert Co.
2. Industrial Chemical Corporation.
3. Or equal.

F. Air vents (manual and automatic).

1. AMTROL.
2. Bell & Gossett.
3. Armstrong.
4. Or equal.

G. Strainers.

1. Mueller.
2. Armstrong.
3. Watts.
4. Sarco.
5. Steamflo.
6. Or equal.

H. Suction diffusers.

1. Bell & Gossett.
2. Weinman
3. Grundfos.
4. Or equal.

I. Balancing valves.

1. Bell & Gossett.
2. Armstrong.
3. Taco.
4. Or equal.

J. Pressure reducing valves.

1. Watts.
2. Bell & Gossett.
3. Armstrong.
4. Or equal.

K. Safety valves.

1. Watts.
2. Bell & Gossett.
3. Armstrong.
4. Or equal.

L. Pressure-temperature test plugs.

1. Peterson-Engineering Company.
2. Taco, Inc.
3. Or equal.

M. Flexible connectors.

1. Flex-Weld.
2. Mason Industries.
3. Metraflex. Co.
4. Or equal.

2.2 EXPANSION TANKS

A. Bladder type.

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after, taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
4. Cleaned, prime coated.
5. Pre-charge as indicated on drawings.
6. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
7. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
8. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch-diameter gage glass, and slotted-metal glass guard.

2.3 STORAGE/BUFFER TANKS

A. Designed and built-in accordance with the ASME Boiler & Pressure Vessel Code Section VIII, Division 1.

1. Maximum design pressure: 125 psi.
2. Maximum design temperature: 650 ˚F.

B. Construction.

1. Installation: Vertical.
2. Shell: Carbon steel with exterior gray primer finish.
3. Center baffle plate: Carbon steel.
4. Inlet and outlet connections: Flanged.
5. Vent and drain connections: FNPT.
6. Angle legs with 14” minimum clearance from the bottom of the head to the floor/equipment pad.
7. Inspection opening.

2.4 AIR/DIRT SEPARATORS

A. Inline air and dirt separator.

1. Inline air and dirt separator capable of handling the water flow indicated on the Drawings.
2. ASME construction: 125 pounds per square inch operating pressure.
3. Tank: Carbon steel. Painted finish.
4. Copper integral tube bundle.
5. Seal: Viton.
6. O-ring: Viton.
7. Integral float actuated brass air vent.
8. Valved side tap to flush floating dirt and/or liquids.
9. Removable lower head.

B. Spirotherm VDT or equal.

2.5 BYPASS CHEMICAL FEEDER

A. Batch feeder for closed circulating water systems.

B. Capacity: 5 gallons.

C. Steel shell and heads.

D. Cap: Cast iron with Buna N O-ring: Quarter turn to open.

E. 3/4-inch tapping’s for water in, out and drain.

F. Operating pressure and temperature:

1. Minimum rated operating pressure up to 125 pounds per square inch.

2. Minimum rated operating temperature up to 250 °F.
3. Design and installation as indicated.

G. Wingert Model HD or equal.

2.6 AIR VENTS

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.
8. Bell & Gossett Model 78 or equal.

B. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Bell & Gossett Model 98 or equal.

2.7 STRAINERS

A. Sizes.

1. Screwed ends: to 2-inch.
2. Flanged 2-1/2 inch and larger.

B. Body.

1. To 100 psi: 125 lb. wsp class, cast iron.
2. 100 psi to 250 psi: 250 lb. wsp class, cast iron.
3. Over 250 psi: 300 lb. wsp class, forged steel or cast steel.

C. Screen.

1. 304, 316 stainless steel or Monel, reinforced.
2. Free area not less than 2-1/2 times inlet area.

3. Perforations.

    a. Water.

        1) To 8-inch: 1/8 inch.
        2) 10 inch and larger: 5/32 inch.

D. Y-Type.

1. Cast iron or bronze body as indicated.
2. Screwed.

    a. Faced cap, straight thread, and gasket.
    b. Mueller Steam Specialty or equal.

        1) Steel piping No. 1MFCB.
        2) Copper piping No. 35-1/2 M.

3. Flanged.

    a. Bolted cover.
    b. Mueller Steam Specialty or equal.

        1) Steel - 125 psi steam, 200 psi water on gauge (WOG) - No. 751.
        2) Steel - 250 psi steam, 500 psi water on gauge (WOG) - No. 752.
        3) Copper - 150 psi steam, 225 psi water on gauge (WOG) - No. 851.
        4) Copper - 300 psi steam, 500 psi water on gauge (WOG) - No. 852.

E. Basket type.

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. Mueller Steam Specialty Muessco No. 165 or equal.

2.8 SUCTON DIFFUSER

A. Angle type suction guide fitting.

1. Flanged cast iron body.
2. 125 pounds per square inch.
3. Steel or cast-iron guide vanes.
4. Stainless steel orifice cylinder.
5. Bronze start-up strainer.

6. Free area five times cross section area of pump suction opening.
7. Vane length no less than 2-1/2 times pump connection diameter.
8. Adjustable support foot to carry weight of suction.
9. System side connection size same as incoming pipe size.
10. Blowdown tapping in bottom.
11. Gauge tapping inside.

B. Use product manufactured by associated pump manufacturer if available.

2.9 BALANCING VALVES

A. Calibrated-Balancing Valves:

1. Combination balancing and shut-off valves.
2. Calibrated name plate and adjustable memory stop.
3. Capped read-out valves.
4. Pre-formed insulation.
5. One differential pressure read-out meter for all valves in system.
6. 2 inches and smaller.

    a. Brass body.
    b. Threaded or soldered ends.
    c. Teflon seats.
    d. 250 pounds per square inch at 250 deg F.

7. 2-1/2 inches and larger.

    a. Ductile or cast-iron body.
    b. Flanged.
    c. 175 pounds per square inch at 250 deg F.

8. Devices using venturi type flow meter not acceptable (due to propensity for clogging and ease of putting valve with limited flow range in wrong direction).
9. Devices using Pitot tube or Annubar type flow meter not acceptable (due to propensity for clogging)
10. Devices using other than ball or butterfly valves shall not be used for coil isolation – a separate ball valve or butterfly valve shall be added for isolation (to ensure positive shut-off and to allow 90˚ open-close with memory stop).
11. Bell & Gossett type CB, or equal.

2.10 PRESSURE REDUCING VALVES

A. For water.

1. 2 inches and Smaller.

    a. Bronze body, threaded.
    b. Watts Model 223 or equal.

2. 2-1/2 inches and Larger.

    a. Iron body, flanged.
    b. Watts Model 2300 or equal.

2.11 SAFETY AND RELIEF VALVES

A. Use “pressure relief valves” for unheated liquids.

B. Use “safety relief valves” for heated liquids.

C. ASME rated direct spring-loaded type.

1. Lever operated.
2. Non-adjustable factory set discharge pressure.

D. Constructed, rated, and stamped in accordance with ASME.

1. Relief valves: for unheated liquids.
2. Safety relief valves: for heated liquids.
3. Safety valves for gases and vapors: Including air and steam.

E. Set pressures and ratings.

1. Suitable and rated for system pressure and temperature: For safety relief valves, minimum temperature rating: saturated steam temperature corresponding to pressure 10 percent higher than valve set pressure.
2. Not to exceed pressure rating of protected equipment.

F. Valves to open, under test, at set pressure with following tolerance.

1. Set pressure up to 70 pounds per square inch gage: plus, or minus 2 pounds per square inch.
2. Set pressure, above 70 pounds per square inch gage: plus, or minus 3 percent.

G. Capacities.

1. Valves shall have capacity to relieve maximum possible generated energy while maintaining pressure in protected equipment at no more than 10 percent above vessel working pressure.
2. Greater than make-up pressure reducing valve capacity.
3. Equipment relief valve capacity to exceed rating of connected equipment.

4. Provide multiple valves if required for capacity even though only one valve may be shown on Drawings.

H. Maintain pressure in protected equipment at not more than following.

1. Low pressure Boilers: 5 pounds per square inch above boiler working pressure.
2. High pressure Boilers: 6 percent above boiler working pressure.
3. Unfired Pressure Vessels: 10 percent above vessel working pressure.

I. Provide multiple valves if required for capacity even though only one valve may be shown on Drawings: Factory manifold.

J. Safety and Relief Valves: Similar to Consolidated.

K. Relief Valves, Water: Equal to Watts.

2.12 PRESSURE/TEMPERATURE TEST PLUG

A. Solid brass with valve core.

B. Valve core: Nordel.

C. Fitted with a color coded and marked cap with gasket.

D. Suitable for 500 pounds per square inch gage and 275ºF for water systems.

E. Pete's Plug: No. 110/100XL with yellow cap or equal.

2.13 FLANGES

A. Convoluted.

B. Carbon steel, cold-formed.

C. Weld-neck and blind flanges in conformance with the design criteria of Section VIII, Division I of the ASME Pressure Valve Code.

D. Flanges drilled and tapped to match ANSI 150.

E. All material to comply with requirements of ASTM A516.

F. Gaskets: Teflon or as recommended by the flange manufacturer and suitable for the service.

G. Slip-on flanges will not be permitted.

H. 150-pound and 300-pound weld-neck and screwed steel flanges on steel lines to conform to ANSI Standard B16.5 for dimensions and ASTM A 181 Material Standard.

2.14 FLEXIBLE CONNECTORS

A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:

1. 2” and Smaller: Threaded.
2. 2-1/2” and Larger: Flanged.

B. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

C. Rubber, Flexible Connectors: CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 125-psig minimum working-pressure rating at 220 °F. Units may be straight or elbow type, unless otherwise indicated.

2.15 VENT COCKS

A. Bronze body, 1/4-inch size.

B. Lever handle.

C. 125 pounds per square inch steam working pressure.

D. Weiss LC-14 or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All installation shall be in accordance with manufacturer’s published recommendations.

B. Installation shall meet or exceed all applicable federal, state, and local requirements, referenced standards, and conform to codes and ordinances of authorities having jurisdiction.

C. Remove temporary strainers after cleaning systems. Clean all permanent strainers after circulating systems for a minimum of 48 hours at full capacity.

3.2 EXPANSION TANKS

A. Support expansion tanks from building structure in accordance with manufacturer's instructions.

B. Make piping connections as indicated.

1. Expansion tank connection to the piping main shall be on the side of the pipe (3 o’clock or 9 o’clock).
2. On hot water systems, provide an anti-thermosyphon loop to prevent warm water from migrating to the tank.

C. Connect with ball valve with locked guard.

1. Relief valve shall be located on system-side of expansion tank isolation valve.

3.3 STORAGE/BUFFER TANKS

A. Install on 6” concrete housekeeping pad.

B. Insulate tank per specifications.

C. Provide vent and drain valves.

3.4 AIR/DIRT SEPARATORS

A. Install at lowest pressure, highest temperature point or, where indicated on drawings.

B. Provide drain valve.

C. Install automatic vent with cock on top tapping.

3.5 STRAINERS

A. Wye-type: Where shown on drawings and ahead of all automatic flow control valves and pressure regulating valves.

B. Basket-type strainers: Where shown on drawings.

C. Install strainers in horizontal or vertical-down position.

D. Provide valved drain and hose connection on strainer blow down connection.

3.6 SUCTION DIFFUSERS

A. Provide on suction side of base mounted centrifugal pumps where indicated.

B. Support with floor mounted pipe and flange supports: From pump isolation base where provided.

C. Match pump inlet and pipe connection sizes.

3.7 PRESSURE TEMPERATURE TEST PLUGS

A. Provide pressure/temperature test plugs, where shown on drawings.

B. Install at all equipment, coil, and heat exchanger connections. Install at each VAV terminal unit.

C. Also locate at all temperature/pressure wells for calibration, see Section 230900 – Energy Management & Control Systems.

3.8 VALVE APPLICATIONS

A. Install shut-off-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install calibrated balancing valves at each branch connection to return main.

C. Install calibrated balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.

G. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

H. Select system relief valve capacity so that capacity is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

I. Pipe relief valve outlet to nearest floor drain.

J. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

3.9 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

C. For automatic air vents in above-ceiling spaces or other concealed locations, extend vent tubing to nearest drain.

3.10 INSPECTION

A. Verify that adequate clearance between piping specialties and adjacent walls or equipment is available to permit maintenance and repairs.

END OF SECTION

SECTION 15.185 HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Work included in this section: materials, equipment, fabrication, installation, and tests in conformity with applicable codes and authorities having jurisdiction for all water pumps except.

1. Where integral with manufactured piece of equipment.
2. Where specialty pumps applicable to specific systems are specified under the relevant Section.

1.3 REFERENCE STANDARDS

A. Underwriters' Laboratories, Inc.: UL 778 – Motor Operated Water Pumps.

B. American Society of Mechanical Engineers: ASME Section VIII – Boiler and Pressure Vessel Code – Pressure Vessels.

C. ANSI/HI Pump Standards.

1.4 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Pump data	R	R		R
Mounting details				R

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

1. ITT, Bell and Gossett.
2. Grundfos (PACO).
3. Armstrong.
4. Or equal.

2.2 GENERAL

A. Centrifugal, single stage, unless otherwise noted.

B. Bronze fitted.

C. Statically and dynamically balance rotating parts.

D. Construction to permit complete servicing without breaking piping connections.

E. Pumps to operate at 1750 rpm unless specified otherwise.

F. Bearings: Grease lubricated roller or ball bearings.

G. Shaft seals.

1. Mechanical.
2. Single, inside mounted, end face rubber bellows type.
3. Springs: stainless steel.
4. Seal head: brass or stainless steel.
5. Babbitt filled carbon rotating washer.
6. Stationary seat: Ni-Resist.
7. Elastomer: EPDM.

H. Substitutions.

1. Brake horsepower rating at design conditions shall be no more than 10 percent above that scheduled.
2. Motor horsepower shall be no larger than that scheduled or compensate Division 26 contractor for any associated cost to increasing motor size.

I. Motors: See pump schedule and Section– Motors and Controllers.

J. Pump characteristics.

1. Pump curve shall rise continuously from maximum capacity to shutoff.
2. Shutoff head approximately 10 percent greater than design head.
3. Operation at or near peak efficiency.
4. For pumps serving variable flow (2-way valve) systems; or where multiple pumps operate in parallel other than lead/standby applications.

    a. Pump shall be capable of operating at 40 percent beyond design flow rate without exceeding break off point.
    b. Motors shall be selected for non-overloading operation at a flow rate 40 percent beyond design flow rate.

5. Impeller diameter.

    a. Maximum 90 percent of maximum published impeller diameter.
    b. Constant speed pumps: Trim to duty.
    c. Variable speed pumps: Trim to the maximum impeller size that does not cause an increase in motor size (so that maximum efficiency is achieved).

K. Pumps and flanges tested and rated to withstand 1-1/2 times specified working pressures based on both inlet pressures scheduled and pump shut-off head or 175 pounds per square inch working pressure at 250 degrees Fahrenheit, whichever is greater.

L. Pumps to be suitable for handling fluids at scheduled temperatures.

M. Pressure taps on both inlet and outlet for gauge connection mounted in the pump casing (not in external piping).

N. Factory tested.

O. Painted with at least one coat of high-grade machinery enamel.

2.3 END SUCTION

A. Base/motor type as scheduled.

1. Close-coupled.

    a. Back pullout feature for easy replacement of seals.
    b. Mounting base that provides sufficient height, so the pump casing is above the bottom of the base feet (not requiring the pump to hang out over the front of the inertia base or housekeeping pad).
    c. Provide with base mounting elbow on vertical installations.

2. Flex coupled.

a. Provide removable coupling guards.
b. Flexible couplings: EPDM.
c. Foot mounted volute.
d. Groutable base.

B. Mounting base that provides sufficient height, so the pump casing is above the bottom of the base feet (not requiring the pump to hang out over the front of the inertia base or housekeeping pad).

C. Shaft: stainless steel.

D. Casing wearing ring: None.

E. Suction and discharge connections: flanged or threaded.

2.4 IN-LINE

A. Type as scheduled.

1. Close coupled.
2. Back pullout design.
3. Suitable for horizontal or vertical operation.

B. Shaft: stainless steel.

C. Wearing rings: renewable bronze.

D. Shaft sleeves: bronze.

E. Casing with suction and discharge gauge ports, vent and plugged drain ports.

F. Capable of being serviced without disturbing piping connections.

G. Pump volute base ring tapped for 1-1/2-inch 125-pound ANSI flange to support pump.

H. Pump flanges to have 125-pound ANSI flange drilling.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with work of other trades.

B. Install pump in accordance with manufacturer’s written installation instructions.

C. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.

D. Install on isolation base or housekeeping pad as specified.

E. Decrease to pump suction from line size with flat-top eccentric reducers on horizontal inlet piping (or suction diffuser where indicated on drawings), concentric reducers elsewhere.

F. Support piping adjacent to pump such that no weight is carried on pump casings.

G. Allow at least 5 pipe diameters between pump suction entry and closest elbow, unless a pump suction diffuser is installed.

H. Inlet and discharge valves and other piping specialties shall be pipe size, not pump inlet or discharge connection size.

I. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment bases.

J. Floor mounted pumps: mount base to foundation or inertia base.

1. Bolts in embedded pipe sleeve.
2. Double nuts or shims to form level assembly.

K. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support weight of in-line pumps.

3.2 MOUNTING AND ALIGNMENT

A. See Section– Mechanical Sound and Vibration Control.

B. Floor mounted pumps: mount base to foundation or inertia base.

1. Bolts in embedded pipe sleeve.
2. Double nuts or shims to form level assembly.

C. Align pump and motor shafts by adjusting shims or double nuts.

D. Pour non-shrink grout under base, filling voids, and allow to set.

3.3 INSPECTION

A. Verify that adequate clearance between pump and adjacent walls or equipment is available to permit maintenance and repairs.

B. Check that pump is suspended from building structure and not supported by piping.

C. Flex Coupled Pumps Alignment Verification.

1. By pump manufacturer, at start-up, with dial indicator of plus or minus 0.002-inch accuracy.
2. Certify in writing b pump manufacturer’s millwright at start-up:

    a. Alignment work has been performed by manufacturer's personnel.
    b. Pumps are operating in accordance with design requirements.

3.4 PRE-OPERATING CHECKS

A. Before operating pumps.

1. Assure that piping is clear of debris which might clog pump.
2. Vent air from pump system to assure water in pump and piping system.
3. Check for proper and sufficient lubrication.
4. Check for correct operation of check valve.
5. Check for correct rotation.
6. Confirm alignment again after grouting has properly set and re-align if required.
7. Check packing nut adjustment for proper leakage rate and packing lubrication.
8. Assure that strainer is clean before commencing testing.
9. Check for proper adjustment of vibration isolation.

3.5 TESTING AND ADJUSTING

A. After starting pumps.

1. Check for high bearing temperatures.
2. Check temperature of packing gland or mechanical seal for proper cooling operation.
3. Check for motor overload by taking ampere reading at maximum operating conditions, i.e. all valves open and individual pump running.
4. Check shut-off head to ensure impellers properly trimmed.

3.6 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel on.

1. Procedures for starting and stopping and troubleshooting pumps.
2. Procedures and schedules for maintaining and servicing pumps.
3. Organization and content of Operations & Maintenance Manuals.

END OF SECTION

SECTION 15.190 FACILITY NATURAL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes materials, equipment, fabrication, special-duty valves, specialties, and installation for the following:

1. Natural gas piping.

1.3 PROJECT CONDITIONS

A. Site Gas System Pressure: (CONTRACTOR SHALL VERIFY).

B. Building Gas System Pressure: Field verify and provide medium pressure regulator as required.

1.4 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Piping (below ground and above ground	R			R
Valves, all types	R			R
Meters	R	R		R
Pressure regulators	R			R
Specialties	R	R		R

1.5 QUALITY ASSURANCE

A. FM Standard: Provide components listed in FM's Fire Protection Approval Guide if specified to be FM approved.

B. IAS Standard: Provide components listed in IAS's Directory of AGA and CGA Certified Appliances and Accessories if specified to be IAS listed.

C. UL Standard: Provide component listed in UL's Gas and Oil Equipment Directory if specified to be UL listed.

D. ANSI Standard: Comply with ANSI Z223.1 and NFPA 54 (2009 Edition), "National Fuel Gas Code."

1.6 COORDINATION

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Using Agency or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner not less than seven days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Appliance Connector Valves.

a. Conbraco Industries, Inc.: Apollo Div.
b. Mueller Co.: Mueller Gas Products Div.
c. Watts Industries, Inc.: Water Products Div.
d. Brass Craft Manufacturing Co.
e. American Valve.

2. Gas Valves, NPS 2 and smaller.

a. Nibco, Inc.
b. Flow Control Equipment, Inc.

c. Grinnell Corp.
d. Honeywell, Inc. Co.
e. Crane Valves.
f. McDonald: A.Y. McDonald Mfg. Co.
g. Milwaukee Valve Co., Inc.
h. Mueller Co.: Mueller Gas Products Div.
i. Watts Industries, Inc.: Water Products Div.

3. Plug Valves, NPS 2-1/2 and larger.

a. Walworth Co.
b. Olson Technologies, Inc.; Homestead Valve Div.
c. Milliken Valve Co., Inc.

4. Service Meters: As approved by the Utility Provider or Owner.
5. Line Pressure Regulators.

a. American Meter Co.
b. Equimeter, Inc.
c. Fisher Controls International, Inc.
d. Schlumberger Industries: Gas Div.

6. Appliance Pressure Regulators.

a. Eaton Corp.: Controls Div.
b. Harper Wyman Co.
c. Maxitrol Co.

2.2 PIPING MATERIALS

A. Steel Pipe: ASTM A 53; Type E or S; Grade B (Grade A for pipe 1-1/2 inch and smaller) Schedule 40; black.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
3. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
4. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
5. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
6. Joint Compound and Tape: Suitable for natural gas.
7. Steel Flanges and Flanged Fittings: ASME B16.5.
8. Gasket Material: Thickness, material, and type suitable for natural gas.

B. Polyethylene Pipe: All polyethylene pipe used in the Project must comply with ASTM D-2513 and be manufactured in the United States.

1. Pipe and Fitting Material. All pipes shall conform to the requirements of the currently approved ASTM D-25 13 specification “Thermoplastic Gas Pressure Pipe, Tubing and Fittings.” All fittings shall conform to the requirements of ASTM D-2683 specification “Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe” or ASTM D3261 “Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.” All pipes shall be manufactured of virgin material, with the exception of the clean rework material that is generated from the manufacturer’s own production, as long as the pipe and/or fittings meet the required specifications. All pipe formulation must have suitable outdoor weather resistance. The color of all polyethylene pipes shall be either orange or yellow.
2. Pipe Design. All pipe shall be designed for direct burial as specified in D.O.T. Title 49, Part 192, “Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards,” through current Amendment, for natural gas mains and services operated at 60 psig. or less. The pipe must also be suitable for replacing old steel mains and services. The pipe must be homogeneous and be free of holes, cracks, foreign material, blisters, or other deleterious faults. The minimum design stress must comply with the requirements of ASTMD-2513.
3. Any defect such as a groove, notch, or gouge, greater than ten percent (10%) of the wall thickness of the pipe, shall not be used.

C. Transition Fittings: Type, material, and end connections to match piping being joined.

2.3 SPECIALTY VALVES

A. Valves, NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

B. Valves, NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

C. Appliance Connector Valves: ANSI Z21.15 and IAS listed.

D. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.

E. Gas Valves, NPS 2 and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating.

1. Tamperproof Feature: Include design for locking.

F. Plug Valves, NPS 2-1/2 and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating.

1. Tamperproof Feature: Include design for locking.

G. Automatic Gas Valves: ANSI Z21.21, with electrical operator for actuation by appliance automatic shutoff device.

2.4 PRESSURE REGULATORS

A. Description: Single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.

1. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
2. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
3. Line Pressure Regulators: ANSI Z21.80.
4. Appliance Pressure Regulators: ANSI Z21.18. Regulator may include vent limiting device, instead of vent connection, if approved by Architect.

B. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

2.5 METERS

A. Natural gas meter: Provide outside adjacent to mechanical room entrance, a meter for the Owner's use in determining the gas usage for this building. Meter shall be pipe or pedestal mounted, rotary style, enamel coated steel case. Provide combined register totalizer, water escape hole in housing and means for sealing against tampering. Provide with a pulse sensor so the building meter reading system can connect to the gas meter.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31.

3.2 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 piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping adjacent to machines to allow service and maintenance.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

J. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.

K. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

L. Install sleeve seals for piping penetrations of concrete walls and slabs.

M. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 PREPARATION

A. Close equipment shutoff fuel gas to premises or section of piping. Perform leakage test as specified in Article entitled, Field Quality Control, to determine that all equipment is turned off in affected piping section.

B. Comply with ANSI Z223.1, paragraph entitled, Prevention of Accidental Ignition.

3.4 SERVICE ENTRANCE PIPING

A. Extend fuel gas piping and connect to fuel gas distribution for service entrance to building.

B. Install dielectric fitting downstream from and adjacent to each service meter unless meter is supported from service-meter bar with integral dielectric fitting. Install shutoff valve downstream from and adjacent to dielectric fitting.

C. Provide Schedule 40 black steel riser (from underground) at building or equipment, extending minimum 2' horizontal to connect with underground piping.

3.5 PIPING APPLICATIONS

A. Flanges, unions, transitions, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, provided compliance with the IFGC is maintained.

B. Fuel Gas Piping above ground: Use the following:

1. NPS 2 and Smaller: Steel pipe, malleable-iron threaded fittings, and threaded joints.
2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.

C. Fuel-Gas Piping below ground: Use the following:

1. Thermoplastic gas pressure pipe, tubing and fittings, ASTM D2513 with transition riser.

3.6 VALVE APPLICATIONS

A. Appliance Shutoff Valves for Pressure 0.5 psig or less. Appliance connector valve or gas stop.

B. Appliance Shutoff Valves for Pressure 0.5 to 2 psig: Gas stop or gas valve.

C. Appliance Shutoff Valves for Pressure 2 to 5 psig: Gas valve.

D. Piping Line Valves, NPS 2 and Smaller: Gas valve.

E. Piping Line Valves, NPS 2-1/2 and Larger: Plug valve or general-duty valve.

3.7 PIPING INSTALLATION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

I. PE Piping Install regulator assemblies aboveground. Include gas valve or plug valve for each assembly.

1. Install gas valve or plug valve and strainer upstream from each service pressure regulator.
2. Install service pressure regulators with vent outlet turned down and with corrosion-resistant-metal insect screen.

J. Service Entrance Piping: Extend fuel gas piping and connect to fuel gas distribution for service entrance to building.

1. Exterior service meter will be provided by gas utility.

K. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.

1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
2. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls.
3. In Walls: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in walls, subject to approval of authorities having jurisdiction.
4. Prohibited Locations: Do not install gas piping in or through circulating air ducts, chimneys or gas vents (flues), ventilating ducts, or elevator shafts.

    a. Exception: Accessible above-ceiling space specified above.

L. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

M. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings and in floor channels, unless indicated to be exposed to view.

N. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

O. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

P. Connect branch piping from top or side of horizontal piping.

Q. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

R. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.

S. Install pressure gage upstream and downstream from each line pressure regulator.

T. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.

U. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

V. Purging Pipes and Fittings: A combustible gas indicator shall be used when purging mains and piping. When purging gas from abandoned lines, the air and the gas must be discharged aboveground and directed away from power lines or structures. When purging air from new lines, installation of a 3/4 service saddle and non-corrodible riser is required four (4) feet from each dead-end on all new installations of pipe in order to purge air from all dead-ends simultaneously. Release gas into new lines at a rate that will prevent formation of a hazardous mixture of gas and air or precede natural gas with a slug of inert gas.

W. Pipe Placement and Backfill.

1. When installing polyethylene pipe, sufficient slack shall be provided to allow for possible contraction. The polyethylene pipe shall not have a bend that is less than 25 times the outside diameter of the pipe. If a bend is required that is less than 25 times the outside diameter of the pipe, then an approved polyethylene elbow fitting is required. A fusion joint shall not be placed at a bend. During extremely high temperature conditions it may be necessary to cool the pipe before the last connection.
2. No polyethylene gas line shall be installed above ground. During maintenance, repair, and tie-in work, temporary polyethylene gas lines may be used above ground.
3. The minimum clearance required between the distribution piping and other underground structures is twelve (12) inches. Trench width and minimum cover shall comply with another Section of specification, Excavation, Trenching and Backfilling for Utilities. Unless otherwise shown on plans, pipe embedment shall be select material and remainder of trench may be backfilled with spoil from trenching operation.

3.8 VALVES AND VALVE BOXES

A. Provide valves and valve boxes plumb. All boxes shall be installed flush with the finished grade. Support box with brick or other approved material. Adequate backfill shall be placed around the valve boxes and valve extension boxes to prevent any damage or settlement to the pipeline that may be transferred to the pipe through the valve box. Protective sleeves shall be installed over fusion joints and extend through the valve boxes on the polyethylene valve installations.

3.9 HANGERS AND SUPPORTS

A. Refer to Section– Hangers and Supports.

3.10 CONNECTIONS

A. Install piping adjacent to appliances to allow service and maintenance. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.

B. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

C. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
2. Do not use gas pipe as grounding electrode.

3.11 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator and specialty valve.

1. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator and specialty valve.
2. Refer to Mechanical Identification.

B. Label piping per Mechanical Identification.

3.12 PAINTING

A. Use materials and procedures in Division 09 – Painting.

B. Paint exterior pipe, fittings, pressure regulators, specialty valves, etc.

1. Pipe and Fittings, Color: Yellow (Confirm color with Architect prior to painting).
2. Pressure Regulators, Specialty valves, Etc., Color: Red (Confirm color with Architect prior to painting).

C. Paint exposed interior pipe, fittings, pressure regulators, specialty valves, etc.

1. Pipe and Fittings, Color: Yellow (Confirm color with Architect prior to painting).
2. Pressure Regulators, Specialty valves, Etc., Color: Red (Confirm color with Architect prior to painting).

3.13 FIELD QUALITY CONTROL

A. Inspect, test, and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing, and Purging" and requirements of authorities having jurisdiction. Isolate pressure reducing valves and equipment controls during testing. Test pressure to be 100 psi for a period of 24 hours with no drop in pressure.

B. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

C. Report test results promptly and in writing to Architect.

D. Verify capacities and pressure ratings of pressure regulators, valves and specialties.

E. Verify correct pressure settings for pressure regulators.

F. Verify that specified piping tests are complete.

3.14 ADJUSTING

A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

Natural Gas Piping Test Log						
Date	System	Description of Piping Section Tested	Test Press. (psig)	Test Duration (hours)	Results Pass/ Fail	Witness (Contractor) Initials
This form stall be completed and submitted with the project closeout documents. Contractor shall copy this form if more sheets are required. Piping pressure test log shall be kept at project site and shall be made available to the Architect upon request.						

END OF SECTION

SECTION 15.400 PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Plumbing fixtures and trim.
2. Accessories.

1.3 REFERENCE STANDARDS

A. As specified in Section “Mechanical General Provisions.”

1.4 SUBMITTALS

A. See Section Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Plumbing fixtures	R			R
Trim	R			
Supports	R			R
Accessories	R			

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act".

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Hand Sinks: NSF 2 construction.
3. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
4. Stainless-Steel Fixtures Other Than Service Sinks: ASME A112.19.3M.
5. Vitreous-China Fixtures: ASME A112.19.2M.
6. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
7. Water-Closet, Flushometer Tank Trim: ASSE 1037.

H. Comply with the following applicable standards and other requirements specified for sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
4. Faucet Hose: ASTM D 3901.
5. Faucets: ASME A112.18.1M.
6. Hose-Connection Vacuum Breakers: ASSE 1011.
7. Hose-Coupling Threads: ASME B1.20.7.
8. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
9. NSF Materials: NSF 61.

10. Pipe Threads: ASME B1.20.1.
11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
12. Supply and Drain Fittings: ASME A112.18.1M.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1M.
3. Manual-Operation Flushometers: ASSE 1037.
4. Plastic Tubular Fittings and Piping: ASTM F 409.
5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
6. Tubular Brass Drainage Fittings and Piping: ASME A112.18.1M.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Floor Drains: ASME A112.21.1M.
3. Grab Bars: ASTM F 446.
4. Hose-Coupling Threads: ASME B1.20.7.
5. Hot-Water Dispensers: ASSE 1023 and UL 499.
6. Off-Floor Fixture Supports: ASME A112.6.1M.
7. Pipe Threads: ASME B1.20.1.
8. Plastic Toilet Seats: ANSI Z124.5.
9. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 COORDINATION

A. Coordinate roughing-in and final plumbing fixture locations and verify that fixtures can be installed to comply with original design and referenced standards.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Provide two service kits for each type of faucet, flush valve, shower/tub valve and all other trim/accessories having serviceable parts.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:

1. Provide fixtures and trim complete for proper installation as described in the manufacturer's catalog with the modifications as shown on Plumbing Fixture Schedule in the plans or specifications.
2. All fixtures, specified to be of vitreous ware, shall be of a quality known commercially as "twice fired" vitreous chinaware of the best quality, nonabsorbent, burned so that the whole mass is thoroughly fused and vitrified producing a material white in color, which when fractured will show a homogeneous mass, close-grained and free from pores. The glazed and vitreous china fixtures shall be white, thoroughly fused, and united to the body, without discoloration, chips, or flaws and shall be free from cracks. Warped or otherwise imperfect fixtures will not be acceptable.
3. Factory grind back and bases of fixtures smooth.
4. Enamelware to be white cast iron with acid-resisting enamel.
5. Unless otherwise specified, water closets to have a waste passage to pass a 2-1/2-inch ball minimum. Bolt water closets to flanges with a 1-inch-thick rubber foam gasket.
6. Fixture trim and exposed metal items shall be polished chrome-plated unless otherwise noted, and pipes passing through walls shall have polished chrome-plated escutcheon plates. All stainless steel shall be satin brushed (US32D) finish unless noted otherwise.
7. Fixtures shall be free from imperfections, true as to line, angles, curves, and color; smooth, watertight, and practically noiseless in operation.
8. Exposed Pipe, Trim Including Fittings, Traps, Escutcheons, Valves, Valve Handles, and Accessories: Above and Below Fixtures:

    a. Polished chrome plated CP brass.
    b. Setscrew cast brass escutcheons for piping.
    c. Covering tubes not permitted.
    d. Provide Hudee stainless steel rims, as applicable, for non-self-rimming counter mounted fixtures.

9. Supply Fixtures With:

    a. Renewable seats or replaceable internal units.
    b. Compositional washers.

2.2 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models are acceptable.

1. Vitreous china fixtures:

    a. American Standard.
    b. Toto.
    c. Zurn.

d. Kohler.
e. Or equal.

2. Stainless steel sinks:

a. American Standard.
b. Just.
c. Elkay.
d. Kohler.
e. Or equal.

3. Sink and lavatory trim:

a. Zurn.
b. Kohler.
c. Delta.
d. Or equal.

4. Mop Basins:

a. Stern-Williams.
b. Fiat Products.
c. Florestone.
d. Or equal.

5. Electric drinking fountains:

a. Elkay.
b. Haws.
c. Halsey Taylor
d. Or equal.

6. Fixture carriers:

a. Wade.
b. Zurn.
c. J.R. Smith
d. Or equal.

2.3 FLUSH VALVE PLUMBING FIXTURES – GENERAL

A. Provide vacuum breakers and angle control-stop valves for each flush valve. Vacuum breakers shall conform to ASSE 1001. Exposed to view and pressure containing components of flush valves, vacuum breaker, angle control-stop valve, tail pieces, slip nuts, escutcheon plates, and wall plates shall be chromium-plated copper alloy or polished stainless steel. Water flushing volume of the flush valve shall not exceed the gallons per flush required below, and is

factory set as required by the fixture. Mount flush valves not less than 11 inches above neither the fixture nor more than 44 inches above the floor for ADA accessible fixtures. For ADA accessible water closets, controls for flush valves shall be located on the wide side of the toilet area.

B. See plumbing fixture schedule for basis of design and options required.

2.4 SUPPLY PIPES

A. Supply pipe to be braided stainless steel riser complete with chrome plated steel flange and chrome plated, quarter-turn, solid brass angle stop.

2.5 LAVATORY GRID

A. Chrome plated cast brass solid top, open grid, P.O. plug. Provide offset lavatory strainers as required by ADA/cabinets.

2.6 TRAP

A. Chrome plated cast brass body P-trap with cleanout, tubular brass wall bend, die-cast nuts, and shallow escutcheon with compression inlet.

2.7 CARRIER SUPPORTS

A. Where wall hung plumbing fixtures (water closets, urinals, lavatories, electric drinking fountains, or sinks) are installed back-to- back and carriers are required, provide one carrier to serve both fixtures in lieu of individual carriers. Provide appropriate carriers for all wall mounted plumbing fixtures, and as indicated elsewhere in these specifications or on the drawings, or as required. All carriers shall be concealed, floor mounted type unless otherwise approved by the Architect. Provide offset arm type, or pass thru leg type, to suit special applications.

2.8 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Guard: Manufactured, plastic covering or enclosure for hot- and cold-water supplies and trap and drain piping and complying with ADA requirements Truebro Lav Guard model #102 and model #105 or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water, soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.

B. Examine walls and floors for suitable conditions where water closets will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Include supports for plumbing fixtures according to the following:

1. Heavy-Duty, Floor Mounted Chair Carriers: For all wall mounted plumbing fixtures.

B. Include fitting insulation kits for accessible fixtures according to the following:

1. Lavatories: Cover Hot-and cold-water supplies, stops and handles, drain, trap, and waste to wall.
2. Fixtures with Offset Drain: Cover hot-and cold-water supplies, offset drain, trap, and waste to wall.
3. Other Fixtures: Cover exposed fittings below fixture.

3.3 FIXTURE INSTALLATION

A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. For wall-hanging fixtures, install off-floor supports/carriers affixed to building substrate. See Architectural Drawings for fixture heights. If no fixture height is included consult Architect.

C. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate. Closet flanges shall be anchored to the floor per manufacturer’s recommendations.

E. Install wall-hanging fixtures with tubular waste piping attached to supports.

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

J. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

K. Install toilet seats on water closets.

L. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

M. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.

N. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

O. Install traps on fixture outlets.

P. Install escutcheons at piping wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Heavy-duty type escutcheons, with setscrews shall be utilized in exposed applications under wall mounted lavatories and sinks and on exposed piping applications on tank type water closet stops and on exposed piping to flush valves, etc. Light duty slip-on type may be utilized in concealed installations within cabinets. Use deep-pattern escutcheons if required to conceal protruding fittings.

Q. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Grout excessive gaps as required. Match sealant and grout color to fixture color.

R. Items supplied by others as denoted are to be furnished complete with stops, risers, faucets, strainers, tailpiece, and traps. The intent is that this Contractor

shall provide all "rough-in" through face of wall and shall connect equipment provided by others, except where otherwise noted.

S. Water Hammer Arrestors.

1. All water supply piping fittings and fixtures shall be protected against water hammer, shock, or surge pressure by installation water hammer arrestors.
2. Water hammer arresters shall be installed per the manufacturer's recommendations. This shall include spacing, sizing, etc.
3. Fixture piping shall be adequately anchored to prevent vibration.
4. Contractor must guarantee against water hammer at end of project.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Section. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect water supplies from water distribution piping to fixtures.

C. Connect drain piping from fixtures to drainage piping.

D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.

E. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

F. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

G. Arrange for electric-power connections to fixtures and devices that require power. Electric power is specified under Division 26.

3.5 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.6 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets, and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

3.7 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

3.8 PROTECTION

A. Provide protective covering for installed fixtures and fittings throughout construction.

B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

C. Replace any fixtures or equipment broken, cracked, discolored, pitted, or otherwise imperfect.

3.9 OPERATIONAL TESTS

A. Pour at least five (5) gallons of water into every floor drain to test for pipe stoppage. Remedy all stoppage.

END OF SECTION

SECTION 15.441 SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Submersible sump pumps.
2. Oil detection control system.

1.3 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Pump data	R	R		R
Controls	R	R		R
Mounting details				R

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS (ELEVATOR SUMP PUMP WITH PUMP AND OIL DETECTION CONTROL SYSTEM)

A. Submersible Sump Pumps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Goulds Water Technology; a Xylem brand.
    b. Grundfos Pumps Corp.
    c. Pentair Pump Group.
    d. Or equal.

2. Description: Submersible centrifugal high head effluent pump.
3. Construction.

    a. Pump volute, motor, and sealed housing, gray cast iron, ASTM A-48, Class 30.
    b. Pump Inlet: open and clear, without screening to provide access for effluent and solids.
    c. External mating parts shall be machined with Buna N, O-ring seals.
    d. Fasteners exposed to liquid shall be 300 series stainless steel.
    e. Power cord shall be water resistant UL approved, with double insulation, and sized for full amp draw.

4. Motor and shaft shall be mounted in a sealed submersible housing. Single phase motors shall be shaded pole. Three phase motors shall be polyphase.
5. Bearings, Shaft and Mechanical Seal: Upper radial and lower thrust bearings required. Upper bearing shall be brass, lower bearing, single row ball. All bearing shall be permanently and continuously lubricated and cooled by the dielectric oil which fills the motor housing. Motor shaft shall be corrosion resistant steel and sealed from the pumped liquid with a carbon ceramic mechanical seal.
6. Impeller: High capacity, two vane, high head design.
7. Cast iron parts shall be painted prior to assembly with a water reducible alkyd air dried enamel. Minimum paint thickness shall be 3 to 4 mils.
8. Controls:

a. Complete elevator sump pump control system approved for oil/water detection, ASME 17.1 compliant.
b. Control panel with separate pump and control circuits.
c. Remote alarm.
d. Enclosure: NEMA 250, Type 1.
e. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
f. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
g. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
h. Sequence of Operation.

1) Upon a rise in fluid level, fluid level reaches pump “ON” probe to activate the pump. Pump remains on until fluid level is below the “OFF” probe. The “OFF” probe senses air or oil and shall turn the pump off so the oil layer (if present) will not be pumped out of the sump. If the fluid level reaches the “ALARM” probe and mechanical float, the system shall differentiate between water and oil and activate the remote alarm.

i. Pentek EPC-115 Oil Detection Control System or equal.

9. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Energy Management and System Interface: Auxiliary contacts in pump controls for interface to EMCS and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section Motors and Controllers.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Division 31.

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.3 INSTALLATION

A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation, and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust pumps to function smoothly and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION

SECTION 15.480 FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Commercial, gas-fired, domestic-water heaters.
2. Domestic-water heater accessories.

1.3 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Water heaters	R	R		R
Accessories	R	R		R
Controls	R	R		R

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: Five years.
2) Controls and Other Components: One year(s).

b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Atmospheric, Gas-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Lochinvar, LLC.
    b. Rheem Manufacturing Company.
    c. Smith, A. O. Corporation.
    d. Or equal.

2. Standard: ANSI Z21.10.3/CSA 4.3.
3. Minimum 95% thermal efficiency.
4. Storage-Tank Construction: ASME-code steel with 150-psig working-pressure rating.

    a. Tapping's: Factory fabricated of materials compatible with tank. Attach tapings to tank before testing.

        1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
        2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

    b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    c. Lining: Glass complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

5. Factory-Installed Storage-Tank Appurtenances:

    a. Anode Rod: Replaceable magnesium.
    b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
    c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
    d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
    e. Jacket: Steel with enameled finish.
    f. Burner: Modulating gas burner.
    g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
    h. Temperature Control: Adjustable temperature control via graphical user interface. Digital temperature readout.
    i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
    j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input and include

pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

6. Special Requirements: NSF 5 construction.
7. Draft Hood: Draft diverter, complying with ANSI Z21.12.
8. Automatic Damper: ANSI Z21.66/CSA 6.14-M, electrically operated, automatic-vent-damper device with size matching draft hood.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMTROL, Inc.
   b. Smith, A. O. Corporation.
   c. Taco, Inc.
   d. Or equal.

2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.

3. Construction:

   a. Tapping's: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
   b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation.

Include ball valves to isolate each domestic-water heater and calibrated balancing valves to provide balanced flow through each domestic-water heater.

F. Comply with requirements for ball valves specified in Section – Valves.

G. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

H. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include pressure rating as required to match gas supply.

I. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

J. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

K. Vent System: Provide complete concentric combination combustion air intake and exhaust vent piping system including but not limited to the following: vertical discharge adaptor, vertical concentric piping, vent pipe clamps, condensate collector, roof flashing assembly, roof discharge terminal and fittings.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and re-inspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section Valves.

C. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section Facility Natural-Gas Piping.

D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section Domestic Water Piping Specialties.

G. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section Meters and Gages.

H. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Section Valves and comply with requirements for thermometers specified in Section Meters and Gages.

I. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

J. Fill domestic-water heaters with water.

K. Charge domestic-water compression tanks with air in accordance with manufacturer’s instructions. Support tanks separately from piping.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section Domestic Water Piping.

B. Comply with requirements for gas piping specified in Section Facility Natural-Gas Piping.

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section Mechanical Identification.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 for retesting and re-inspecting.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain domestic-water heaters.

END OF SECTION

SECTION 15.514 COPPER WATER-TUBE BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes gas-fired, copper finned boilers, trim, and accessories for generating hot water.
   1. Boilers.
   2. Controls and boiler trim.

1.3 REFERENCE STANDARDS

A. Published specifications standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this section where cited below:
   1. CSA – Canadian Standards Association International.
   2. American Society of Mechanical Engineers: ASME Section VIII – Boiler and Pressure Vessel Code – Pressure Vessels.
   3. ANSI Z21.13 Standard for Gas-Fired Low Pressure Steam and Hot Water Boilers.
   4. AHRI/GAMA/Hydronics Institute Testing and Rating Standard for Rating Boilers.

1.4 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.
   1. “R” means required.

“R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Boilers	R	R		R
Boiler controls and trim	R	R		R

B. Boiler
   1. Certified dimensioned shop drawings.
   2. Materials of construction, thickness of tubes, shell, boilerplate and insulation.
   3. Firing and combustion air control systems.
   4. Electrical requirements.
   5. Safety devices.
   6. Minimum and maximum gas pressure at burner.
   7. Controls.
   8. Wiring diagrams.
   9. Field mounted equipment and devices.

C. Manufacturer's instructions for:
   1. Installation.
   2. Operation.
   3. Maintenance and repair.

D. Written warranty indicating full compliance with Warranty paragraph herein.

1.5 WARRANTY

A. The pressure vessel and heat exchanger shall be fully guaranteed for 10 years, non-prorated, against failure due to condensate corrosion, thermal stress, mechanical defects, or workmanship without a minimum flow rate or minimum return water temperature requirement.

B. One year all parts warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options.

   1. Lochinvar.
   2. Laars.
   3. Fulton.
   4. Ray Pak.

2.2 CONSTRUCTION

A. Description: Boiler shall be natural gas fired and vertical water tubed design. The boiler shall be factory-fabricated, factory-assembled, and factory-tested,

water-tube boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

B. Heat Exchanger: The heater exchanger shall bear the ASME “H” stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be a “Fin Tube” design with 7/8” I.D. straight copper tubes having extruded integral fins spaced seven fins per inch. These tubes shall be “rolled” securely into glass-lined, cast iron headers. There shall be no bolts, gaskets or “O” rings in the head configuration. Removable access plugs shall be provided on the heat exchanger headers for the purposes of inspection, cleaning or repair.

C. Burner: Natural gas, forced draft single burner premix design. The burner shall be high temperature stainless steel with a ceramic fiber outer covering to provide modulating firing rates. The burner shall be capable of a 5:1 gas train turndown without loss of combustion efficiency.

D. Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.

E. Gas Train: The boiler shall be supplied with a gas train designed with negative pressure regulation and shall be capable of a minimum 5:1 turndown. Gas train to be ASME CSD-1.

F. Ignition: Hot surface ignition with 100 percent main-valve shutoff with electronic flame supervision.

G. Casing:
   1. Jacket: 18 gauge pre-primed and painted steel jacket
   2. Control Compartment Enclosures: NEMA 250, Type 1A.
   3. Insulation: Minimum ½ inch thick, mineral fiber insulation surrounding the heat exchanger.
   4. Combustion-Air Connections: Inlet and vent duct collars.

H. Characteristics and Capacities:
   1. Heating Medium: Hot water.
   2. Design Water Pressure Rating: 160 psi working pressure.

2.3 TRIM

A. Safety Relief Valve:
   1. See schedules for psi.
   2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

B. Pressure Gage: Minimum 3-1/2 inch diameter. Gage shall have normal operating pressure about 50 percent of full range.

C. Drain Valves: (2) 3/4” NPS

2.4 CONTROLS

A. Boiler controls shall feature a standard, factory installed 8” LCD full color screen display with the following standard features:
   1. Control module shall include the CON-X-US mobile communication platform for remote access via a smart phone or Tablet. This will allow the ability to monitor and manage multiple boilers and send alerts via text or e-mail notifying of changes in system status. A user shall have the ability to check system status or re-program any boiler function remotely.
   2. Password Security: Boiler shall have a different password security code for the User and the Installer to access adjustable parameters.
   3. Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.
   4. Pump exercise: Boiler shall energize any pump it controls for an adjustable time if the associated pump has been off for a time period of 24 hours.
   5. Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.
   6. Boost function: Boiler may be programmed to automatically increase the set point a fixed number of degrees (adjustable by installer) if the setpoint has been continuously active for a set period of time (time adjustable by installer). This process will continue until the space heating demand ends.
   7. PC port connection: Boiler shall have a PC port allowing the connection of PC boiler software.
   8. Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.
   9. Service reminder: Boiler shall have the ability to display a yellow colored service notification screen based upon months of installation, hours of operation, and number of boiler cycles. All notifications are adjustable by the installer.
   10. Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.
   11. Night setback: Boiler may be programmed to reduce the space heating temperature set point during a certain time of the day.
   12. Freeze protection: Boiler shall turn on the boiler and system pumps when the boiler water temperature falls below 45 degrees. When the boiler water temperature falls below 37 degrees the boiler will automatically turn

on. Boiler and pumps will turn off when the boiler water temperature rises above 43 degrees.

13. BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0-10V input signal.
14. Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, hours running and ignition attempts and should be able to view on boiler screen.

B. The boiler shall have a built in controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different btu inputs without utilization of an external controller. The internal cascade controller shall include:
   1. Lead lag: The Control module shall allow the “Lead” boiler to modulate with demand to capacity. As demand increases, additional boilers fire and modulate to capacity. This continues, with additional boilers firing and modulating to capacity until all units are operating.
   2. Efficiency optimization: The Control module shall optimize the modulation capabilities of all the Boiler Plant while evenly distributing run time across all cascaded boilers.
   3. Redundancy: If the Leader boiler shall loose communication with the members an alternate member will become the Leader until the original lead boiler regains communication.
   4. Front end loading: The Control module shall allow a Condensing boiler to be cascaded with a non-condensing boiler with a Smart System control with no third party cascading or communication devices. A call for heat will allow the Condensing boiler to fire first and bring the non-condensing boiler on when the demand is needed.
   5. Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the controller. Following that, the leader will be changed once every 24 hours.

C. Boiler operating controls shall include the following devices and features:
   1. Set-Point Adjust: Set points shall be adjustable.
   2. Operating Pressure Control: Factory wired and mounted to cycle burner.
   3. Sequence of Operation: Factory installed controller to modulate burner firing rate to maintain system water temperature in response to call for heat.
   4. Sequence of Operation: Factory installed controller to control burner firing rate to reset supply-water temperature based on the outdoor-air temperature. At 10 deg F outside-air temperature, set supply-water temperature at 180 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.

D. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.
3. High and Low Gas Pressure Switches: Optional pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.
4. Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.
5. Blocked Flue Switch: Pressure switches shall prevent burner operation on a blockage in the flue pipe. Switch to be manually reset on the control interface.
6. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.

E. Building Automation System Interface: BACnet MSTP communication protocols with gateway for BACnet IP to communicate with building automation system to monitor, control, and display boiler status and alarms.

PART 3 - EXECUTION

3.1 Startup for boilers to be by factory-authorized service representative. Representative is to visit site before startup, fill out all pre-startup checklists, startup the boiler and occupancy adjustments after 12 months of service. Multiple visits (3 minimum per boiler) is required. Additional visits to ensure proper startup of boiler is required by the manufacturer representative at no additional cost. Additional visits are required due to different phases of installation.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing during installation.

B. Tests and Inspections:
1. Perform startup checks according to manufacturer's written instructions. Complete startup form included with Boiler and return to Manufacturer as described in the instructions.
2. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

D. Performance Tests:
1. Factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notifications is required in advance of test dates.
8. Perform a combustion analysis after installation and adjust gas valve per the Installation and Operations manual and note in startup report.
9. Document test results in a report and submit with close out documents.

3.3 DEMONSTRATION

A. Factory representative or a factory-authorized service representative required for boiler startup and to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Owner training to be filmed with attendance sheet and video turned in after owner training is completed.

END OF SECTION

SECTION 15.520 HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work included in this section: materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Services of water treatment firm.
2. Chemicals.
3. Feed equipment.
4. Systems provided with water treatment prior to testing and starting for regular operation.

B. Intent of the Section is to provide complete chemical treatment to protect the following systems from scale formations, corrosion, algae and slime growth.

1. Chilled water.
2. Hot water.

1.3 WATER TREATMENT SERVICES

A. Retain qualified water treatment specialist for complete water treatment service including:

1. Perform analysis of water conditions, including local makeup water.
2. Recommend methods and materials required to comply with Paragraph 1.2B above.
3. Furnish all water treatment chemicals.
4. Supervise installation of water treatment chemicals and systems.
5. Provide written report of makeup water conditions and recommended methods and materials for initial and ongoing treatment of all piping systems.
6. Relieve operating staff and contractor of all responsibility for chemical handling, water testing and adjusting water treatment equipment during

Warranty Treatment Period (other than providing required maintenance of treatment equipment).

7. Conduct monthly visits of qualified technical representative to:

    a. Collect samples from each treated system for analysis at firm laboratory.
    b. Inspect and adjust of water treating devices.

B. Water Treatment Period:

1. Water treatment applied concurrently with operation of each system for 1 year after project Substantial Completion.
2. Upon completion of the Warranty Treatment Period, inform Owner in writing of various types of service agreements available.

1.4 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Piping diagram	R			
Power and control diagrams	R			
Bypass chemical feeders	R	R		R
Chemicals	R	R		R
Water treatment equipment and controllers	R	R		R
Water analysis	R	R		
Water treatment services	R			

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Water Treatment Service and Chemicals.

1. Anderson Chemical.

2. Chem-Aqua.
3. Nalco Chemical.
4. GE Betz.
5. Certified.
6. Or equal.

C. Bypass chemical feeders.

1. J.L. Wingert Co.
2. Industrial Chemical Corporation.
3. Or equal.

2.2 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Chemical Feed System Description:

1. Closed-Loop System: One bypass feeder on each system with isolating and drain valves with inlet piping connecting to discharge of circulating pumps, and outlet side of feeder connected to suction side of pump unless otherwise indicated.

a. Introduce chemical treatment through bypass feeder when required or indicated by test.

2.3 PERFORMANCE REQUIREMENTS

A. Maintain water quality for HVAC systems that controls corrosion and build-up of scale and biological growth for maximum efficiency of installed equipment without posing a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed-Loop System: Maintain system essentially free of scale, corrosion, and fouling to sustain the following water characteristics:

1. Conductivity: 1200 to 2500 umhos. (nitrite raises system conductivity).
2. Acceptable pH: Not less than 7.0 or greater than 8.5 (except for piping flush and clean step where the pH level is in the alkaline range of 9.5 to 10.5).

3. Hardness: < 5 ppm. (when closed loops have soft water make-up water).

2.4 CHEMICAL FEEDING EQUIPMENT

A. Bypass Chemical Feeders.

1. Batch feeder for closed circulating water systems.
2. Install feeder in convenient location where it may be easily refilled, maximum 4 feet above floor.
3. Install as indicated on drawings.

    a. Support from floor.
    b. Valves on air release, inlet, outlet and drain.
    c. Air release valve on top.
    d. Drain valve on bottom.
    e. Capacity: 5 gallons.
    f. 3/4-inch tapping's.
    g. Dome bottom with legs.
    h. Steel or stainless steel.
    i. Cap: Cast iron with Buna N O-ring: Quarter turn to open.
    j. Operating pressure and temperature:

        1) Minimum rated operating pressure up to 125 pounds per square inch.
        2) Minimum rated operating temperature up to 250 °F.

4. Wingert Model DB-5HD or equal.

B. Positive-Displacement Diaphragm Pump: Simplex, self-priming, rated for intended chemical with 25 percent safety factor for design pressure and temperature.

1. Pump shall be capable of providing an adjustable flow rate.
2. Pump motor shall be fully enclosed, continuous-duty, 120-VAC, 60-Hz, single-phase motor.
3. Pump shall have a built-in relief valve.

C. Positive-Displacement Piston Pump: Metal and thermoplastic construction.

1. Pump motor shall be fully enclosed, continuous-duty, 120-VAC, 60-Hz, single-phase motor.
2. Pump shall have a built-in relief valve.

D. Chemical Solution Tanks: Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with graduated markings.

1. Polypropylene Molded cover with recess for mounting pump, agitator, and liquid-level switch.
2. Capacity equal to 50 gallons unless specified otherwise on the Drawings.

E. Agitator: Direct drive, 1750 rpm, mounted on tank with angle adjustment.

1. Agitator motor shall be fully enclosed, continuous-duty, 120-VAC, 60-Hz, single-phase motor.
2. Stainless-steel clamp and motor mount, with stainless-steel shaft and propeller.

F. Liquid-Level Switch: Polypropylene housing, Liquid-Level Switch: Polypropylene housing, integrally mounted PVC air trap, receptacles for connection to metering pump, and low-level alarm.

G. Packaged Conductivity Controller: Solid-state circuitry, 5 percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control-function light, output to control circuit, and recorder.

H. Cold-Water Meter: Positive-displacement type with sealed, tamperproof magnetic drive; impulse contact register; single-pole, double-throw, dry-contact switch.

1. Turbine type with bronze or cast-iron body rated for 125 psig.
2. Magnetic-drive or mechanical-impulse contactor matched to signal receiver.
3. At least six-digit totalizer.
4. Contact switches shall be rated at 5 amps, 120-VAC.

I. Solenoid Valves: Forged-brass body, globe pattern, and general-purpose solenoid enclosure with 120-V, continuous-duty coil.

J. Electronic Timers: 150-second and 5-minute ranges, with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.

K. Chemical Tubing: Schedule 40 PVC with solvent-cement joints; or polypropylene tubing with heat fusion.

L. Plastic Ball Valves: Rigid PVC or CPVC body, integral union ends, and polytetrafluoroethylene seats and seals.

M. Plastic-Body Strainer: Rigid PVC or CPVC with cleanable stainless-steel strainer element.

N. Condenser Water-Treatment Control Panel: Incorporate solid-state integrated circuits and digital LED displays, in NEMA 250, Type 12 enclosure with gasketed and lockable door.

1. Control dissolved solids, based on conductivity, and shall include the following:

    a. Digital readout display.
    b. Temperature-compensated sensor probe adaptable to sample stream manifold.
    c. High, low, and normal conductance indicator lights. Programmable set points and alarms.
    d. High or low conductance alarm light, trip points field adjustable; with silence switch.
    e. Hand-off-auto switch for solenoid bleed-off valve.
    f. Bleed-off light to indicate valve operation.
    g. Internal adjustable hysteresis or dead band.
    h. Network and phone line capable controller for remote monitoring/alarming.
    i. Interface for start/stop and status indication for control and monitoring by the Building Automation System (BAS).

2. Control inhibitor feeding, based on make-up volume, and shall include the following:

    a. Solid-state reset counter (accumulator), with selections from 1 to 15.
    b. Solid-state timer, adjustable from 15 to 300 seconds.
    c. Test switch.
    d. Hand-off-auto switch for chemical pump.
    e. Illuminated legend to indicate feed when pump is activated.
    f. Solid-state lockout timer, adjustable from 15 to 180 minutes, with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
    g. Electromechanical-type, panel-mounted make-up totalizer to measure amount of make-up water.
    h. Interface for start/stop and status indication for control and monitoring by the Building Automation System (BAS).

3. Control biocide with an adjustable time programmer and shall include the following:

    a. 24-hour timer with 14-day skip feature to permit activation any hour of the day.
    b. Precision, solid-state, bleed-off lockout (zero to nine hours) and biocide module (zero to two and one-half hours). Pre-bleed and bleed lockout.
    c. Solid-state alternator to enable the use of two different formulations.
    d. 24-hour digital display of time of day.
    e. 14-day LED display of day of week.
    f. Fast and slow internal clock set controls.
    g. Battery backup so clock is not disturbed by power outages.

h. Quartz timekeeping accuracy.
i. Hand-off-auto switches for biocide pumps.
j. Biocide A and Biocide B illuminated legends to indicate pump is running.
k. Interface for start/stop and status indication for control and monitoring by the Building Automation System (BAS).

2.5 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer recommended equipment and chemicals, in a carrying case, for testing pH, total dissolved solids, dissolved oxygen, biocount, chloride, and total alkalinity and for calcium hardness field tests.

B. Corrosion Test Coupon Assembly: Constructed of corrosion material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test coupon assembly.

1. Two-station rack for closed-loop systems.
2. Four-station rack for open condenser water systems.

2.6 CHEMICALS

A. Furnish chemicals recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment.

B. Provide supply of the following chemicals for treatment of water systems during the treatment period identified in 1.3B.

C. System Cleaner: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.

D. Biocide: Chlorine release agents or microbiocides.

E. Closed-Loop, Water Piping Chemicals: Sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.

F. All products shall be properly registered with the US Environmental Protection Agency and EPA registration number shall be clearly shown on all product literature and drum labels.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to maintain the water quality as specified in "Performance Requirements" Article.

3.2 INSTALLATION

A. Per manufacturer’s recommendations

B. Install chemical application equipment on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

C. Install water-testing equipment on white polypropylene backboard (on wall or free-standing support structure) near water-chemical-application equipment.

D. Install interconnecting control wiring for chemical treatment controls and sensors.

E. Mount sensors and injectors in piping circuits.

F. Bypass chemical feeders.

1. Mount on floor with top of reservoir tank maximum 4 feet above floor.
2. Supply to bottom of feeder to encourage mixing.

G. Valves and Piping.

1. See Section– Hydronic Piping for piping materials and installation.
2. See drawings; arrange to be confirmed by manufacturer.

H. Install automatic chemical-feed equipment and include the following:

1. Install water meter in makeup-water supply.
2. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

    a. Pumps shall operate for timed interval on contact closure at water meter in makeup-water supply connection.

3. Install test equipment and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.

4. Install dissolved solids controller with sensor and bleed valves.

    a. Bleed valves shall cycle to maintain maximum TSS concentration.

5. Install pH sensor and controller with injection pumps and solution tanks.

    a. Injector pumps shall operate to maintain required pH.

6. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.

    a. Injection pumps shall operate to feed biocide on an alternating basis.

3.3 INITIAL CLEANING OF SYSTEMS

A. Prior to operation clean system as specified in Section– Hydronic Piping.

B. Upon completion of cleaning, dose system with chemicals to obtain specified corrosion inhibition conditions.

3.4 START-UP AND SUPERVISION

A. Provide installation supervision and start-up automatic water treatment systems by qualified representative of water treatment equipment/chemical supplier.

3.5 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel on:

1. Procedures for programming and troubleshooting controllers.
2. Procedures and schedules for testing and maintaining water quality.
3. Organization and content of Operations & Maintenance Manuals.

END OF SECTION

SECTION 15.623 AIR-COOLED SCROLL WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes packaged, air-cooled, electric-motor-driven, scroll water chillers.

1.3 DEFINITIONS

A. 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.

B. DDC: Direct digital control.

C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in Btu/h to the total power input given in watts at any given set of rating conditions.

D. EMCS: Energy Management and Control System.

E. GFI: Ground fault interrupt.

F. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.

G. I/O: Input/output.

H. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

I. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.

J. SCCR: Short-circuit current rating.

K. TEAO: Totally enclosed air over.

L. TENV: Totally enclosed nonventilating.

1.4 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop and coordination drawings (where shop and coordination drawings are required) according to the following table.

1. "R" means required.
2. "R2" means required only for products and equipment differing for the specified manufacturer and model and for "or equals" where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Chillers	R	R		R
Chiller controls	R	R		
Chiller accessories	R	R		
Chiller BACnet PICS Statement	R			

B. Product Data: For each type of product.

1. Performance at ARI standard conditions and at conditions indicated.
2. Performance at ARI standard unloading conditions.
3. Performance data including; unit efficiency, full load and part load performance data, acoustical data, etc.
4. Minimum evaporator flow rate.
5. Refrigerant capacity of water chiller.
6. Oil capacity of water chiller.
7. Fluid capacity of evaporator.
8. Minimum entering condenser-air temperature.
9. Performance at varying capacity with constant design entering condenser-air temperature. Repeat performance at varying capacity for different entering condenser-air temperatures from design to minimum in 10 ˚F increments.
10. Dimensioned plan and elevation view drawings, required clearances, and location of all field connections.
11. Product data indicating rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.
12. Required clearances for maintenance and operation.
13. Size and location of piping and wiring connections.
14. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

D. Startup service reports.

E. Warranty: Sample of special warranty.

F. Touchup Paint: 32 oz. container of paint used for finish coat. Label outside of container with detailed description of paint to allow for procurement of a matching paint in the future.

1.5 QUALITY ASSURANCE

A. AHRI Certification: Certify chiller according to AHRI 590 certification program.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

B. Package water chiller for export shipping.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

a. Refrigerant and oil charge.

1) Loss of refrigerant charge for any reason due to manufacturer's product defect and product installation.

b. Parts and labor.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Performance Tolerance: Comply with the following in lieu of AHRI 550/590:

1. Allowable Capacity Tolerance: Five (5) percent.
2. Allowable Full-Load Energy Efficiency Tolerance: Five (5) percent.
3. Allowable Part-Load Energy Efficiency Tolerance: Five (5) percent.

B. AHRI Rating: Rate water chiller performance according to requirements in AHRI 550/590.

C. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.

F. Comply with NFPA 70.

G. Comply with requirements of UL 1995, "Heating and Cooling Equipment," and include label by a qualified testing agency showing compliance.

H. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
2. See drawings for equipment served by backup power systems.
3. Provide means and methods required to satisfy requirement even if not explicitly indicated.

I. Outdoor Installations:

1. Chiller shall be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a 25-year period with minimal degradation due to exposure to outdoor ambient conditions.
2. Chillers equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures

encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past 30-year period.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Daikin Applied.
2. Trane.
3. YORK; a Johnson Controls company.
4. Or equal.

2.3 MANUFACTURED UNITS

A. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser with fans, electrical power, controls, and indicated accessories.

B. Sound-reduction package shall have the following:

1. Acoustic enclosure around compressors.
2. Reduced-speed fans with acoustic treatment.
3. Designed to reduce sound level without affecting performance.

C. Architectural Louvered Panel Package: Provide removable louvered panels with fasteners for additional protection of compressors, evaporator, and condenser coils without inhibiting service access. Finish to match cabinet.

2.4 CABINET

A. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.

B. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.

C. Casing: Galvanized steel.

D. 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.

2.5 COMPRESSOR-DRIVE ASSEMBLIES

A. Compressors:

1. Description: Positive-displacement direct drive with hermetically sealed casing.
2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.

    a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.

3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
4. Capacity Control: On-off compressor cycling.

    a. Digital compressor unloading is an acceptable alternative to achieve capacity control.

5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug or removable magnet in sump, and initial oil charge.

    a. Manufacturer's other standard methods of providing positive lubrication are acceptable in lieu of an automatic pump.

6. Vibration Isolation: Mount individual compressors on vibration isolators.

    a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.

B. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.

C. Compressor Motor Controllers:

1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

2.6 REFRIGERATION

A. Refrigerant: R-410A. Classified as Safety Group A1 according to ASHRAE 34.

B. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

C. Refrigerant Circuit: Each circuit shall include an 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.

D. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.

1. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in each circuit in lieu of each compressor.

E. Pressure Relief Device:

1. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
3. ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger.

2.7 EVAPORATOR

A. Brazed Plate:

1. Direct-expansion, single-pass, brazed-plate design.
2. Type 304 or 316 stainless-steel construction.
3. Code Compliance: Tested according to ASME Boiler and Pressure Vessel Code.
4. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.
5. Inlet Strainer: Factory-furnished, 20-mesh strainer for field installation in supply piping to evaporator.

B. Factory-furnished, thermal dispersion type chilled-water flow switch for field installation, if not factory installed. If not factory installed, wiring of flow switch to chiller control panel is specified under Division 15 HVAC.

C. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F.

2.8 AIR-COOLED CONDENSER

A. Coil(s) with integral subcooling on each circuit.

B. Copper Tube with Plate Fin Coils:

1. Construct coils of copper tubes mechanically bonded to aluminum fins.

C. Aluminum Microchannel Coils (as an alternate to copper tube with plate fin coils to meet specified equipment efficiencies):

1. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
2. Single- or multiple-pass arrangement.
3. Construct fins, tubes, and header manifolds of aluminum alloy treated with a corrosion-resistant coating.

D. Hail Protection: Provide condenser coils with architectural louvers, baffles, or hoods to protect against hail damage.

E. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.

F. Fan Motors: TENV or TEAO enclosure, with sealed and permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.

1. Overcurrent- and thermal-overload protection not integral to motor is acceptable if provided with chiller electrical power package.

G. Fan Guards: Removable steel safety guards with corrosion-resistant PVC coating.

2.9 INSULATION

A. Closed-cell, flexible, elastomeric thermal insulation complying with ASTM C 534/C 534M, Type I for tubular materials and Type II for sheet materials.

1. Thickness: 1-1/4 inches (high-humidity insulation package).

B. Adhesive: As recommended by insulation manufacturer.

C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

1. Apply adhesive to 100 percent of insulation contact surface.
2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
3. Seal seams and joints to provide a vapor barrier.
4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
5. Manufacturer has option to factory or field insulate chiller components to reduce potential for damage during installation.
6. Field-Applied Insulation:

    a. Components that are not factory insulated shall be field insulated to comply with requirements indicated.
    b. Manufacturer shall be responsible for chiller insulation whether factory or field installed to ensure that manufacturer is the single point of responsibility for chillers.
    c. Manufacturer's factory-authorized service representative shall instruct and supervise installation of field-applied insulation.
    d. After field-applied insulation is complete, paint insulation to match factory-applied finish.

2.10 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.

C. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.

D. Wiring shall be numbered and color-coded to match wiring diagram.

E. Field power interface shall be to circuit breaker. Minimum SCCR according to UL 508 shall be as required by electrical power distribution system.

F. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:

1. 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.
2. NEMA KS 1, heavy-duty, nonfusible switch.
3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

G. Each motor shall have overcurrent protection.

H. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.

I. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.

J. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

K. Control Relays: Auxiliary and adjustable time-delay relays, or an integral to water chiller microprocessor.

L. Service Receptacle:

1. Unit-mounted, 120-V GFI duplex receptacle.
2. Power receptacle from chiller internal electrical power wiring.

M. Indicate the following for water chiller electrical power supply:

1. Current, phase to phase, for all three phases.
2. Voltage, phase to phase and phase to neutral for all three phases.
3. Three-phase real power (kilowatts).
4. Three-phase reactive power (kilovolt amperes reactive).
5. Power factor.
6. Running log of total power versus time (kilowatt hours).
7. Fault log, with time and date of each.

2.11 CONTROLS

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Standalone, microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

C. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.

D. Provide and field install NEMA 4 enclosure over factory-mounted unit controller for protection. Coordinate NEMA 4 enclosure dimensions with unit controller dimensions.

1. NEMA 4 enclosure with lift-off hinges.
2. Continuously welded, no holes or knockouts.
3. Seamless, watertight foam gasket.
4. Hasp and staple for padlocking.

5. Removable door.
6. Hoffman NEMA 4 A-ALP or equal.

E. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, digital display. Display the following:

1. Date and time.
2. Operating or alarm status.
3. Operating hours.
4. Outside-air temperature if required for chilled-water reset.
5. Temperature and pressure of operating set points.
6. Chilled-water entering and leaving temperatures.
7. Refrigerant pressures in evaporator and condenser.
8. Saturation temperature in evaporator and condenser.
9. No cooling load condition.
10. Elapsed time meter (compressor run status).
11. Pump status.
12. Antirecycling timer status.
13. Percent of maximum motor amperage.
14. Current-limit set point.
15. Number of compressor starts.
16. Alarm history with retention of operational data before unit shutdown.
17. Superheat.

F. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Capacity control based on evaporator leaving-fluid temperature.
3. Capacity control compensated by rate of change of evaporator entering-fluid temperature.
4. Chilled-water entering and leaving temperatures, control set points, and motor load limit.
5. Current limit and demand limit.
6. External water chiller emergency stop.
7. Antirecycling timer.
8. Automatic lead-lag switching.
9. Ice-building mode.

G. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:

1. Low evaporator pressure or high condenser pressure.
2. Low chilled-water temperature.
3. Refrigerant high pressure.
4. High or low oil pressure.
5. High oil temperature.
6. Loss of chilled-water flow.

7. Control device failure.

H. EMCS System Interface: Factory-install hardware and software to enable system to monitor, control, and display chiller status and alarms.

1. Hardwired I/O Points:

a. Control: On/off operation.

2. Communication Interface: ASHRAE 135 (BACnet) communication interface shall enable control system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through DDC system for HVAC.

I. Factory-installed wiring outside of enclosures shall be in NFPA 70-complaint raceway. Make terminal connections with liquidtight or flexible metallic conduit.

2.12 ACCESSORIES

A. Factory-furnished neoprene isolators for field installation.

B. Low ambient kit: Allow chiller operation down to 0 ˚F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.

1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WATER CHILLER INSTALLATION

A. Coordinate sizes and locations of bases with actual equipment provided. Cast anchor-bolt inserts into concrete bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures with actual equipment provided.

C. Install water chillers on support structure indicated.

D. Equipment Mounting:

1. Install water chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation devices specified in Section "Vibration Controls for HVAC."

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Maintain clearances required by governing code.

G. Chiller manufacturer's factory-trained service personnel shall charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.

H. Install separate devices furnished by manufacturer and not factory installed.

1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

3.3 PIPING CONNECTIONS

A. Comply with requirements in Section "Hydronic Piping" and Section "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to chillers, allow space for service and maintenance.

C. Evaporator Fluid Connections:

1. Connect to evaporator inlet with shutoff valve, flexible connector, thermometer, and plugged tee with pressure gage. See piping detail on Drawings.
2. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve. See piping detail on Drawings.
3. Make connections to water chiller with a mechanical coupling.

D. Connect each drain connection with a drain valve, full size of drain connection. Connect drain pipe to drain valve with union and extend drain pipe to terminate over floor drain.

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

3.5 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between chiller control interface and EMCS system for remote monitoring and control of chillers. Comply with requirements in Section "Energy Management and Control System - General."

D. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
2. Verify that pumps are installed and functional.

3. Verify that thermometers and gages are installed.
4. Operate water chiller for run-in period.
5. Check bearing lubrication and oil levels.
6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
9. Verify and record performance of chilled-water flow and low-temperature interlocks.
10. Verify and record performance of water chiller protection devices.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

D. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.

E. Prepare a written startup report that records results of tests and inspections.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers. Video record the training sessions and provide electronic copy to Owner. See Section “Mechanical General Provisions.”

1. Instructor shall be factory trained and certified.
2. Provide not less than eight hours of training.
3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain Owner sign-off that training is complete.
6. Owner training shall be held at Project site.

END OF SECTION

SECTION 15725 MODULAR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work included in this section: materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Air handling units.
2. Field installed coils.

1.3 REFERENCE STANDARDS

A. AMCA 99 – Standards Handbook.

B. AMCA Standard 203.

C. ANSI/AMCA 210 – Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

D. ANSI/AMCA 230 – Laboratory Methods of Testing Air Circulator Fans for Rating.

E. AMCA 300 – Reverberant Room Method of Sound Testing of Fans.

F. AMCA Standard 301 – Method for Calculating Fan Sound Ratings from Laboratory Test Data.

G. AMCA Standard 500-D – Laboratory Methods of Testing Dampers for Rating.

H. AMCA 500-L – Laboratory Methods of Testing Louvers for Rating.

I. ARI 410 – Standard for Forced – Circulation Air-Cooling and Air Heating Coils.

J. ARI 430 – Central Station Air-Handling Units.

K. ANSI/AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.

L. ANSI/AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.

M. ASHRAE/ANSI Standard 111.

N. ASHRAE Standard 52.

O. ASHRAE 90.1.

P. ASTM A525 – Specification for General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process.

Q. NFPA 90A – Installation of Air Conditioning and Ventilation Systems.

R. SMACNA – Low Pressure Duct Construction Standards.

S. UL Standard 1995.

1.4 QUALITY ASSURANCE

A. AMCA certified ratings per applicable AMCA standard based on the testing conducted in an independent laboratory.

B. Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal for both sound and performance.

C. Units shall be designed and manufactured in strict accordance with UL 1995, Standard for Heating and Cooling Equipment. Air handler shall be ETL or UL listed in accordance with UL 1995, or the current equivalent by UL, and shall carry the ETL or UL label. If manufacturer cannot provide ETL/UL sticker on air handler, it will be the sole responsibility of the contractor to arrange for local, on-site, ETL or UL approval and labeling at no additional cost to the Owner.

D. Schedule equipment performance is minimum capacity required.

E. The Contract Documents are based on the equipment scheduled. Contractor is advised that the use of equipment other than that scheduled may directly affect and require coordination with (but not limited to) the following items:

1. Mechanical room sizes and building structural conditions, with required clearances.
2. Variable frequency drive/electrical starter/disconnect switch, wire and conduit sizes; electrical clearances as per NEC.
3. Ductwork and piping layouts and return air opening sizes and locations.
4. Plumbing floor drain location.

F. Units shall fit into the space available with adequate clearances meeting manufacturer’s requirements for service and as determined by the Architect. Submitted units, which do not meet these criteria, shall be rejected. The

Contractor shall not assume that all of the manufacturers listed as acceptable manufacturers will provide a unit that will fit in the space allocated for the unit(s).

1.5 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop and coordination drawings (where shop and coordination drawings are required) according to the following table.

1. "R" means required.
2. "R2" means required only for products and equipment differing for the specified manufacturer and model and for "or equals" where specified.

Item	Product Data	O&M Manual	Samples	Shop Draw-ing
Air handling units	R	R		R
Coils, performance data	R	R		R
Fans, performance data	R			
Acoustical performance data	R			
Motors	R	R		
Variable frequency drives	R	R		R
Dampers and actuators	R	R		
Filters	R			
Factory installed controls	R	R		R
Accessories	R	R		R
Coordination drawings				R

B. Additional submittal requirements.

1. List of exceptions to the specifications including section number and a detailed description of alternative materials and methods. If there are no exceptions, so state in precise language.
2. List of proposed manufacturers for fans, filters, coils, motors, drives, dampers and other components.
3. Complete graph of fan curves (not just curve for design conditions) indicating efficiency, BHP, and RPM.
4. Sound power levels per ARI 260 by octave bands; radiated and at inlet and discharge.
5. Coil performance and flow rates.
6. Filter and filter frame product data.
7. Wiring diagram.
8. Control panel location, including elevation indicating height above the ground.
9. Internal static pressure drop with filters clean and dirty.

10. Casing materials of construction and methods of assembly.
11. Construction details including panel sealing, thermal break, door seal and hardware, shipping split and field treatment of panel penetration (sleeve) details.
12. The number of shipping sections requiring field reassembly.
13. Complete dimensional data including exterior dimensions and dimensions of internal components.
14. Coordination Drawings: Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent structural and mechanical elements. Show service clearance requirements, and support locations, type of support, and weight on each support. Indicate and certify field measurements.

1.6 DELIVERY, STORAGE AND HANDLING

A. Accept products on Site in factory-fabricated protective containers or covered to protect from weather and construction debris, with factory-installed shipping skids and lifting lugs. Inspect for damage and make any necessary repairs at no expense to the Owner.

B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish. Replace damaged equipment.

C. Protect openings in casing and seal them with plastic wrap to keep out dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models are acceptable.

1. Daikin Vision.
2. Trane CSAA.
3. York/Johnson Controls Solution.
4. Or equal.

2.2 GENERAL

A. Types and performance as scheduled on Drawings.

B. Performance certified under ARI Standard 430.

C. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

D. All internal components specified shall be factory furnished and installed. Units shall be post and panel bolted modular and sectionalized construction for ease of disassembly and reassembly for maintenance, cleaning, and inspection in accordance with the most recent edition of ASHRAE Standard 62.1. At a minimum, sectionalized modules shall consist of fan, coils, access and filter sections. All internal components specified shall be factory furnished and installed as applicable.

E. Provide all necessary and required tags and decals to aid in the service or indicate caution areas.

F. Ship unit in one piece whenever possible. If shipping splits are required for installation, the unit must be assembled, with all required gasketing. If assembled on-site, unit shall comply with casing leakage requirements herein.

G. Provide complete unit with segments as indicated on Drawings and in this Specification or as required for unit operation in accordance with performance requirements specified herein. Refer to filter Specification Section for filter requirements.

H. All outdoor openings shall have a 1/2 inch mesh bird-screen provided on louvers.

2.3 FANS, MOTORS, AND DRIVES

A. Comply with Section– HVAC Power Ventilators and Section– Motors and Controllers.

B. Mounted on common shaft.

C. Type.

1. Provide fan sections with, airfoil (AF), backward inclined (BI), or single-width single-inlet (SWSI) plenum (PF) fans, minimum class II, as scheduled on Construction Drawings, or:
2. Direct plenum fans provided with factory mounted VFD’s.
3. Any type that has no greater sound power levels and fan power than fan selected on Drawings. All sound pressure level measurements and calculations shall be in accordance with AHRI 260. Test and calculation procedures based on sound intensity measurements may be substituted for the above procedures, if directed in advance by the Professional.

D. Higher RPM AF and BI fan casings shall come equipped with additional heavy duty rectangular angle framework for increased strength and stability.

E. Fan and unit performance shall be rated and certified in accordance with AHRI 430, AMCA300 and AHRI 260 as specified elsewhere herein.

F. Fan wheels shall be constructed aluminum or steel, keyed to the fan shaft, and shall be statically and dynamically balanced at the factory as a complete fan assembly regardless of duty. Dynamic fan balancing shall be conducted from 16Hz to 105Hz to identify and eliminate critical speeds to ensure stable operation through the entire operating range of the fan and drive assembly.

G. Forward factory balancing test report upon request of Architect.

H. Mount motor drive and fan on integral framework, internally isolated from the casing with factory installed 1-inch deflection spring vibration isolators on units with 8 square feet of coil area or less, and 2-inch deflection on units with coils greater than 8 square feet in area. The fan, and base assembly shall be factory point load tested and balanced on corner isolators selected accordingly for increased stability and to minimize fan assembly noise and vibration.

I. Provide internal flexible connection on the fan inlet cone to isolate the fan vibration from casing. Additionally, provide spring loaded fan-shroud-to-casing thrust restraints for plug fans, and on all units with coil face areas greater than 30 square feet.

J. Each plenum fan shall be provided with a backdraft damper to isolate the inlet side of the fan/motor that has failed, on standby, or is being removed from the fan array. The function shall prevent air bypass through a fan cube when not in operation. The backdraft damper shall be constructed of extruded aluminum frame and blades with low friction bearings for long life, continuous operation.

K. Discharge arrangement: As indicated on the Drawings.

L. Motors and Drives.

1. Fan motor shall be premium efficiency and compatible for inverter duty and meet the endurance and bearing performance requirements for the standard nominal horsepower rating per Section Motors and Controllers.
2. Fan motors shall have permanently sealed non-greasable bearings.
3. Units with scheduled plenum fans and variable frequency drives shall be direct drive.
4. Variable Frequency Drives (VFD).

    a. Refer to Section Motors and Controllers.
    b. Where indicated on the Construction Drawings, furnish as a part of the unit assembly by the AHU manufacturer, with drive matched to motor without noise or vibration over the entire operating range.

2.4 UNIT CONSTRUCTION

A. Base Rail.

1. Minimum 6-inch height.
2. Minimum 12 gauge, continuous full-length galvanized structural steel unit perimeter base frame rail to form a unitized assembly.
3. Base rail height shall be sufficient to allow proper condensate trapping. Lowest coil condensate drain connection shall not be less than a minimum of 6 inches from the bottom of the rail.

B. Double wall, 2-inch thick with solid galvanized steel exterior and interior panels.

1. The construction of the air handling unit shall consist of a complete structural frame with removable panels. Casing shall be supported in such a manner so that maximum allowable air leakage shall not exceed 1% and panel deflection shall not exceed a L/240 ratio when subjected to ±8-in. w.g. static pressure. This maximum leakage shall include the access doors. All panels shall be completely gasketed prior to shipment and shall be completely removable for unit access and removal of components. Removal of any or all panels shall not affect the structural integrity of the unit.
2. Outer liner: Minimum 22-gauge galvanized sheet metal.
3. Inner liner shall be 22-gauge solid galvanized steel except as follows:

    a. Provide solid 304 stainless steel liner at humidifier, 1 foot upstream, 3 feet downstream.
    b. Provide 22 gauge perforated steel liner in any section of the unit (except at cooling coil) where required to meet acoustical criteria, and at a minimum in all sections exposed to the fan.

4. Floor panels: Double wall construction, designed to provide at most L/240 deflection based on 300 lb. concentrated load at mid-span. The interior liner of the floor panels shall be a solid lining of minimum 22-gauge galvanized steel.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Insulation.

1. Minimum 2-inches thick. R-13 minimum
2. Minimum 1.5 pound density.
3. Casing panels (roof, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A.

E. Provide coil removal panel on access side of AHU to facilitate ease of coil removal

F. Standard factory finish.

1. Indoor units galvanized.

2.5 ACCCESS DOORS

A. Hinged access doors with quick opening handles.

B. Gasketed air tight when closed.

C. Provide minimum 18 inch access doors on fan, access and filter sections of the unit and additional locations where specified on the Drawings. Comply with door sizes shown on AHU detail. If size is not shown on detail, size is to be confirmed with the Professional during submittal process. Maximum door size to be provided.

D. Sections with dual thermal pane windows, minimum window dimensions 8 inches by 8 inches. Provide with LED lights in each section with a window.

1. Economizer section (when return/relief fan is present)
2. Fan sections.
3. All access sections.

E. Sections without window.

1. Both upstream and downstream of cooling coils.
2. Upstream of filter section.

F. All doors shall be a 60-inch high when sufficient unit height is available, or the maximum height allowed by the unit height.

G. Multiple door handles shall be provided for each latching point of the door necessary to maintain the specified air leakage integrity of the unit.

H. All access doors shall open against air pressure, unless approved by the Architect in writing.

I. Provide factory re-sealable test ports in each access door.

2.6 DRAIN PANS

A. Provide drain pans extending under complete cooling coil section and extending 24 inches minimum downstream of cooling coil. Provide intermediate drain pans that extend minimum of 6 inches from the coil face with downspouts to bottom drain pan for cooling coil banks more than one coil high. Intermediate drain pans shall be stainless steel to match the main drain pan.

B. 304 Stainless steel: minimum 16-gauge; in accordance with ASHRAE 62.1.

C. Corners soldered, welded or brazed.

D. Pitched to drain flange to fully drain; double broken, double sloped to ensure no standing water.

E. Drain flange.

1. Minimum per code.
2. Stainless steel or brass.
3. Welded or soldered into bottom of pan.

F. Accessible for cleaning.

G. Insulation: The drain pan insulation shall be closed cell foam injected water impervious rigid type, minimum R-value of 14, and shall occupy all voids and areas between the drain pan and outer wall to prevent the occurrence of trapped water, condensation, and microbial growth. Fiberglass drain pan insulation is not acceptable. Intermediate drain pans need not be insulated.

H. Separate field constructed drip pan shall be installed under the entire equipment base.

2.7 FILTER SECTION

A. Holding Frames: Holding frames shall be factory fabricated of 16-gauge galvanized steel and shall be equipped with gaskets and 2 heavy duty positive sealing fasteners. Each fastener shall be capable of withstanding 25 pounds pressure without deflection and be attached or removed without the use of tools.

B. Filter type, MERV rating, and arrangement shall be provided as defined in Section Air Cleaning Devices.

C. Filters shall be lifted out where access is available upstream of the filter, or side slide out when front access is not available.

D. Filter gauges: See Section Air Cleaning Devices. Magnahelic differential pressure gauges shall be installed and mounted on drive side of unit to measure the pressure drop across the filter sections as indicated on the Construction Drawings.

E. Performance: Select fan for mean pressure drop (midway from clean to maximum).

F. Manufacturer shall provide one set of startup filters. Spare filters provided by Contractor

2.8 VIBRATION ISOLATION

A. Internally isolated.

B. Spring, 2 inch static deflection.

C. Comply with Section Mechanical Sound and Vibration Control.

2.9 HOT AND CHILLED WATER COILS

A. Extended surface type coils.

1. Copper tubes.

a. Brazed or welded joints.
b. Minimum thickness: 0.020 inches.
c. Outside diameter: 1/2 inch or 5/8 inch.

2. Plate fins of aluminum, unless otherwise indicated on Drawings.

a. Minimum thickness: 0.0075 inches.

B. Rows and fin spacing.

1. To meet performance scheduled at similar pressure drop.
2. Selected with tube fouling factor of 0.0001.
3. Maximum fins: 10 per inch.
4. Select to avoid moisture carryover.

C. Circuiting: full row.

D. Headers: Copper tubing or cast iron.

E. Certified by ARI per current Standard 410.

F. For field installed coils, coil frame designed for bolting to other sections or ductwork.

G. Coil Casing.

1. Minimum 16-gauge.
2. 304 stainless steel casing and tube sheet.
3. Intermediate supports of same materials as casing.

H. Design for 200 pounds per square inch, 250 degrees Fahrenheit unless otherwise indicated on Drawings.

I. Factory tested to.

1. 300 psi for water coils.

J. Factory cleaned, degreased and flushed. Piping connections shall be capped with removable caps.

2.10 TESTING AND BALANCING PORTS

A. Provide a permanent factory-installed sealable port on each section of unit to allow for testing and balancing of system, except where port would be blocked by filters or coils.

2.11 AUXILIARY CONTAINMENT PAN (UNDERNEATH AHU)

A. Provide fully welded galvanized leak containment pan underneath AHU. Containment pan shall be sized to such that it extends 6 inches beyond the AHU on all sides with 6 inch high sides (completely around perimeter). Containment pan shall be sealed with waterproof protective coating.

2.12 ELECTRICAL PROVISIONS

A. Each motor shall be wired to a factory installed external junction box for electrical service connection.

B. Provide water-proof, LED light fixtures in each section of the air handling unit. Each light fixture shall output a minimum of 3,000 lumens at a 4,000 K color temperature. Light fixtures in each air handling unit section shall be switched. Wire lights to external 120V, 20A power connections (one for each service) for connection by Division 26.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with work of other trades.

B. Units shall ship with all openings securely covered and watertight. Protection shall be retained until completion of construction or until opening is field connected to ductwork.

C. Verify that adequate clearance between air handling units and adjacent walls or equipment is available to permit maintenance and repairs.

D. Provide auxiliary drain pans where required, see Section “Air Duct Accessories.”

E. Provide accurate alignment between unit and connected ducts.

F. Install air handling units in accordance with manufacturer's written installation instructions.

G. Outdoor units shall be fully waterproof.

H. Mount units sufficiently high to allow for proper condensate trapping and drainage.

I. Piping.

1. See Section "Hydronic Piping."
2. See Section "Refrigerant Piping."
3. See piping diagrams.
4. Do not block access doors with piping. Access doors shall be capable of opening 90 degrees.
5. Pipe condensate to nearest appropriate drain.

J. See Section "Energy Management and Control System."

K. The Contractor shall be responsible to coordinate all installation requirements with other trades to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or welded joints, and all other installation and assembly requirements.

L. The AHU manufacturer shall provide all screws and gaskets for joining of sections in the field.

M. The Contractor shall verify that the following items have been completed prior to scheduling the AHU manufacturer's final inspection and start up:

1. All spring-isolated components have had their shipping restraints removed and the components have been leveled.
2. On all field-joined units, that all interconnections have been completed, i.e., electrical and control wiring, piping, casing joints, bolting, welding, etc.
3. All water piping connections have been completed and hydrostatically tested and all water flow rates have been set in accordance with the capacities scheduled on the Drawings.
4. All ductwork connections have been completed and all ductwork has been pressure tested for its intended service.
5. All power wiring, including motor starters and disconnects, serving the unit has been completed.
6. All automatic temperature and safety controls have been completed.
7. All dampers are fully operational.
8. All shipping materials have been removed.

9. All (clean) filter media has been installed in the units.

3.2 INSPECTION

A. Verify that adequate clearance between air handling units and adjacent walls or equipment is available to permit maintenance and repairs.

3.3 PRE-OPERATING CHECKS

A. Before operating air handling units:

1. Complete provided Pre-Functional Test Data Sheet for each unit.

3.4 CLEANING

A. Clean modular air-handling units externally and internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

B. After completing system installation and testing, adjusting, and balancing modular air-handling and air-distribution systems, clean filter housings and install new filters.

3.5 TESTING AND ADJUSTING

A. Do not operate fans for any purpose, temporary or permanent until:

1. See Section Basic Mechanical Materials and Methods.
2. Ductwork is clean.
3. Filters are in place.
4. Bearings are in place.
5. Bearings are lubricated.
6. Fan(s) has been run under observation.

B. Start and test fans in accordance with manufacturer's written installation instructions.

C. Test cooling coil drain pans. See Section Duct Accessories.

D. Start-up and adjust completed air handling units to insure proper operation.

E. See Section Testing, Adjusting, and Balancing.

F. After starting fans: Check for objectionable noise and/or vibration. Correct as needed at no additional cost to the Owner.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

B. See Section Mechanical General Provisions.

END OF SECTION

SECTION 15.810 METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work included in this section: materials, equipment, fabrication, installation, and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Ductwork.
2. Plenums.
3. Boiler flues and breechings.
4. Fasteners, sealants, and gaskets.
5. Hangers and supports.
6. Duct air leakage tests.

1.3 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ASHRAE - Handbook of Fundamentals; Duct Design.
2. ASHRAE - Handbook of HVAC Systems and Equipment; Duct Construction.
3. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
4. ASTM E 96 - Standard Test Methods for Water Vapor Transmission of Materials.
5. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

6. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
7. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.
8. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate.
9. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
10. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
11. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.
12. NFPA 45 – Laboratory Ventilating Systems and Hood Requirements.
13. SMACNA – HVAC Duct Construction Standards.
14. SMACNA – Rectangular Industrial Duct Construction Standards.
15. SMACNA – Round Industrial Duct Construction Standards.
16. SMACNA – HVAC Air Duct Leakage Test Manual.
17. UL 181 - Factory-Made Air Ducts and Connectors.
18. Engineering Design Manual for Air Handling Systems, United McGill Corporation (UMC).
19. Assembly and Installation of Spiral Ducts and Fittings, UMC.
20. Engineering Report No. 132 (Spacing of Duct Hangers), UMC.
21. AWSD1.1 American Welding Society Structural Welding Code.

1.4 DEFINITIONS

A. Seam: locks or weld applied longitudinally to close section of duct, for example longitudinal seam, spiral seam.

B. Joint: abutting connection between duct sections for continuity of air passage, for example cross joint, transverse joint, coupling.

C. Reinforcement: hardware applied to strengthen duct, for example girth angles, tie rods, fasteners (not connectors), and the like.

D. Stiffening: folding, bending, beading, cross breaking or corrugating of sheets to achieve strength through shape, for example pocket lock secures joint and is transverse stiffener, with girth angle and fasteners applied (not connectors), joint or stiffener is reinforced.

E. Duct Classification:

1. Pressure classification: except as indicated on the Drawings:

a. Low Pressure: Ductwork systems up to 2-inch w.g. positive or negative static pressure with velocities less than or equal to 1500 fpm.
b. Medium Pressure: Ductwork systems over 2-inch w.g. and up to 6-inch w.g. positive or negative static pressure with velocities less than or equal to 2500 fpm.

c. High Pressure: Ductwork systems over 6-inch w.g. and up to 10-inch w.g. positive or negative static pressure with velocities greater than 2500 fpm.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements.

1. Entire ductwork system, including materials and installation, installed in accordance with NFPA 90A.
2. Ductwork and components shall be listed as U.L. 181, 181A and 181B, Class I air duct, flame rating not to exceed 25 and smoke rating not to exceed 50.
3. Flues shall conform to the requirements of NFPA-211. Products shall be listed to UL-103 and shall carry the appropriate UL listing mark or label.

1.6 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop and coordination drawings according to the following table.

1. "R" means required.
2. "R2" means required only for products and equipment differing for the specified manufacturer and model and for "or equals" where specified.

B. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

Item	Product Data	O&M Manual	Samples	Shop Draw-ing
Ductwork materials and fittings	R			R
Duct fasteners, sealants, and gaskets	R			
Flexible duct	R			R
Flue	R			R
Duct pressure testing reports		R		

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Spiral oval and round ducts:

1. United Sheet Metal Division, United McGill.
2. Semco Manufacturing, Inc.
3. Eastern Sheetmetal.
4. Lindab, Inc.
5. Or equal.

C. Duct Connection Systems:

1. Ductmate Industries, Inc.
2. Fabriduct Transverse Duct Connection system.
3. Ward Industries, Inc.
4. Or equal.

D. Flexible Connections:

1. Ventfabrics.
2. Duro Dyne.
3. Or equal.

E. Flexible Ducts:

1. Thermaflex.
2. Hart & Cooley.
3. Flexmaster.
4. Or equal.

F. Duct Sealants:

1. Foster Products Corporation.
2. Hardcast Corporation.
3. 3M.
4. Or equal.

G. Flexible Duct Clamps:

1. Panduit.
2. Dura-Dyne.

3. Young Regulator Company.
4. Or equal.

H. Hi-efficiency & conical Tap Fittings:

1. Flexmaster.
2. Crown.
3. Die Stamp.
4. Or equal.

I. Flues:

1. Metal-Fab, Inc.
2. American Metal Products Amerivent.
3. Selkirk Metalbesots.
4. Centrotherm.
5. Selkirk PolyFlue
6. Or equal.

2.2 MATERIALS

A. General Material Requirements.

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. (Minimum duct thickness shall be 24 gauge). Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
2. All duct sizes shown on the Drawings are clear inside dimensions. Allowance shall be made for internal lining, where specified, to provide the required free area.
3. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched) and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for future connections/phases, otherwise plastic covers are acceptable.

B. Galvanized Steel Sheet Metal:

1. Prime, cold rolled soft galvanized steel sheets.
2. Each sheet shall be stenciled with manufacturer's name and gauge.
3. ASTM A653 and A924.
4. Galvanizing: 1-1/4 ounces per square foot, total both sides.

    a. General: G-90.
    b. Exposed to weather: G-90.
    c. Plenum walls and blank-offs where in contact with cooling coil: G-90.

5. Lock-forming quality.
6. Where ductwork is shown to be painted, same is to provide with "paint grip" factory finish on exposed to view applications in finished spaces such as classrooms, offices, meeting rooms, etc.

C. Miscellaneous Products.

1. Screws and rivets:

a. Same material as sheet, except as indicated on the Drawings.
b. On aluminum sheets, provide cadmium plated or stainless steel.
c. Zinc or cadmium plated, permitted on galvanized sheets.
d. Minimum screw size: No. 10.
e. Minimum rivet size: 4 pound.

2. Duct Sealants:

a. Sealing compound: UL-181 listed, water based:

1) Foster Safetee Duct Sealant 32-19.
2) Childers CP-146.
3) Hardcast Products Group Flex-Grip 550.
4) Or equal.

b. Rolled Elastomeric Duct Sealant: Hardcast Products Group Foil Grip 1403-181BFX, or equal, UL 181 listed.
c. Gaskets:

1) Continuous, reinforced, inert self-conforming type.
2) 1/8 inch thick.
3) Width: to match angle connection.
4) 3M Weatherban Ribbon Sealant PF5422 or equal.

d. Two-Part Hard-Setting Joint Tape:

1) Two-part process includes tape and hard setting sealant.
2) Mineral impregnated woven fiber tape.
3) Impregnated with activator/adhesive of polyvinyl acetate type.
4) UL Listed.
5) Flame spread: 10.
6) Smoke contributed: 0.
7) Equal to Hardcast RTA-50 sealant and DT-5400 4 inch tape.

3. Spring Fasteners:

a. Oval head stud and receptacle.
b. Screwdriver slot.
c. Self-ejecting.

d. Dzus or equal.

4. Angles, tie rod and shapes for reinforcing ducts: In accordance with SMACNA HVAC Duct Construction Standards, except as indicated on the Drawings.
5. Duct connection system:

a. Transverse bolted duct joints.
b. Flanges with permanent, non-hardening sealant.
c. Ductmate Industries Ductmate 25 and 35, Fabriduct TDC, or equal.

D. Flexible Connections:

1. Conforming to NFPA 701, UL Standard No. 214 and NFPA 90A.
2. SMACNA HVAC Duct Construction Standards, except as indicated on the Drawings.
3. With metal edges at each end: No. 24 USSG galvanized steel. Double lock joint.
4. Length of fabric connections.

a. Minimum: 4 inch.
b. Maximum: 10 inch.

5. Materials:

a. Coated glass fabric.
b. Flame spread rating: 25.
c. Smoke development rating: 50.
d. 30 ounces per square yard.
e. Sewed and cemented seams.
f. Indoors:

1) Neoprene.
2) Ventfabrics, Inc. Ventglas or equal.

E. Turning Vanes:

1. Galvanized steel ductwork: galvanized steel or painted black steel, except as indicated on the Drawings.
2. Other ductwork: same material as ductwork.
3. Construction per SMACNA HVAC Duct Construction Standards for:

a. Double wall vanes.
b. Vane length: Provide separate equal size sections for vane length greater than those indicated in referenced Standards.
c. Vane runners: Type 1 or 2 acceptable.

4. Vane radius:

a. 2 inch radius: duct width up to 36 inches.
b. 4-1/2 inch radius: duct with 36 inches or larger.

5. Vane shall be at the correct angle for airflow (leading edge in line with the entering duct section; leaving edge in line with existing duct section). If only 45° angles are available, turning vanes shall only be used in 90° elbows where the entering width equals the exiting width; all other elbows shall be full radius type unless otherwise indicated on the drawings.

F. Conical Taps: Low-pressure round take-off fittings in rectangular duct:

1. Heavy 26-gauge G-90 Galvanized Steel Body
2. (1") 26-gauge G-90 Galvanized Steel Flange
3. Double Sided Adhesive Gasket on Flange
4. Extra Heavy 24-gauge G-90 Galvanized Steel Blade
5. 3/8" Square Axle Secured to Blade with U-bolts (2 U-bolts used for 8" diameter and larger)
6. Nylon bushings on thru and end (all sizes)
7. 2" Stool with Locking Quadrant and Handle (all sizes, wing nuts not acceptable)
8. Sealed on all Seams
9. BO3 (2") Build-out, 3/8" Square Shaft (solid rod), U-bolt, Locking Quadrant, Handle
10. Flexmaster CBD-SOG-BO3 UT 3000G, Crown 3210-DS2 or equal.

2.3 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS (LOW PRESSURE)

A. Duct Classification: Ducts shall be considered low pressure when design velocities are 1500 fpm or less and maximum static pressure is 2-inch W.G., positive or negative.

B. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction with galvanized sheet metal, according to SMACNA's "HVAC Duct Construction Standards – Metal and Flexible." Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
2. Materials: free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

C. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inches thick or less, with more than 10 square feet of unbraced panel area, unless ducts are lined.

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

G. Bullhead tees are not permitted.

2.4 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS (LOW PRESSURE)

A. Duct Classification: Ducts shall be considered low pressure when design velocities are 1500 fpm or less and maximum static pressure is 2-inch W.G., positive or negative.

B. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

D. Factory-fabricated spiral lock seam duct:

1. Snap-lock is not acceptable.
2. Factory-fabricated longitudinal seam acceptable for ducts larger than standard factory sizes.
3. Round Duct Flanges: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to

connection system manufacturer's tolerances. All flanges to be factory mounted.

4. Flat Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.

E. Fittings:

1. Same material, gauge thickness and construction as duct in which installed.

2. Full body fittings are acceptable.

3. Elbows:

a. Seams:

1) 4 inch and higher pressure, class and all ducts exposed to occupant view: continuously welded seams.
2) 1 inch to 3 inch pressure: spot welded with bonded (sealed) seams.

b. Gores:

1) 2 gores - less than or equal to 30 degrees.
2) 3 gores - 31 degrees through 45 degrees.
3) 4 gores – 46 degrees through 60 degrees.
4) 5 gores - over 61 degrees

Type	Pressure	Location	Fittings	Traverse Joints	Branches	Couplings
Round	< 2”	Concealed	Factory Fabricated	Conical/ 45° Entry	Loose Saddle Tap Field Installed	Slip ≤ 20” Flanges > 20”
	< 2”	Exposed	Factory Fabricated	Conical/ 45° Entry	Factory Installed	Slip ≤ 20” Flanges > 20”
Oval	< 2”	Concealed	Factory Fabricated	Conical/ 45° Entry	Factory Installed	Slip ≤ 20” Flanges > 20”
	< 2”	Exposed	Factory Fabricated	Conical/ 45° Entry	Factory Installed	Slip ≤ 20” Flanges > 20”

2.5 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS (MEDIUM PRESSURE)

A. Duct Classification: Ducts shall be considered medium pressure when design velocities are 1800 fpm or greater and/or a static pressure over 2-inch W.G., positive or negative.

B. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

D. Factory-fabricated spiral lock seam duct:

1. Snap-lock is not acceptable.
2. Factory-fabricated longitudinal seam acceptable for ducts larger than standard factory sizes.
3. Round Duct Flanges: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances. All flanges to be factory mounted.
4. Flat Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.

E. Fittings:

1. Same material, gauge thickness and construction as duct in which installed.

2. Full body fittings are acceptable.

3. Elbows:

a. Seams:

1) 4 inch and higher pressure, class and all ducts exposed to occupant view: continuously welded seams.
2) 1 inch to 3 inch pressure: spot welded with bonded (sealed) seams.

b. Gores:

1) 2 gores - less than or equal to 30 degrees.
2) 3 gores - 31 degrees through 45 degrees.
3) 4 gores – 46 degrees through 60 degrees.

4) 5 gores - over 61 degrees

Type	Pressure	Location	Fittings	Traverse Joints	Branches	Couplings
Round	> 2”	Concealed	Factory Fabricated	Conical/ 45° Entry	Loose ≤ 20” Factory Inst. > 20”	Slip ≤ 20” Flanges > 20”
	> 2”	Exposed	Factory Fabricated	Conical/ 45° Entry	Factory Installed	Slip ≤ 20” Flanges > 20”
Oval	> 2”	Concealed	Factory Fabricated	Conical/ 45° Entry	Factory Installed	Slip ≤ 20” Flanges > 20”
	> 2”	Exposed	Factory Fabricated	Conical/ 45° Entry	Factory Installed	Slip ≤ 20” Flanges > 20”

2.6 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

B. Round, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Ducts to have a perforated inner liner and an outer pressure cell.

C. Interstitial Insulation: Mat faced fiberglass insulation, complying with ASTM C1037, NFPA 90A and NFPA 90B. Insulation to be 1” insulation (1-1/2 pounds per cubic foot density).

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

D. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

E. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.

F. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

G. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

H. Full body fittings are acceptable.

I. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
4. Flat Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seal flat oval duct.
5. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
6. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
7. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
8. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
9. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.

Type	Pressure	Location	Fittings	Traverse Joints	Branches	Couplings
Round	All	Concealed	Factory Fabricated	Conical/ 45° Entry	Factory Installed	Slip ≤ 20” Flanges > 20”
	All	Exposed	Factory Fabricated	Conical/ 45° Entry	Factory Installed	Slip ≤ 20” Flanges > 20”
Oval	All	Concealed	Factory Fabricated	Conical/ 45° Entry	Factory Installed	Factory Inst. Flanges

Type	Pressure	Location	Fittings	Traverse Joints	Branches	Couplings
	All	Exposed	Factory Fabricated	Conical/ 45° Entry	Factory Installed	Factory Inst. Flanges

2.7 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS (LOW PRESSURE)

A. Duct Classification: Ducts shall be considered low pressure when design velocities are 1500 fpm or less and maximum static pressure is 2-inch W.G., positive or negative.

B. Outer Duct: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction with galvanized sheet metal, according to SMACNA's "HVAC Duct Construction Standards – Metal and Flexible." Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
2. Materials: free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

C. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.

D. Interstitial Insulation: Mat faced fiberglass insulation, complying with ASTM C1037, NFPA 90A and NFPA 90B. Insulation to be 1" insulation (1-1/2 pounds per cubic foot density).

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

E. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable

sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

G. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

H. Bullhead tees are not permitted.

2.8 FLEXIBLE DUCTS

A. General Requirements:

1. Flexible ducts shall be used for supply air ducts only (not acceptable for return, exhaust, relief, outdoor, etc. air ducts).
2. UL 181, Class I Air Duct.
3. Labeled for compliance with IMC.
4. Class 1 Air Duct, NFPA 90A and 90B, BOCA, SBBC, HUD/FHA, MIN Property Std.
5. Maximum flex duct length 5’-0” (five feet), installed with no more than 90 degrees of bend to diffusers and grilles. Where longer duct runs or more bends are necessary, provide rigid round ductwork.

B. Type 1 Acoustical Insulated

1. Minimum working pressure:

   a. 10” w.g. positive
   b. 5” w.g. negative, 16” diameter
   c. 1” w.g. negative, 18” & 20” diameter

2. Rated Velocity

   a. 5,550 fpm

3. Acoustic Performance:

   a. Minimum insertion loss (dB) for 6’ of 8” diameter flexible duct for flow velocities less than 2,500 fpm.
   b. Acoustical testing to be performed in accordance with ASTM E477 and ADC Test Code FD 72-RI by ETL

	Sound Power Levels, dB re. 10^{-12} Watts, at Octave Band Center Frequency, Hz					
	125	*250*	*500*	*1000*	*2000*	*4000*
Insertion Loss	*5*	*16*	*17*	*18*	*16*	*11*

4. Duct Fabric:

    a. Polyethylene fabric. Fabric to be mechanically locked to the duct helix without the use of adhesives

5. Duct Helix

    a. Corrosive resistant galvanized steel. Helix is to be mechanically formed to attach the duct fabric without the use of adhesives.

6. Vapor Barrier

    a. Fire retardant, reinforced aluminum.
    b. (.05) perm A.S.T.M. E96, Procedure A

7. Insulation

    a. Factory insulation jacket, factory wrapped. R8 minimum.

8. Flexmaster Type 1M or equal.

C. Type 6 Acoustical Insulated (in locations as indicated on schedules/plans)

1. Minimum working pressure:

    a. 6” w.g. positive
    b. 5” w.g. negative, 16” diameter
    c. 1” w.g. negative, 18” & 20” diameter

2. Rated Velocity

    a. 5,550 fpm

3. Acoustic Performance:

    a. Minimum insertion loss (dB) for 6’ of 8” diameter flexible duct for flow velocities less than 2,500 fpm.
    b. Acoustical testing to be performed in accordance with ASTM E477 and ADC Test Code FD 72-RI by ETL

	Sound Power Levels, dB re. 10^{-12} Watts, at Octave Band Center Frequency, Hz

	63	*125*	*250*	*500*	*1000*	*2000*	*4000*
Insertion Loss	*5.7*	*14*	*13*	*15*	*16*	*18*	*16*

4. Duct Fabric:

    a. Spunbond Nylon fabric. Fabric to be mechanically locked to the duct helix without the use of adhesives

5. Duct Helix

    a. Corrosive resistant galvanized steel. Helix is to be mechanically formed to attach the duct fabric without the use of adhesives.

6. Vapor Barrier

    a. Fire retardant, reinforced aluminum.
    b. (.05) perm A.S.T.M. E96, Procedure A

7. Insulation

    a. Factory insulation jacket, factory wrapped. R8 minimum.

8. Flexmaster Type 6M or equal.

2.9 FLUES

A. Category I appliances:

1. Type B, double wall, factory-built, UL 441 listed for Category I appliances burning natural gas for flue gases less than 550 degrees Fahrenheit.
2. The vent shall have an inner gas carrying pipe of aluminum alloy or stainless steel. The outer jacket shall be G-90 galvanized or aluminum coated steel. The space between the inner and outer pipe, the thickness of materials, and construction of the modular sections and accessories shall be as specified by the terms of the product's UL Listing.
3. The stack system shall be from one manufacturer and shall be complete with caps, supports, and bracing.
4. Where exposed to weather, the outer closure band shall be sealed to prevent rainwater from entering the space between inner and outer walls.
5. Metal-Fab Model M, Selkirk Metalbestos RV, or equal.

B. Category III appliances:

1. Positive pressure, double wall, factory-built, UL 01738 listed for Category III appliances burning natural gas.
2. The vent shall have an inner gas carrying pipe of Type 304 stainless steel. The outer jacket shall be aluminum coated steel. The space between the

inner and outer pipe, the thickness of materials, and construction of the modular sections and accessories shall be as specified by the terms of the product's UL Listing.

3. The stack system shall be from one manufacturer and shall be complete with caps, supports, and bracing.
4. Where exposed to weather, the outer closure band shall be sealed to prevent rainwater from entering the space between inner and outer walls.
5. Metal-Fab Model PIC, Selkirk Metalbestos PS, or equal.

C. Category IV appliances:

1. Single Wall Positive Pressure

    a. The vent shall be of the single wall, factory-built type, designed for use in conjunction with Category IV condensing gas fired appliances.
    b. UL1738 and/or ULC S636
    c. Maximum continuous flue gas temperature shall not exceed 230 degrees F.
    d. Vent shall be listed for a maximum positive pressure rating of 20" w.c.
    e. The vent system shall be continuous from the appliance's flue outlet to the vent termination outside the building. All systems components shall be UL/cUL listed and supplied by the same manufacturer.
    f. All systems components such as vent supports, roof or wall penetrations, terminations, appliance connectors and drain fittings required to install the vent system shall be UL/cUL listed and provided by the vent manufacturer.
    g. All systems components shall include a factory- installed gasket in their female-end to render the vent air and water tight when the male/female ends are pushed together as per manufacturer's instructions. Vent systems requiring field installed sealants or compounds shall not be acceptable.
    h. Vent layout shall be designed and installed in compliance with manufacturer's installation instructions and all applicable local codes.
    i. Manufacturer warranty of 10 years.
    j. Centrotherm InnoFlue, Selkirk PolyFlue

2. Double Wall Positive Pressure

    a. Positive pressure, double wall, factory-built, UL 1738 listed for Category IV appliances burning natural gas.
    b. The vent shall have an inner gas carrying pipe of AL-29-4C superferritic stainless steel. The outer jacket shall be 430 stainless steel. The space between the inner and outer pipe, the thickness of materials, and construction of the modular sections and accessories shall be as specified by the terms of the product's UL Listing.
    c. The stack system shall be from one manufacturer and shall be complete with caps, supports, and bracing.

d. Where exposed to weather, the outer closure band shall be sealed to prevent rainwater from entering the space between inner and outer walls.
e. Metal-Fab Model CG, Selkirt Saf-T Vent CI Plus, or equal.

2.10 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.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

I. Round Duct Supports:

1. Minimum 2" wide 20 gauge galvanized metal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with work of other trades.

B. Ductwork Installation – General:

1. Install ducts in accordance with manufacturer's written installation instructions.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
3. Construct with gages, joints, bracing, reinforcing, and other details per latest IMC, ASHRAE, SMACNA and NFPA, unless specified otherwise.

    a. Comply with most stringent.
    b. Provide ducts with IMC gages or thicker when traversing rated corridors.
    c. Combustion air ducts: Minimum 24 gage.

4. Construct of galvanized sheet metal, except where otherwise indicated herein or on Drawings.
5. Provide for duct rigidity by either of these methods:

    a. Beading at 12 inches on center, maximum.
    b. Cross-break outward in ducts having positive internal pressure.
    c. Cross-break inward in ducts having negative internal pressure.

        1) Exception: All ducts exposed to rain shall outward cross-break on top of the duct.

6. Duct dimensions indicated are outside duct dimensions (OD) unless indicated on the Drawings as inside dimension (ID or net, clear dimension).
7. Alter duct sizes on basis of equal friction where required to facilitate installation. Reflect changes in shop drawings for review by Architect.
8. At duct penetrations of walls, floors and ceilings where exposed to occupant view, provide sheet metal angle type escutcheons with no sharp corners or edges.

    a. Clearance from duct to opening shall not exceed 2 inches.
    b. Escutcheons shall overlap wall, floor, or ceiling surface by ½ inch minimum.

9. Frame, trim, caulk and seal all duct penetrations through acoustical walls and partitions.
10. Tapers:

    a. Pitch sides of duct in diverging or converging airflow maximum of 1 to 4 taper.
    b. Abrupt, bushing type fitting not allowed.

11. Duct Openings:

    a. Provide openings where required to accommodate thermometers, smoke detectors, controllers, and the like. Insert through airtight rubber grommets.
    b. Where openings are provided in insulated ductwork for insertion of instruments, install insulation material inside metal ring for use as plug.
    c. At fire dampers allow adequate length of duct to install access door.

12. Avoid penetration of ducts; provide airtight seal at unavoidable penetrations of hanger rods.
13. No exposed sharp metal allowed.

    a. All exposed pins, screws and sharp objects shall be covered with hardening silicon.
    b. All exposed sheet metal edges shall be hemmed with exposed corners rounded smooth.
    c. Remove all sheet metal fish hooks.

14. Install lining in ducts and plenums as specified in Section 230713 – Duct Insulation.
15. Flexible Connections:

    a. Coated glass fabric.
    b. For indoor or outdoor use.
    c. Use diaphragm type at plug fan inlets.
    d. Install at connections to fans and air handling units and as indicated on Drawings.
    e. 2 inch slack in fabric; install to allow minimum movement of 1 inch in both tension and compression.
    f. Protect from direct solar and rain exposure with sheet metal shroud where outdoors.

16. Volume dampers: Install dampers as specified in Section 233300 – Duct Accessories.
17. All sheet metal ductwork in exposed to view applications, in finish spaces, shall include factory "paint grip" finish, where shown to be painted.

C. Elbows and Splits:

1. Use radius elbows in rectangular ducts unless otherwise indicated on the Drawings: Centerline radius dimension shall not be less than 1-1/2 duct width.
2. Where space does not permit duct radius specified above, install short radius splitter vanes per SMACNA HVAC Duct Construction Standard.

    a. Number of vanes determined by ratio of inner radius (R) to duct width in plane of radius (W).

b. One vane: Radius to width ratio above 0.3.
c. Two vanes: Radius to width ratio between 0.1 to 0.3
d. Three vanes: Radius to width ratio 0.1 and smaller.

3. Use square turns with turning vanes in rectangular ductwork, unless otherwise indicated on the Drawings, at following locations.

a. Use only where full radius elbow cannot fit.
b. Use only in ducts with 2000 fpm or less design velocity.
c. In high and medium pressure ductwork spot weld turning vane to duct.

D. Rectangular Duct Joints:

1. Transverse Joints:

a. In medium pressure ductwork shall be Fabriduct TDC or Ductmate or equal.
b. In low pressure ductwork shall be Fabriduct TDC or equal except that ducts under 19 inches longest side may be slip & drive (S&D)

2. Longitudinal seams shall be Pittsburgh. Snap lock not allowed.

E. Plenum walls, blank-offs, and casings:

1. Construct per SMACNA HVAC Duct Construction Standard, Casings and Plenums.
2. Static pressure class:

a. Upstream of fan: -2 inches.
b. Downstream of fan: fan static pressure or greater.

3. Seal all joints, edges, and penetrations as per HVAC ducts as specified herein.

F. Round and oval ductwork:

1. Joints between ducts:

a. Made with beaded sleeve joints as scheduled.
b. Duct sealer applied to male end.
c. Mechanically fastened with sheet metal screws or pop rivets.
d. Over joint and screw or rivet heads, apply coating of duct sealer.

1) Duct where exposed to occupant view: Sealant shall be within joint only and not visible.

2. Joints, duct and fitting:

a. Slip projecting collar of fittings into duct: Per SMACNA HVAC Duct Construction Standard.
b. Apply duct sealer: Seal and tape as specified above.
c. Mechanically fasten: Fastening schedule: Per SMACNA HVAC Duct Construction Standard.

3. Branch take-offs:

a. Medium pressure: 45 degrees (fittings).
b. Low pressure: straight 90 degrees (fittings).

4. Horizontal supports:

a. One or two-piece clamp band strap.
b. Minimum: one per section.
c. Support fittings as required to prevent sagging.

5. Vertical Supports: one of the following:

a. Clamp bands with extended ends supported by floor.
b. Clamp bands with knee bracing.
c. Pedestal at base of vertical.

G. Flexible ductwork:

1. Not allowed for:

a. Return, exhaust, or outdoor air ducts.
b. Product conveying systems such as kitchen exhaust and laboratory exhaust.
c. Dryer exhaust (other than final exposed connection at dryer).
d. Medium and high pressure, ducts.

2. Continuous, single pieces:
3. Length:

a. Low pressure:

1) Maximum 5 feet, except where longer lengths are indicated on drawings. Where longer lengths are shown, the last 3 feet to 5 feet shall be wire flex duct and remaining ductwork shall be aluminum flex duct.
2) Minimum length: 3 feet.

4. End connections:

a. Connect to duct collars, terminal unit connections and round air outlets per manufacturer's instructions.

b. Secure with strap clamps specified above.

5. Installations:

a. Support adequately to avoid excessive droop.
b. Minimum inside bending radius not less than one duct diameter.
c. Install as straight as possible except as shown on drawings for sound attenuation.
d. Cut ducts to lengths required rather than create bends to take up excess lengths except as shown on drawings for sound attenuation.

H. Grille connections:

1. Provide at entry to diffuser collar either.

a. Straight duct for 1 duct diameters or greater.
b. Full radius elbow.
c. Side inlet plenum.

1) Height: 4 inches minimum taller than top of grille to provide room for uniform airflow to grille.
2) Width/length: 2 inches wider than duct or round diffuser collar, whichever is larger.
3) Internal surfaces lined with minimum 1/2 inch thick Type AL duct liner as specified under Section 230713 – Duct Insulation.
4) At contractor's option, where plenum is required at round neck diffuser, square neck diffuser with length and width equal to diffuser diameter may be substituted.

d. Thermaflex FlexFlow Elbow or equal.

2. Connections at grilles shall be insulated to the extent the duct is insulated including the final register box.
3. Seal connections at grilles per seal class of upstream ductwork.

I. Sound-rated duct packing:

1. Wherever possible avoid duct penetrations through sound-rated walls, floors and ceilings.
2. Provide packing for unavoidable duct penetrations.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Ductwork exposed to occupant view shall be run straight and true, in line with building elements. No sagging or out-of-true straight runs shall be acceptable. Sidewall taps, and duct joints shall be clean and free of visual blemishes and all sealant shall be internal to joint and not visible. Ducts shall have no external markings or tags. All duct beads shall be parallel.

C. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

D. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

E. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

F. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease and sloped a minimum of 2 percent to drain grease back to the hood.

B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings.

C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 DUCT SEALING

A. Ducts not exposed to weather: Seal using one of the following:

1. Duct sealer compound.
2. Gasketed TDC or Duct-Mate.
3. Two-Part Hard-Setting Joint Tape.
4. Flexible duct:

    a. Secure with straps or clamps as specified herein.
    b. Supplement with duct tape, both inner and outer liner.

5. Indoor duct where exposed to occupant view: Sealant shall be within joint only and not visible.
6. Fire and fire/smoke dampers: Sealant shall be listed as approved on manufacturer’s UL installation sheet.
7. Continuously welded ducts: Additional sealing not required.

B. Seal punched holes and corner cracks.

C. Seal all factory fabricated ducts, including transverse joints on gored elbows.

D. Seal end caps.

E. After installation and testing reseal joints found to be leaking at no additional cost to the Owner.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor, and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 FLUE INSTALLATION

A. Install in accordance with manufacturer's installation instructions and UL listing requirements and with local codes.

B. Category 1 Appliances: Minimum stack height shall be in accordance with GAMA Venting Tables for Category I Appliances and IMC.

C. Support from building structure using rigid structural shapes for attachment of fixed point supports. Anchor supports to structure by welding, bolting, steel expansion anchors, or concrete inserts. Size of structural shapes shall be in accordance with manufacturer's recommendations.

D. Roof penetration pieces shall be UL listed products of the chimney manufacturer. Where roof is pitched up to 45° roof penetration pieces shall be of the pitched type so that it is not necessary to provide a horizontal roof curb. If roof pitch exceeds 45°, provide a curb around roof opening.

E. All inner pipe joints shall be held together by means of formed vee bands and sealed with P077 Silicone Sealant for flue gas temperature up to 600°F, or P071 High Temperature Sealant for flue gas temperatures over 600°F.

F. Screws shall be of the hex head type with shoulder stops and tapered leading threads for easy starting. Nuts for the inner and outer bands shall be retained by means of a free-floating cage to allow easy alignment.

G. Where exposed to weather:

1. The outer closure band shall be sealed with the same sealant as the inner joint.
2. Paint with one coat of corrosion and heat resistant primer and cone coat heat resistant paint. Paint color selected by Architect.

H. Termination:

1. Roof termination: Terminate with listed wind resistant flue cap 3 feet above the highest point where it pass through a roof and at least 2 feet higher than any portion of the building within a horizontal distance of 10 feet.
2. Wall termination: Terminate with listed 45° miter cut with bird screen unless otherwise indicated on plans.

3.7 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section Air Duct Accessories.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.8 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

3.9 DUCT AIR LEAKAGE TESTING

A. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test. See the Duct Air Leakage Test Log at the end of this section.
2. Test the following systems:

    a. Supply, Return, Exhaust, and Outdoor Air Ducts: Test 100% of installed duct sections.
    b. Field installed plenums. Test 100% of all field installed plenums.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

B. General:

1. Pretesting shall be conducted prior to conducting test in presence of TAB Agency and Architect. Once all required ductwork has passed the pretest duct pressure test, the TAB Agency and Architect shall be notified to visit the site for witness testing.
2. Use portable high pressure, blower and necessary instruments to indicate amount of leakage.
3. Conduct tests as prescribed in SMACNA HVAC Air Duct Leakage Test Manual and make test before duct sections are concealed.
4. Procedure:

    a. Seal openings in ducts and plenums to be tested.
    b. Connect test apparatus to test section using flexible duct connection or hose.

c. Close damper on blower suction side, to prevent excessive buildup of pressure.
d. Start blower and gradually open damper on suction side of blower.
e. Build up pressure in test section equal to static pressure class.
f. Noise generated from duct leakage not acceptable. Seal as required.
g. Determine amount of air leakage by makeup air flow measurements:

1) Maximum permitted leakage for HVAC ductwork shall be:

$$CFM_{max} = \left(\frac{A}{100}\right) C_L P^{0.65}$$

Where,

CFM_{max} = The maximum permitted leakage, cubic feet per minute (cfm).
A= Surface area of the tested duct sections, square feet.
C_L= Duct leakage class, cfm/100 square feet at 1 inch water column.
= 6 for rectangular sheet metal, rectangular fibrous ducts, and round flexible ducts
= 3 for round/flat oval sheet metal or fibrous glass ducts
P= Test pressure which shall be equal to the design duct pressure class rating, inches water column.

2) Allowable leakage can also be calculated as 1 percent of the design operating air volume for the entire system. If this method is used, the total system leakage must first be determined and then compared with the 1 percent (of system volume flow) allowable leakage. Acceptance is indicated if the actual measured leakage of the entire system is less than the calculated allowable leakage.
3) If leakage exceeds permitted limit, repair leaks and retest duct sections at no additional cost to the Owner until permitted leakage limits are obtained.

5. Visually mark tested sections with certification sticker and initials of field test inspector.

C. Documentation:

1. Submit certification of test results of compliance to Architect (must be initialed by TAB Agency representative prior to submitting to Architect).
2. Include Duct Air Leakage Test Log indicating compliance.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and test logs.

3.10 PROTECTION

A. Adhere to SMACNA Duct Cleanliness for New Construction Guidelines for Intermediate Level Duct Cleanliness unless more stringent requirements are indicated herein.

B. Storage: Porous materials, such as lined and flexible duct, shall be stored where they will not be exposed to rain or other moisture sources.

C. Temporary closure: Provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris at the following conditions:

1. Exposed ends of unlined installed ducts at the end of each day.
2. Exposed ends of lined ducts or plenums whether in storage or installed.

D. Duct cleaning:

1. Using the connected fan(s) force air at high velocity through duct to remove accumulated dust.
2. Protect equipment and spaces, which may be harmed by excessive dirt with filters, or bypass during cleaning.
3. In areas, which must be kept dust free, seal all outlets duct tight. When closures are removed avoid spilling dust in room.

3.11 INSPECTION

A. Verify that adequate clearance between ducts and adjacent walls or equipment is available to permit proper sealing, maintenance and repairs.

3.12 PRE-OPERATING CHECKS

A. Before operating the duct systems: Set all manual dampers in full open position.

3.13 TESTING AND ADJUSTING

A. After starting the duct systems: Check for noise and leakage. Repair as required at no additional cost to the Owner.

B. See Section Testing, Adjusting, and Balancing: Coordination with Balance Agency:

1. Provide services of a sheet metal installer familiar with the system ductwork to provide assistance to the balancing agency during the initial phases of air balancing in locating all sheet metal dampers.
2. Install missing dampers.

Duct Air Leakage Test Log					
Date	System	Description of Duct Section Tested	Test Press. (in w.g.)	Results Pass/ Fail	Witness (TAB Agency) Initials

END OF SECTION

SECTION 15820 AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Duct Access Doors.
2. Manual, Automatic and Backdraft Dampers.
3. Fire Dampers.
4. Wall Louvers and Combination Louvers/Dampers.
5. Duct Accessory Hardware.
6. Equipment stands/plenums

1.3 QUALITY ASSURANCE

A. Fire, smoke, and fire/smoke dampers shall be UL listed and constructed in accordance with UL Standard 555 Fire Dampers and UL Standard 555S.

B. Demonstrate operation of smoke dampers to authorities having jurisdiction and Architect as part of life safety testing.

C. Access doors shall be UL labeled.

D. Damper pressure drop and leakage ratings shall be based on tests and procedures performed in accordance with AMCA 500 - Test Methods for Louvers, Dampers and Shutters.

1.4 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop and coordination drawings according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Access doors	R2			R
Balancing dampers	R2			R
Automatic dampers	R	R		R
Backdraft dampers	R2			R
Fire dampers	R	R		R
Smoke dampers	R	R		R
Wall louvers	R			R
Combination louvers/dampers	R	R		R
Drain pans	R2			R
Condensate pumps	R	R		
Equipment plenum/stand shop drawings	R			R

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

2.2 DUCT ACCESS DOORS

A. Manufacturers

1. Ventfabrics, Inc.
2. Duo Dyne, Corporation.
3. Ruskin Mfg. Company.
4. PCI Industries – Pottorff.
5. Ductmate.

B. In accordance with SMACNA Duct Construction Manuals, except as indicated in the Drawings.

C. Construction:

1. Galvanized steel.
2. Rating same as duct pressure class.
3. Where duct is insulated:

a. Fiberglass insulation, thickness to match duct insulation installed R-value, see– Duct Insulation.
b. Double wall.

4. Removable type with safety chain linking door permanently to frame.
5. Positive seal polyethylene gasket.
6. Paired progressive cam-locks, quantity as required for tight, low leakage fit.
7. No tools required for opening and closing.

D. Size:

1. 20 inches x 14 inches unless otherwise indicated in the Drawings.
2. Ducts less than 16 inches: one dimension 20 inches; other dimension 2 inch less than duct width.
3. Larger sizes where required for access.

E. Provide in the following locations:

1. Coils in ducts (including at VAV boxes).

    a. Entering and leaving side for cooling coils.
    b. Entering side for heating coils.

2. Automatic dampers: linkage side.
3. Smoke dampers.
4. Fire dampers.
5. Smoke detection heads.
6. At the top of each lined duct riser accessible from the fan room floor (for inspection of duct liner).
7. Fan bearings enclosed in ducts.
8. Sprinkler heads in ducts.
9. Motors, actuators, or other accessories that require access or service inside ducts.
10. Outdoor air plenums as required to clean plenum from dirt and debris.
11. Where otherwise indicated on the Drawings.

2.3 MANUAL, AUTOMATIC AND BACKDRAFT DAMPERS

A. Manufacturers:

1. Ruskin Manufacturing Company.
2. Greenheck Fan Corp.
3. PCI Industries - Pottorff
4. Johnson Controls

B. Manual Dampers:

1. Conform to requirements of SMACNA HVAC Duct Construction Standards.
2. General:

a. Blades of same material as duct where damper is located.
b. Damper Hardware:

    1) Ventlok 400 and 4000 series or equal; for low pressure systems 2 inch SMACNA pressure class and less.
    2) Ventlok HiVel hardware or equal; for greater than 2 inch SMACNA pressure class.

c. Actuating quadrants typical for single and multi-blade dampers; provide closed bearing on opposite end from quadrant to prevent air leakage: Ventlok No. 609 or equal.
d. Bearing at one end of damper rod: Ventlok No. 609 or equal.
e. Sealed bushings installed at both ends to avoid duct leakage.
f. Accessible quadrant at other end of damper rod.

    1) With lever and lock screw: Ventlok No. 635 or equal.
    2) Insulated ducts.

        a) Quadrants mounted on collar to clear insulation.
        b) Ventlok Nos. 637, 638, or 639 or equal.
        c) Selection based on insulation thickness.

g. For dampers above non-removable ceilings and without ceiling access panels provide Ventlok No. 677 or equal concealed damper regulator.

    1) With paintable cover plate.
    2) Required interconnecting hardware.

3. Round, Inline

    a. Heavy 26-gauge G-90 Galvanized Steel Body (all sizes)
    b. Extra Heavy 24-gauge G-90 Galvanized Steel Blade
    c. 3/8" Square Axle Secured to Blade with U-bolts
    d. Nylon bushings on thru and end (all sizes)
    e. 2" Stool with Locking Quadrant and Handle (all sizes, wing nuts not acceptable)
    f. Sealed on all Seams
    g. BO3 (2") Build-out, 3/8" Square Shaft (solid rod), U-bolt, Locking Quadrant, Handle
    h. Flexmaster Co. Connecting Sleeve (SL-BO3), Crown 175-XS2 or equal.

4. Rectangular

    a. Single blade dampers:

1) Galvanized steel ductwork: galvanized steel, except as indicated in the Drawings.
2) Blade: Two gages heavier than duct gage, or 18 gage, whichever is lighter.

b. Multi-blade dampers.

1) Low Pressure/Low Velocity Systems (2-inch water column or less static pressure class and 1500 fpm or less face velocity).

a) Opposed blade damper.
b) Ruskin Model CD35 or equal.

5. High Pressure/High Velocity Systems (greater than 2-inch water column static pressure class or greater than 1500 fpm face velocity):

1) Rectangular.

a) Opposed blade damper.
b) Ruskin Model CD60 or equal.

2) Round and Oval.

a) Oval: Ruskin Model CDR25 and DO25 or equal.
b) Round: Up to 20-inch diameter: Ruskin Model MDRS25 or equal.
c) Round: Larger than 20-inch diameter: Ruskin Model CDRS25 or equal.

C. Automatic Dampers:

1. Actuators: See Section EMCS Basic Materials and Control System.
2. Construction:

a. Return air dampers (AHUs):

1) Class 2 smoke-rated Ruskin Model SD-36 or equal.
2) End switches: Provide end switch to indicate fully-closed position.

b. Blade Action:

1) Throttling duty: opposed.
2) Mixing duty: parallel.
3) Two-position: parallel or opposed.

c. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.
d. Seals:

1) Blade: Inflatable PVC coated fiberglass material or neoprene mechanically attached to blade edge.
2) Jamb: Flexible metal compression type.

e. Linkage: concealed in frame. External linkage and jack-shafts will not be accepted.
f. Axles: Minimum 1/2-inch diameter plated steel, hex-shaped, mechanically attached to blade. Side access for direct-coupled actuator.

3. Finish: Mill galvanized.
4. Damper area: See Drawings for sizes.
5. Low Pressure/Low Velocity Systems (2-inch water column or less static pressure class and 1500 fpm or less face velocity).

a. Integral, heavy-duty factory-installed motorized damper acceptable for exhaust fans unless otherwise scheduled.
b. Ruskin Model CD36 or equal.

6. High Pressure/High Velocity Systems (greater than 2-inch water column static pressure class or greater than 1500 fpm face velocity):

a. Ruskin Model CD60 or equal.

D. Backdraft Dampers:

1. Required locations:

a. Where indicated on the Drawings.
b. In suction or discharge of all exhaust fans as listed in equipment schedule.

1) Integral, heavy-duty factory-installed type acceptable unless otherwise scheduled.

2. General Applications:

a. Construction:

1) Extruded aluminum construction.
2) Extruded vinyl locked into blade edge.
3) Blade ends overlapping frame.

b. Performance:

1) Start to open: .02 inches w.g. or less.
2) Fully open: .05 inches w.g. or less.
3) Leakage for 24 inch wide damper: 25 cfm per ft^2 or less.

c. Ruskin Series CBD4 or equal.

3. High Velocity Applications:

a. Applies to discharge of air handlers and where velocity exceeds 1500 fpm. Damper shall be specifically designed for location at turbulent fan discharge.
b. Frame:

1) Minimum 12 gage galvanized steel channel.
2) Bolt Holes: Both flanges.

c. Blades:

1) Airfoil-shaped with integral structural reinforcing tube running full length of each blade.
2) Material: 7 inches x minimum 0.080 inch Alloy 6063-T5 extruded aluminum.
3) For multiple section dampers, provide galvanized steel or aluminum bracket to link dampers so they operate together.

d. Axles: Minimum 3/4 inch diameter plated steel.
e. Bearings: Bolt-on bearings with re-lube ball bearings.
f. Linkage:

1) 3/16 inch thick x 3/4 inch plated steel tie bar with minimum 16 gage plated steel linkage arms; stainless steel pivot pins.
2) Located out of airstream (side or external linkage).

g. Counterbalance: Located out of airstream.
h. Seals:

1) Blade:

a) Mechanically attach blade seals to blade.
b) Silicone rubber rated for 300 degrees Fahrenheit.

2) Jamb: Vinyl

i. Ruskin CBS92 or equal.

2.4 FIRE DAMPERS

A. Manufacturers:

1. Ruskin Manufacturing Company.
2. Greenheck Fan Corp.
3. Air Balance Inc.

4. PCI Industries – Pottorff.

B. Ratings (test conditions and label) per UL Standard 555.

1. 250 degrees Fahrenheit minimum.
2. 1-1/2 hour fire rating, unless otherwise indicated in the Drawings.
3. Dynamic (closes against air flow).

C. Factory sleeve.

D. Damper.

1. Multi-bladed, equipped with fusible link, spring loaded type.
2. Style:

a. As indicated on the Drawings.
b. Ducted, rectangular duct: Style B (out of airstream).
c. Ducted, round duct: Style A (in airstream) with damper sleeve 2” in each dimension larger than duct; plus, cap and collar.
d. Un-ducted: Style A (in airstream).

E. Fusible Link.

1. UL listed.
2. Fusible links on fire dampers shall be constructed to UL Standard 33 – Fusible Links for Fire Protection Service.
3. Temperature rating: Per code.

F. Type:

1. Rectangular type up to 1000 feet per minute: Ruskin DIBD2 or DIBD10 Style A or equal.
2. Rectangular type 1000 feet per minute and higher: Ruskin DIBD2 or DIBD10 Style B or equal.
3. Circular and oval type: Ruskin DIBD2 Style CR and CO, or DIBD10 Style R and LO or equal.

G. Status end switches:

1. Where indicated on the Drawings.
2. Ruskin SP100 or equal Switch Package.

2.5 WALL LOUVERS & COMBINATION LOUVER/DAMPERS

A. Manufacturers:

1. Ruskin Manufacturing Company.
2. Greenheck Fan Corp.

3. PCI Industries – Pottorff.
4. United Enertech

B. Louvers licensed to bear AMCA Certified Ratings Seal. Ratings based on tests and procedures performed in accordance with AMCA 511 and comply with AMCA Certified Ratings Program. AMCA Certified Ratings Seal applies to air performance and water penetration ratings.

C. Materials.

1. Frame.

a. Extruded aluminum, Alloy 6063-T5.
b. Wall Thickness: 0.081 inch, nominal.
c. Depth: 6 inches minimum.
d. Downspouts and caulking surfaces.

2. Blades.

a. Horizontal rain resistant style.
b. Extruded aluminum, Alloy 6063-T5.
c. Wall Thickness: 0.081 inch, nominal.
d. 2 inch blade spacing.

D. Screen (¼" opening hardware cloth on intake, ½" opening on exhaust/relief).

1. Aluminum wire screen.
2. 14 gauge.
3. Frame: Removable, rewireable.
4. Mounted on inside of louver.

E. Gutters: Drain gutter in head frame.

F. Downspouts: Downspouts in jambs to drain water from louver for minimum water cascade from blade to blade.

G. Vertical Supports: Hidden vertical supports to allow continuous line appearance up to 120 inches.

H. Sill: Steeply angled integral sill eliminating areas of standing or trapped moisture where mold or mildew may thrive and effect indoor air quality.

I. Assembly: Factory assemble louver components; mechanically fastened.

J. Blank off panels for unused portions of louvers: 20 gage galvanized sheet metal.

K. Factory Finish:

1. Kynar 500 (70% Kynar Resin) 2-Coat Fluoropolymer Coating or equal, unless otherwise specified on Drawings.

    a. Conform to AAMA 2605-98.
    b. Apply coating following cleaning and pretreatment.
    c. Cleaning: AA-C12C42R1X.
    d. Dry louvers before final finish application.
    e. Total Dry Film Thickness: Approximately 1.2 mils, when baked at 450 degrees Fahrenheit for 10 minutes.
    f. Warranty: Limited 20 year warranty on standard colors.
    g. Color: Color as selected by Architect from manufacturer's standard colors.

L. Basis of Design Louvers:

1. Outside air intake: Greenheck EHH-601 or equal. 6-inch deep wind-driven rain louver.
2. Exhaust outlet: Greenheck EHH-601 or equal. 6-inch deep wind-driven rain louver.
3. Combination louver/damper: Greenheck EACA-601 or equal, 6” frame.

2.6 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.7 EQUIPMENT STAND

A. Provide structural equipment support stand for blower coils, furnaces, etc. for stand-alone indoor above floor raised equipment applications. Stand may be welded angle iron braced frame, with minimum 2" x ¼" flat steel bar feet, where separate duct/connections are indicated. Prime/paint fame. Size of structural frame to match unit base at height indicated.

B. Where platform also acts as an air distribution plenum, construction shall include structurally sound ductwork grade minimum 20-gauge galvanized sheet metal. Plenum size to match application. Contractor shall submit detail of proposed plenum construction, size, and connections, bracing, etc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Compliance with ASHRAE/IESNA 90.1-2010 includes Section 6.4.3.3.3 - "Shutoff Damper Controls," restricts the use of backdraft dampers, and requires control dampers for certain applications. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Volume dampers.

1. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

    a. Volume dampers shall be installed as far away from air outlets as functionally reasonable to avoid noise in the occupied space.
    b. Provide also in wyes and branch take-offs to outlets whether indicated on the Drawings or not, except.

        1) To sidewall outlets in exposed ducts (opposed blade dampers in outlets shall be provided).

2. For ductwork exposed to occupant view, volume damper handles shall be on top of duct or otherwise concealed from occupant view.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Fire dampers.

1. Provide in all fire rated walls.
2. Provide access door in duct adjacent to each in location where damper may be inspected and internal fusible link or fire-stat may be replaced.
3. Install duct smoke detector provided by Division 26 if required; see Division 26 drawings.

4. Smoke and fire dampers installed in tunnel corridors shall have weight of damper supported from structure above.

H. Control dampers.

1. Field mounted control dampers installed with concealed linkage shaft accessible on side of damper with space for direct-coupled actuator.
2. Actuator installation: See Section EMCS Basic Materials and Devices

I. Install belt guards at all exposed belts.

J. Drain pans.

1. See Section Sanitary Waste and Vent Piping.
2. Condensate drain pans (including pans on fan-coils, packaged units, and air handlers).

a. Slope to drain connection to allow complete draining of pan.
b. Provide condensate pump where scheduled.
c. Piping from intermediate drain pan to lowest pan.

1) Pipe to within 1 inch of and discharge into lowest drain pan.

d. Piping from lowest pan drain connection to sewer.

1) Trap height and offset must allow water seal to remain and to allow complete drainage of pan both when fan is operating or not.

e. Field test.

1) Test all drain pans after installation to ensure proper slope and drainage and to prevent conditions of water stagnation that result in microbial growth.
2) Drainage shall be considered acceptable if after covering the entire pan with 1/2 inch water, the pan drains within 3 minutes to leave puddles no more than 2 inch in diameter and no more than 1/8 inch deep.
3) Test with the fan system in operation for pans on the suction side of the fan, and with the fan off for pans on the discharge side of the fan.
4) Document tests: See Section Mechanical General Provisions.

3. Auxiliary drain pans.

a. See Section– Sanitary Waste and Vent Piping.
b. Separate drain from main drain pan.

c. Discharge where water flow is readily observed but not over any material or equipment that may be damaged by water.

K. Connect ducts to duct silencers rigidly.

L. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

M. Install access doors with swing against duct static pressure.

N. Label access doors according to Section Mechanical Identification to indicate the purpose of access door.

O. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

3.3 TESTING AND ADJUSTING

A. After starting duct accessories.

1. Check for noise and leakage; repair as required at no additional cost to the Owner.
2. Operation test: Test each piece of equipment to show that it will operate in accordance with requirements.

END OF SECTION

SECTION 15.830 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Ceiling Exhaust Fans.

1.3 REFERENCE STANDARDS

A. ANSI/AFBMA Standard 9 – Load Rating and Fatigue Life for Ball Bearings.

B. AMCA 99 – Standards Handbook.

C. AMCA 211 – Product Rating Manual for Fan Air Performance.

D. AMCA 300 – Reverberant Room Method for Sound Testing of Fans.

E. AMCA 311 – Fan Sound Performance.

F. ANSI/AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.

G. UL 705 – Standard Power Ventilators.

1.4 QUALITY ASSURANCE

A. AMCA certified ratings per applicable AMCA standard based on the testing conducted in an independent laboratory.

B. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.

C. Sound Ratings: AMCA 301; tested to AMCA 300 and bear the AMCA Certified Sound Rating Seal.

D. Fabrication: Conform to AMCA 99.

E. Conform to AMCA Bulletins regarding construction and testing.

1. Fans shall bear AMCA certified rating seal.

F. Scheduled equipment performance is minimum capacity required.

G. Scheduled electrical capacity shall be considered as maximum available.

1.5 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. "R" means required.
2. "R2" means required only for products and equipment differing for the specified manufacturer and model and for "or equals" where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Fans	R	R		R
Performance curves	R			
Sound Power ratings	R			
Motor ratings and electrical characteristics	R			
Dampers, housings, linkages, and operators	R			
Roof curbs	R			R
Fan speed controllers and other accessories	R	R		

B. Include:

1. Complete graph of fan curves, not just curve for design conditions.
2. Sound power levels:

a. Fans 1 horsepower and larger: dB by octave bands.
b. Fans less than 1 horsepower: sones.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

1. Loren Cook.
2. Greenheck.
3. PennBarry.
4. Or equal.

2.2 GENERAL

A. AMCA certification in accordance with ARI Standard 210 and 211, and AMCA Standard 2408 for centrifugal fans.

B. Fans used shall not increase motor size, increase noise level, or increase tip speed by more than 10 percent, or increase inlet air velocity by more than 20 percent, from specified criteria.

C. Performance.

1. See fan schedule on the Drawings.
2. Capacities: minimum as scheduled on the Drawings.
3. Brake horsepower rating: Maximum 10 percent above that scheduled on the Drawings.
4. Fans and drives shall be capable of accommodating static pressure variations of plus or minus 10 percent.
5. Motor horsepower: No larger than that scheduled on the Drawings or compensate Division 26 contractor for any associated cost to increasing motor size.
6. Sized for a critical speed of at least 125% of maximum RPM.

D. Painting.

1. Electrostatically applied, baked polyester powder coating, minimum 2 mil thick.
2. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.

E. Discharge: As indicated on Drawings.

F. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA Certified Transit Tested Packaging

2.3 CEILING EXHAUST FANS

A. Description

1. Fan shall be ceiling mounted centrifugal exhaust fan.

B. Housing: Fan housing shall be galvanized steel and acoustically insulated. Galvanized steel shall be minimum as required by manufacturer model number on plans.

C. Fan Wheel: Wheel shall be centrifugal forward curved type

D. Motor:

1. See plans for type motor required.
2. Motor shall be totally enclosed type with permanently lubricated bearings and built-in thermal overload protection. Motor shall be furnished at the specified voltage and phase.
3. Motor shall be totally enclosed, not ventilated (TENV) electronically commutated (EC) with permanently lubricated bearings, built-in thermal overload protection and disconnect plug. Motor shall have an adjustable speed range from 500 to 1725 rpm. Motor shall be furnished at the specified voltage.

E. Grille: Painted aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Sound Data: Maximum sound data allowed per schedules.

H. Accessories:

1. See schedules for accessories.

2. All occupancy sensors to be provided by manufacturer and installed by Division 23 contractor including any wiring.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with work of other trades.

B. Install fans in accordance with manufacturer’s written installation instructions.

C. Flexible duct connection at inlet and outlet: See Section 233113 – Metal Ducts.

D. Backdraft Dampers.

1. Comply with ASHRAE 90.1 and IMC.
2. Provide backdraft or shutoff dampers for suction or discharge of every exhaust fan as scheduled on the Drawings.
3. See schedules on the Drawings and Section 233300 – Air Duct Accessories for where fan manufacturer may provide dampers and when specialty damper manufacturer must provide them.

E. Roof Mounted Fans.

1. Install on factory fabricated curbs.
2. See Division 7 Thermal and Moisture Protection for waterproofing and roofing.
3. Roof curbs:

a. Secured to structure with hold down methods as detailed.
b. Made fully weatherproof.

F. Pipe scroll drains to code compliant waste receptacle.

3.2 MOUNTING AND ALIGNMENT

A. See Section Mechanical Sound and Vibration Control.

3.3 INSPECTION

A. Verify that adequate clearance between fans and adjacent walls or equipment is available to permit maintenance and repairs.

3.4 PRE-OPERATING CHECKS

A. Do not operate fans for any purpose, temporary or permanent, until:

1. Ductwork is clean.
2. Filters in place.
3. Bearings lubricated.

3.5 TESTING AND ADJUSTING

A. Before starting fans install belts and motor guards.

B. Start and test fans in accordance with manufacturers written installation instructions.

C. Start up and adjust fans to insure proper operation.

D. The submitted sound power level shall be verified through actual measurements and calculations in accordance with AMCA standards 300 and 301.

E. After starting fans: Check for objectionable noise or vibration. Correct as needed at no additional cost to the Owner.

F. Balancing: See Section Testing, Adjusting and Balancing.

END OF SECTION

SECTION 15.840 AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Shutoff, single-duct air terminal units.

1.3 QUALITY ASSURANCE

A. Terminal units rated and certified in accordance with ARI Standard 880-98 Certification Program.

B. Heating coils rated in accordance with ARI Standard 410.

C. All electrical components shall be UL listed and installed in accordance with the UL Standard 1995.

1.4 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
VAV boxes	R	R		R
Hot water coils	R			R
Air terminal unit accessories	R	R		

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. VAV Boxes.

1. Titus.
2. Price.
3. Trane.
4. Or equal.

2.2 VAV BOXES

A. General.

1. Ship as a complete assembly requiring no field assembly (including accessories).
2. Casings:
   a. Minimum 22-gage, galvanized steel outer wall.
   b. Leakage rating: 7 cubic feet per minute maximum leakage at 1 inch water column.
   c. Acoustic lining.

      1) Material: Fiberglass with high density facing.
      2) Minimum thickness:

         a) Terminals located in conditioned space or return air plenum: 1/2 inch.
         b) Terminals located in unconditioned spaces: 1 inch.

      3) Minimum 1.5 pound per cubic foot density.
      4) Maximum thermal conductivity: 0.28 Btu-in per hour per foot squared per degree Fahrenheit (BTU-inch/h·ft^{2}·°F) measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 75 degrees Fahrenheit.
      5) Meet erosion test method described in UL publication No. 181.
      6) Meet smoke developed and flame spread rating requirements of NFPA-90A.
      7) Meet ASTM C1136 and ASTM C665 for biological growth in insulation.

   d. Gasketed access door.

1) For actuators inspection, repair and replacement if mounted internally.
2) Upstream of reheat coil for inspection and cleaning.
3) Door to be in bottom of VAV box.

e. Discharge duct connection.

3. Controls unit mounted by manufacturer.

a. Multi-point, cross-flow or flow-ring, center averaging sensor.

1) The average amplification factor for sizes 6 to 16 inch shall be greater than 2.0 and minimum amplification factor shall be 1.8. Provide documentation with submittal that substantiates this requirement.
2) Be rated for inlet or discharge duty, as indicated on the Drawings.
3) Provide accurate flow sensing regardless of inlet duct configuration.
4) Brass balancing taps and unit mounted airflow versus flow sensor pressure signal charts for field airflow measurements.

b. Control panel.

1) Control panel with cover to fully enclose VAV box controller.

c. For Direct Digital Controls, see Section Energy Management & Control Systems

4. Radiated and discharge sound power.

a. Equal or less in each octave band than terminal selections scheduled on the Drawings at noted capacities assuming 1.0 inch inlet static pressure, with a tolerance of + 2 dB in any band.
b. Minimum performance sound power less than 68 dB in the 125 Hz octave band.
c. Due to added space and pressure drop, providing additional plenums or attenuators to meet sound power ratings is not acceptable.

5. Total pressure drop.

a. Equal or less than terminal selections scheduled on the Drawings at noted capacities, with a tolerance of 0.02 inches of water.
b. This limitation is in total, not static, pressure. Where total pressure is not listed on certified performance documents, provide a table of manual adjustments of static pressure with velocity pressure calculated from inlet and outlet velocities.

6. Dampers.

    a. Heavy gage steel.
    b. Single blade damper; opposed blade dampers are not acceptable.
    c. Shaft rotating in self-lubricating Delrin or equal bearings; nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicate damper position.
    d. Damper shall have durable synthetic seal. Foam seals are not acceptable.
    e. Close-off leakage rating: 5 cubic feet per minute maximum leakage at 1.50 inches water column.

7. Hot water heating coils.

    a. Removable type.
    b. Tubes.

        1) 2-row, unless otherwise scheduled on the Drawings.
        2) Copper, 0.015 inches minimum tube wall thickness.
        3) Connections: external, same end, solder type connection, minimum 1/2 inch outside diameter.

    c. Fins.

        1) Aluminum, with full fin collars.
        2) As scheduled on the Drawings or as required to provide heating capacity listed.
        3) Maximum: 12 fins per inch.

    d. Factory leak-tested at 300 pounds per square inch.
    e. Access or removable panel for coil inspection and cleaning. Access door to be in bottom of VAV Box.

B. Variable Air Volume Terminal Units.

1. Single duct: Equal to Trane VCWF.
2. Options and features: As scheduled on the drawings.
3. Electrical Services (factory mounted).

    a. One-point wiring connection for all electrical devices.
    b. Control panel.
    c. Controls transformer.
    d. Components mounted in sheet metal control enclosure.
    e. ETL or UL listed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with work of other trades.

B. Install terminal units in accordance with manufacturer's written installation instructions.

C. Duct connections: See Section Metal Ducts.

1. Provide sheet metal duct connections at inlet; flexible not acceptable.
2. No flexible connection required on duct outlet.

D. Sound attenuation discharge duct.

1. Downstream of units where indicated on the Drawings.
2. Sound linings: Type AL. See Section Duct Insulation.
3. Minimum lining 5 feet of duct downstream of box.
4. Provide a minimum of 3 feet of ductwork prior to first fitting or outlet branch duct takeoff.

E. Piping connections: See Section Hydronic Piping.

F. Coordinate access with respective trades.

G. See Section Energy Management & Control Systems.

3.2 MOUNTING AND ALIGNMENT

A. Support VAV boxes at four corners with minimum, 1" x 18 gage sheet metal straps or 3/8 inch all-thread rod. Secure lower end of strap to the side of unit casing with minimum two #10 sheet metal screws, or bolt through casing with washers to prevent leakage. Bend end of strap and secure to bottom of casing with one #10 sheet metal screw.

B. See Section Mechanical Sound and Vibration Control.

3.3 INSPECTION

A. Verify that adequate clearance between air terminal units and adjacent walls or equipment is available to permit maintenance and repairs.

3.4 TESTING AND ADJUSTING

A. Before operating air terminal units.

1. Complete the provided Pre-Functional Test Data Sheet for each air terminal unit.

B. After starting air terminal units: Check for objectionable noise or vibration. Correct as needed at no additional cost to the Owner.

END OF SECTION

SECTION 15.850 AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work included in this section: materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following: All air outlets, inlets, grilles, registers and diffusers except where integral with manufactured piece of equipment

1.3 REFERENCE STANDARDS

A. ARI Standard 650 – Air Outlets and Inlets.

B. ASHRAE Standard 70 – Methods of Testing for Rating the Airflow Performance of Outlets and Inlets.

C. AMCA Standard 500 – Laboratory Methods of Testing dampers for Rating.

D. NFPA Standard 90A – Installation of Air Conditioning and Ventilating Systems.

E. NFPA 90B – Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

1.4 QUALITY ASSURANCE

A. Comply with ARI Standard 650, ASHRAE Standard 70, AMCA Standard 500, NFPA Standard 90A, and NFPA Standard 90B.

B. Provide outlets and inlets that have, as minimum, throw and noise criteria ratings for each size device as listed in manufacturer's current data, rated as required by the above standards.

1.5 SUBMITTALS

A. See Section 15010 – Mechanical General Provisions

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Grilles, registers, and diffusers	R			R
Accessories	R			

PART 2 - PRODUCTS

2.1 MANUFACTUERERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

1. Titus.
2. Metal Aire.
3. Nailor.
4. Or equal.

2.2 AIR DISTRIBUTION DEVICES

A. Manufacturer shall examine and approve of application of each outlet.

B. Noise level at design capacities: no larger than diffuser selection indicated on the drawings.

C. Material:

1. All grilles are to be of steel construction unless otherwise indicated on schedules.

D. Volume dampers:

1. Do not provide dampers built into grille or directly attached to the grille unless specifically called out on drawings.
2. Opposed blade volume damper key-operated adjustable from face of diffuser on register except as noted.

E. Diffuser frame:

1. Frame type shall be coordinated with ceiling type. Refer to architectural reflected ceiling drawings.

    a. At plaster or drywall ceilings:

        1) Lay-in diffuser with drywall frame (Titus TRM to match diffuser material). Drywall frame to match diffuser color.

2. No visible screw allowed on diffusers or frames, unless otherwise indicated on the Drawings.
3. Linear and bar diffusers shown as one collinear piece on plans shall be constructed as one piece within manufacturing limitations and to appear as one section if manufacturing limitations require multiple pieces. Provide with Border Type shown on plans. Coordinate exact border type with design professional before ordering.

F. Color:

1. Face and frame: Factory-baked #26 white enamel unless otherwise indicated on the Drawings.
2. Internal parts of grille visible from occupied space, including all parts behind perforated face diffusers and visible parts of plenums: flat black.

G. Provide square to round adapters where required.

H. Provide one-, two-, three- or four-way discharge patterns as indicated on plans.

I. See Construction Drawings for air outlets and inlets type and sizes.

2.3 SCREENED OPENINGS

A. Mesh:

1. 3/4 in. square pattern.
2. No. 16 galvanized wire.
3. Interwoven.
4. Welded or secured to frame.

B. Frames:

1. 1 inch by 1 inch by 1/8 inch galvanized steel angles.
2. Continuous around perimeter of screen (welded at corners).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with work of other trades.

B. Install air outlets and inlets in accordance with manufacturer's written installation instructions and Section 15810 – Metal Ducts.

C. Return and exhaust registers: Install with blades oriented to prevent sight through outlets.

D. Grille backs or plenums visible through grilles painted flat black.

E. Transfer grilles.

1. See indications on the Drawings.
2. Wall installations, unless otherwise indicated, provide two grilles.

    a. One on each side of wall, except where open to return air plenum.
    b. Connecting sheet metal collar with 18 inch elevation offset for sound and light attenuation.

F. Provide duct screens at termination ducts as indicated on the Drawings.

3.2 MOUNTING AND ALIGNMENT

A. See Section 15070 – Mechanical Sound and Vibration Control.

B. All air outlets and inlets shall be secured to building.

1. Ceiling grilles shall be secured to prevent falling from ceiling during construction or service with minimum of two 16-gage ceiling wires, two 22-gage by 1 inch galvanized sheet metal strap or two #10 sheet metal screws.
2. Comply with IBC.

C. Mount directional grilles as indicated on the Drawings.

D. Adjust grille throw patterns.

1. As indicated on the Drawings.
2. For double-deflection grilles, adjust rear blades horizontal and front blades in 45 degree pattern at each end gradually rotating to be almost straight at blades in center of grille.
3. Adjust grille throw patterns prior to test and balance. See Section 15950 – Testing, Adjusting, and Balancing for HVAC.

3.3 INSPECTION

A. Verify mounting, direction and adjustments are installed as indicated on the Drawings.

3.4 TESTING AND ADJUSTING

A. See Section 15950 – Testing, Adjusting, and Balancing for HVAC.

END OF SECTION

SECTION 15.860 AIR CLEANING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work included in this section: materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Filter media.
2. Filter frames in built-up systems.

1.3 REFERENCE STANDARDS

A. ASHRAE Standard 52.2-1999 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

B. ANSI/UL 900 – Test Performance of Air Filter Units.

1.4 QUALITY ASSURANCE

A. Filters shall have MERV ratings in accordance with ASHRAE Standard 52.2 with preconditioning as specified in Appendix J of that Standard.

1.5 SUBMITTALS

A. See Section 15010 – Mechanical General Provisions

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Draw-ing
Filters	R			
Filter frames	R			
Filter gauges	R	R		

PART 2 - PRODUCTS

2.1 MANUFACTUERERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Filter Media and Frames:

1. Camfil/Farr Filtration Group.
2. Flanders/Precisionaire.
3. American Air Filter.
4. Or equal.

2.2 FILTERS

A. General.

1. UL 900 listed.
2. Disposable type.
3. Each filter shall consist of media, media support grid, and enclosing frame.
4. Each filter shall have flow direction and MERV rating permanently affixed to frame.

B. Type 1: Pleated Filter:

1. 2 inch or 4 inch pleated.
2. Media: Cotton & synthetic media (no polyester).
3. Minimum performance:

a. MERV 8.

4. Maximum initial pressure drop at 500 feet per minute face velocity shall not to exceed 0.3 inches water column. Final pressure drop shall be no less than 1.0 inch water column.

5. Camfil/Farr 30/30 or equal.

C. Type 2: Bulk Media:

1. 1 inch fiberglass.
2. Filter media shall consist of a continuous filament fiberglass of graduated density. Media shall include a skin on the leaving air side. Furthermore, the media shall be treated with a non-toxic, non-flammable, odor free adhesive.
3. UL listed, Class 2.

2.3 FRAMES

A. For air handlers and fan-coils, see individual specifications Sections.

PART 3 - EXECUTION

3.1 FILTER MEDIA

A. Media as selected in equipment schedules on the Drawings.

B. Construction filters:

1. Type 1 for all equipment: roll media not acceptable.
2. Type 2 filter media is intended to be utilized over return/exhaust air grilles, registers and/or open ductwork during the construction period when the systems are being operated. This filter media is not to be utilized inside the housing of any HVAC systems.

C. Spare Filters:

1. Provide three (3) sets of spare filters for each piece of HVAC equipment and filter grille except the following (provide only one (1) spare set):

a. PTAC's (thru-wall units).
b. VRF system (indoor units).

3.2 INSTALLATION

A. Factory installed in air handling equipment.

B. Coordinate with work of other trades.

C. Install Air Cleaning Devices in accordance with manufacturer's written installation instructions.

D. Filter gauges.

1. Required only for filters with MERV 8 and greater and on systems greater than 2000 cfm.
2. Install filter gauge to filter or AHU housing in a position where reading will be visible but not block maintenance access.
3. Mount probes on upstream and downstream side of filter and pipe to gauge ports with soft copper tubing per gauge manufacturer's instructions.

E. See Section Energy Management & Control Systems.

F. See Section Testing, Adjusting, and Balancing.

3.3 START-UP PROCEDURES

A. Do not operate air handling unit fan systems for any reason until spaces served have been cleaned of dust and debris, to avoid contamination of supply air or return air paths and equipment.

B. Supply fans shall not be operated unless filters are installed, including temporary filters for use during test and balance.

C. If the final pressure drop of the temporary filters is reached during test and balance, replace them with a spare set.

D. Before turning system over to the Owner, remove temporary construction filters and install clean final filters:

1. Remove prefilters in front of cartridge, bag, and HEPA filters after construction and do not replace. Prefilters shall not be used during normal operation.
2. See also Section Testing, Adjusting, and Balancing, Section Mechanical General Provisions and Section Basic Materials and Methods for media installation during temporary equipment operation and test and balance periods.

3.4 INSPECTION

A. Verify that adequate clearance between Air Cleaning Devices and adjacent walls or equipment is available to permit maintenance and replacement of filters.

B. Verify that filters are firmly seated in frame to minimize bypass.

END OF SECTION

SECTION 15.865 AIR PURIFICATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work included in this section: materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Bi-Polar Ionization.

1.3 REFERENCE STANDARDS

A. ASHRAE Standard 62 & 52

B. NFPA 70.

1.4 QUALITY ASSURANCE

A. The Air Purification System shall be a product of an established manufacturer in the USA and shall be manufactured and assembled in the USA.

B. A qualified representative from the manufacturer shall be available to inspect the installation of the air purification system to ensure installation in accordance with manufacturer's recommendation.

C. Projects designed using ASHRAE Standard 62.1 IAQ Procedure shall require the manufacturer to provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1 to validate acceptable indoor air quality at the outside air quantity scheduled. The manufacturer shall provide independent test data on a previous installation in a similar application that proves compliance to ASHRAE 62.1 and the accuracy of the calculations.

D. The Air Purification Technology shall have been tested by UL or Intertek/ETL to prove conformance to UL 867-2007 including the ozone chamber testing and peak ozone test for electronic devices. All manufacturers shall submit their independent UL 867 test data with ozone results to the engineer during the

submittal process. All manufacturers shall submit a copy with their quotation. Contractors shall not accept any proposal without the proper ozone testing documentation.

1.5 SUBMITTALS

A. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Draw-ing
Air Purification Systems	R	R		

PART 2 - PRODUCTS

2.1 MANUFACTUERERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Filter Media and Frames:

1. Plasma Air.
2. Global Plasma.
3. Phenomenal Aire.
4. Or equal.

2.2 BI-POLA IONIZATION DESIGN AND PERFORMANCE CRITERIA

A. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a plasma ion generator with bipolar ionization output as described here within.

B. The Bi-polar Ionization system shall be capable of:

1. Effectively killing microorganisms downstream of the bipolar ionization equipment (mold, bacteria, virus, etc.).

2. Controlling gas phase contaminants generated from human occupants, building structure, furnishings and outside air contaminants.
3. Reducing space static charges.
4. Reducing space particle counts.
5. When mounted to the air entering side of a cooling coil, keep the cooling coil free from pathogen and mold growth.
6. All manufacturers shall provide documentation by an independent NELEC accredited laboratory that proves the product has minimum kill rates for the following pathogens given the allotted time and in a space condition:

    a. MRSA: 99.5% in 60 minutes or less
    b. E. Coli: 93.5% in 30 minutes or less
    c. H1N1: 86.6% in 60 minutes or less
    d. Aspergillus: 74.8% in 60 minutes or less

7. Manufacturers not providing the equivalent space kill rates shall not be acceptable. All manufactures requesting prior approval shall provide to the engineer independent test data from a NELEC accredited independent lab confirming kill rates and times meeting the minimum requirements stated in section 2.2 B, points 6a through 6d.

C. The bipolar ionization system shall operate in such a manner that equal amounts of positive and negative ions are produced. Single pole ion devices shall not be acceptable.

1. Airflow rates may vary through the full operating range of a VAV system. The quantity of air exchange shall not be increased due to the air purification system requirements.
2. Velocity Profile: The air purification device shall not have a maximum velocity profile.

D. Humidity: Plasma Generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions to the air purification system.

E. Ionization Equipment Requirements:

1. Electrode Specifications (Bi-polar Ionization):

    a. Each plasma generator with bipolar ionization output shall include the required number of electrodes and power generators sized to the air handling equipment capacity.
    b. Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating.
    c. Ionization output when tested in the occupied space shall be between 500 and 800 ions/cm3.

d. Manufacturer shall demonstrate that no voltage potential exists due to exposed electrical components in the duct system or plenum. Exposed needles protruding into the air steam will not be accepted.

F. See schedules for type required. Descriptions are below.

1. Air Handler mounted units

a. Ion generators for air handling units 25 tons and larger shall be Plasma Air's BAR (or approved equal) furnished in a linear or bar mounted configuration to minimize the space required for installation. Ionization BAR shall be no more than 3" deep in the direction of airflow.
b. The mechanical contractor shall mount the plasma ionization BAR and connect it to the remote mount power supply panel using only low voltage wiring. Low voltage wiring shall be defined as 12V. The use of high voltage cabling (600V or higher) shall not be acceptable due to safety concerns.
c. The remote mount power supply panel shall be capable of directly accepting voltage of 12V DC or 24V AC. The panel shall have an on/off switch, ionizer indicator LED, and a set of dry contacts which will indicate ionizer functionality. Dry contacts that indicate power available only shall not be acceptable.
d. For systems that don't utilize a feedback functionality indicating ion production, provide a duct mounted ion sensor powered from 12V DC or 24V AC. Ion sensor to be user adjustable from 500 to 20,000 ions per cm3 and contain a dry contact BMS interface. To be clear, for systems that only indicate power available to the ionizer, vendor must provide duct mounted ion sensor described herein.
e. Needles on air handler mounted units shall be recessed for safety and to avoid fouling of any exposed needles.

2. Duct mounted units

a. For systems less than 25 tons and where indicated on the plans and/or schedules to be duct mounted, plasma ion generators to be Plasma Air 7000 series (or approved equal) shall be supplied and installed by the mechanical contractor. The contractor shall follow all manufacturer IOM instructions during installation.
b. Generators shall be furnished with a factory-equipped gasketed mounting flange to prevent air leakage and to provide a thermal break. Gasketed flange shall be a minimum of 1 1/8" wide around the perimeter of the ionizer.
c. Ion generators shall be field installed in a location that is convenient for visual inspection, removal, and servicing. They shall include an ion indicator light clearly visible from below the installed location.
d. Needles on duct mounted units shall be recessed for safety and to avoid fouling of any exposed needles.

3. Variable Refrigerant Flow (VRF) Ductless units

    a. Ion generators for VRF ductless units shall be brush type needlepoint units, Plasma Air model PA600 (or approved equal) designed to be mounted at the fan inlet.
    b. The unit shall be rated to treat up to 2,400 CFM or 6 tons nominal capacity. For airflows greater than 2,400 CFM, multiple units shall be utilized as shown on the plans/schedules.
    c. The housing is made from ABS plastic, contains an LED ionization output indicating LED, and an in-line 1 Amp fuse.
    d. The unit shall contain two (2) mounting feet and shall be configured so the needles are oriented perpendicular to the flow of air entering the fan wheel.

G. Electrical Requirements:

1. Ion generators shall contain a built-in power supply and operate on 24V AC and shall connect to the fan and common terminals of the air handling unit served. Ion generators requiring a loose 24V, 120V or 230V transformer or power supply shall not be accepted.
2. Wiring, conduit and junction boxes shall be furnished and installed by the electrical contractor within housing plenums and shall be UL and NEC NFPA 70 approved.

H. Control Requirements:

1. All plasma ion generators shall include internal short circuit protection, overload protection, and automatic fault reset. Manual fuse replacement shall not be accepted.
2. All BAR and 7000 series plasma ion generators shall include an external BMS interface to indicate ion generator status and alarm.

PART 3 - EXECUTION

3.1 ASSEMBLY AND INSTALLATION

A. All equipment shall be assembled and installed with a high level of workmanship to the satisfaction of the owner, architect and engineer.

B. Any material damaged by handling, water or moisture shall be replaced by the mechanical contractor at no cost to the owner.

C. All equipment shall be protected from damage on a daily basis throughout construction.

3.2 COMMISSIONING AND TRAINING

A. A manufacturer's authorized representative shall provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment.

B. Provide to the owner a portable hand held, ion counter with a calibrated range of 0 to 20,000 ions/cm3 and an accuracy of +/- 25% within the specified range. Ion counter shall have automatic zeroing capability on 10-minute intervals.

3.3 TRAINING

A. See Section 15010 – Mechanical General Provisions.

END OF SECTION

SECTION 15.900 ENERGY MANAGEMENT AND CONTROL SYSTEM - GENERAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Contractor shall furnish and install a direct digital control and Energy Management and Control System (EMCS).

B. The systems to be controlled under work of this Section include but are not limited to the following:

1. HVAC Systems

1.3 RELATED WORK AND REQUIREMENTS

A. Coordination with other Divisions. The table in specification paragraph 1.2-B shall be used to determine scope of work between Division 15 and other Divisions including Divisions 15 and 16. All work not specified to be a part of the EMCS scope of work shall be provided by General Contractor and associated subcontractors for each building and the infrastructure.

B. Communications.

1. Connection to Owner's IT WAN/LAN and terminations to wall jack shall be by Division 15C Contractor. Coordinate connection location of IT WAN/LAN and terminations with Division 16. This connection shall also provide access to Internet through Owner's firewall to Internet Services Provider procured by Owner.
2. Network IT WAN/LAN drop at required EMCS location(s) specified under Division 16. It shall be the responsibility of the Division 15C contractor to communicate required IT WAN/LAN drop location(s) with Division 16.

C. Integration with Existing County Wide Control System

1. Include all services required to integrate this building into the existing County Wide Control System for a fully operational system. This building to be provide and installed with a new controls system.
2. Procedure.

a. Provide all controls work as indicated on drawings and in specifications.
b. Develop all building level control system databases and control programming using existing standards and standard programming.
c. Install building databases and control programming on a temporary portable operator's terminal provided by the Contractor. The POT shall be used for start-up, testing, and commissioning. The POT shall remain the property of the Contractor after final completion of the project.
d. Once the building EMCS has been fully commissioned and accepted by the Owner, merge database and programming with those existing on the existing Operator Workstation and/or servers. Confirm that the merge was successful by sample testing points and sequences and approve final installation in writing.
e. Integrate graphic screens into the existing EMCS graphics including adding appropriate hyperlinks so that the system operates as one integrated system.
f. Provide high level password for Owner operator access to the system only at this point; Owner will not have access to the system prior to system acceptance and integrations.

1.4 REFERENCE STANDARDS

A. Nothing in Contract Documents shall be construed to permit Work not conforming to applicable laws, ordinances, rules, and regulations. When Contract Documents differ from requirements of applicable laws, ordinances, rules and regulations, EMCS contractor shall comply with documents establishing the more stringent requirement.

B. The latest published or effective editions, including approved addenda or amendments, of the following codes and standard shall apply to the EMCS design and installation as applicable.

C. State and Local Codes:

1. Local City and County Codes.

D. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

1. ASHRAE 135: BACnet - A Data Communication Protocol for Building Automation and Control Networks.

E. Electronics Industries Alliance.

1. EIA-232: Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.

2. EIA-458: Standard Optical Fiber Material Classes and Preferred Sizes.
3. EIA-485: Standard for Electrical Characteristics of Generator and Receivers for use in Balanced Digital Multipoint Systems.
4. EIA-472: General and Sectional Specifications for Fiber Optic Cable.
5. EIA-475: Generic and Sectional Specifications for Fiber Optic Connectors and all Sectional Specifications.
6. EIA-573: Generic and Sectional Specifications for Field Portable Polishing Device for Preparation Optical Fiber and all Sectional Specifications.
7. EIA-590: Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant and all Sectional Specifications.

F. Underwriters Laboratories.

1. UL 916: Energy Management Systems.

G. NEMA Compliance.

1. NEMA 250: Enclosure for Electrical Equipment.
2. NEMA ICS 1: General Standards for Industrial Controls.

H. NFPA Compliance.

1. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

I. Institute of Electrical and Electronics Engineers (IEEE).

1. IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. IEEE 802.3: CSMA/CD (Ethernet – Based) LAN.
3. IEEE 802.4: Token Bus Working Group (ARCNET – Based) LAN.

1.5 DEFINITIONS

A. Acronyms

AAC	Advanced Application Controller
AH	Air Handler
AHU	Air Handling Unit
AI	Analog Input
ANSI	American National Standards Institute
AO	Analog Output
APDU	Application Protocol Data Unit
ASC	Application Specific Controllers
ASCII	American Standard Code for Information Interchange

ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers.
ASME	American Society of Mechanical Engineers.
ASTM	American Society for Testing and Materials.
A-to-D	Analog-to-Digital
BACnet	Data Communications Protocol for Building Automation and Control Systems
BC	Building Controller
BIBB	BACnet Interoperability Building Blocks
BMA	BACnet Manufacturers Association \
CAD	Computer Aided Drafting
CHW	Chilled Water
CHWR	Chilled Water Return
CHWS	Chilled Water Supply
COV	Change of Value
CSS	Control Systems Server
CU	Controller or Control Unit
CV	Constant Volume
CW	Condenser Water
CWR	Condenser Water Return
CWS	Condenser Water Supply
DCS	Digital Control Stations
DBMS	Database Management System
DDC	Direct Digital Control
DHW	Domestic Hot Water
DI	Digital Input
DO	Digital Output
D-to-A	Digital-to-Analog
EMCS	Energy Management and Control System
EMT	Electrical Metallic Tubing
EP	Electro-Pneumatic
ETL	Edison Testing Laboratories.
GUI	Graphical User Interface
HOA	Hand-Off-Automatic
HVAC	Heating, Ventilating and Air-Conditioning'
HTTP	Hyper-Text Transfer Protocol
I/O	Input/output
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
LAN	Local Area Network
LANID	LAN Interface Device
LCP	Lighting Control Panel
MAC	Medium Access Control

MHz	Megahertz
MS/TP	Master-Slave/Token-Passing
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association.
NIST	National Institute of Standards and Technology
ODBC	Open Database Connectivity
OI	Operator Interface
OWS	Operator Workstation
P	Proportional
PC	Personal Computer
PI	Proportional-Integral
PICS	Protocol Implementation Conformance Statement
PID	Proportional-Integral-Derivative
POT	Portable Operators Terminal
PTP	Point-to-Point
RAM	Random Access Memory
SOO	Sequence of Operation
SQL	Standardized Query Language
SSL	Secure Socket Layers
TAB	Test, Adjust, and Balance
TDR	Time Delay Relay
THS	Trend Historian Server
UL	Underwriters' Laboratories, Inc.
XML	Extensible Markup Language

B. Terms

Term	Definition
Accessible	Locations that can be reached with no more than a ladder to assist access and without having to remove permanent partitions or materials. Examples include inside mechanical rooms, mechanical equipment enclosures, instrument panels, and above suspended ceilings with removable tiles.
Advanced Application Controller	A device with limited resources relative to the Building Controller. It may support a level of programming and may also be intended for application specific applications.
Application Protocol Data Unit	A unit of data specified in an application protocol and consisting of application protocol control information and possible application user data (ISO 9545).
Application Specific	A device with limited resources relative to the Ad-

Controller	vanced Application Controller. It may support a level of programming and may also be intended for application-specific applications. .
BACnet Interoperability Building Blocks	A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device in a specification.
BACnet/BACnet Standard	BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved addenda.
Building Controller	A fully programmable device capable of carrying out a number of tasks including control and monitoring via direct digital control of specific systems, acting as a communications router between the LAN backbone and sub-LANs, and data storage for trend information, time schedules, and alarm data.
Change of Value	An event that occurs when a digital point changes value or an analog value changes by a predefined amount
Client	A device that is the requestor of services from a server. A client device makes requests of and receives responses from a server device.
Concealed	Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures.
Continuous Monitoring	A sampling and recording of a variable based on time or change of state (e.g., trending an analog value, monitoring a binary change of state).
Contract Documents	Specifications, drawings, and other materials provided with request for bids.
Contractor, EMCS Contractor, or Division 15C Contractor	The Contractor retained by Owner to execute the work defined in Division 15C and associated design documents
Control Systems Server	A computer (or computers) that maintains the systems configuration and programming database.
Controller or Control Unit	Intelligent stand-alone control panel. Controller is a generic reference and shall include BCs, AACs, and ASCs as appropriate.
Digital Control Stations	One or more EMCS control panels
Direct Digital Control	Microprocessor-based control including Analog/Digital conversion and program logic
Energy Management and Control System	The entire integrated management and control system
Equal	Approximately equal in material types, weight, size, design, quality, and efficiency of specified product.
Exposed	Not installed underground or concealed.

Extensible Markup Language	A specification developed by the World Wide Web Consortium. XML is a pared-down version of SGML, designed especially for Web documents. It allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.
Functional Profile	A collection of variables required to define the key parameters for a standard application. As this applies to the HVAC industry, this would include applications like VAV terminal, fan coil units, and the like.
Gateway	Bi-directional protocol translator connecting control systems that use different communication protocols
Handheld Device	Manufacturer's microprocessor-based device for direct connection to a Controller.
Inaccessible	Locations that do not meet the definition of accessible. Examples include inside furred walls, pipe chases and shafts, or above ceilings without removable tiles.
Indicated, shown, or noted	As indicated, shown, or noted on drawings or specifications.
Install	To erect, mount and connect complete with related accessories.
Instrumentation	Gauges, thermometers, and other devices mounted in ductwork or piping that are not a part of the automatic temperature control system
IT LAN	Reference to the facility's Information Technology network, used for normal business-related e-mail and Internet communication.
LAN Interface Device	Device or function used to facilitate communication and sharing of data throughout the EMCS
Local Area Network	General term for a network segment within the architecture.
Supervisory LAN	Ethernet-based LAN connecting Primary Controller LANs with each other and OWSs, CSS, and THS. See System Architecture below.
Master-Slave/Token Passing	Data link protocol as defined by the BACnet standard.
Motor Controllers	Manual or magnetic starters (with or without switches), individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.
Open Database Connectivity	An open standard application-programming interface for accessing a database developed. ODBC compliant systems make it possible to access any data from any application, regardless of which database management system is handling the data.

Operator Interface	A device used by the operator to manage the EMCS including OWSs, POTs, and HHDs.
Operator Workstation	The user's interface with the EMCS system. As the EMCS network devices are stand-alone, the OWS is not required for communications to occur.
Piping	Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.
Points	All physical I/O points, virtual points, and all application program parameters.
Point-to-Point	Serial communication as defined in the BACnet standard.
Portable Operators Terminal	Laptop PC used both for direct connection to a controller and for remote dial up connection.
Primary Controlling LAN	High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below.
Protocol Implementation Conformance Statement	A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device (ASHRAE/ANSI 135).
Provide	To supply, install and connect up complete and ready safe and regular operation of particular work referred to unless specifically noted.
Reviewed, approved, or directed	As reviewed, approved, or directed by the Owner.
Router	A device that connects two or more networks at the network layer.
Secondary Controlling LAN	LAN connecting AACs and ASCs. Generally lower speed and less reliable than the Primary Controlling LAN. Refer to System Architecture below.
Server	A device that is a provider of services to a client. A client device makes requests of and receives responses from a server device.
Smart Device	A control I/O device such as a sensor or actuator that can directly communicate with the controller network to which it is connected. This differs from an ASC in that it typically deals only with one variable.
Standardized Query Language	A standardized means for requesting information from a database.
Supply	To purchase, procure, acquire and deliver complete with related accessories.
Trend Historian Server	A computer (or computers) that maintains the database of recorded trend logs.
Owner	Owner, University, Institution and/or its designated representatives.

Wiring	Raceway, fittings, wire, boxes, and related items.
Work	Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.6 QUALITY ASSURANCE

A. Materials and Equipment

1. Manufacturer's Qualifications: See PART 2 for approved manufacturer.
2. Product Line Demonstrated History: The direct digital control equipment product line being proposed for the project must have an installed history of demonstrated satisfactory operation for a length of one year since date of final completion in at least 10 installations of comparative size and complexity.
3. All products used in this project installation shall be new, currently under manufacture, and shall have been available from the manufacturer for a minimum of 6 months prior to date of proposal and previously installed and proven effective in installations of similar nature, not including test sites. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner in writing. Spare parts shall be available for at least five years after completion of this contract.
4. All BACnet devices must either be certified as complaint with BACnet through the BACnet Manufacturers Association or the vendor must supply proof of having submitted the device for testing by BMA.
5. The EMCS and components shall be listed by Underwriters Laboratories UL 916 as an Energy Management System.

B. Installer

1. EMCS Contractor's Project Manager Qualifications: Individual shall specialize in and be experienced with direct digital control system installation for not less than 3 years. Project Manager shall have experience with the installation of the proposed direct digital control equipment product line for not less than 2 projects of similar size and complexity. Project Manager must have proof of having successfully completed the most advanced training offered by the manufacturer of the proposed product line.
2. EMCS Contractor's Programmer Qualifications: Individual(s) shall specialize in and be experienced with direct digital control system programming for not less than 3 years and with the proposed direct digital control equipment product line for not less than 1.5 years. Programmers must show proof of having successfully completed the most advanced programming training offered by the vendor of the programming application on the proposed product line.

3. EMCS Contractor's Service Qualifications: The installer must be experienced in control system operation, maintenance, and service. EMS Contractor must document a minimum 5-year history of servicing installations of similar size and complexity. Installer must also document at least a 1-year history of servicing the proposed product line.
4. Installer’s Response Time and Proximity.

    a. Installer must maintain a fully capable service facility within Mississippi. Service facility shall manage the emergency service dispatches and maintain the inventory of spare parts.
    b. Installer must demonstrate the ability to meet the emergency response times listed in herein.

5. Electrical installation shall be by manufacturer-trained electricians.

    a. Exception: Roughing in wiring/conduit and mounting panels may be subcontracted to any licensed electrician.

1.7 SUBMITTALS

A. No work may begin on any segment of this project until the related submittals have been reviewed for conformity with the design intent and the Contractor has responded to all comments to the satisfaction of the Architect.

B. Submit drawings, product data, samples and certificates of compliance required as hereinafter specified. See also Division 1 Shop Drawings, Product Data and Samples. Conditions in this Section take precedence over conditions in above referenced Section.

C. Submittal Schedule: Submittal schedule shall be as follows unless otherwise directed by the Owner:

1. Allow 10 working days for approval unless Architect agrees to accelerated schedule.
2. Submittal Package 1 (Hardware and Shop Drawings) shall be submitted in accordance with schedule established by the Owner in bid documents.
3. Submittal Package 2 (Programming and Graphics) and shall be submitted no less than 30 days before software is to be installed in field devices.
4. Submittal Package 3 (Functional Testing) shall be submitted no less than 30 days prior to conducting tests.
5. Submittal Package 4 (Training Materials) shall be submitted no less than 14 days prior to conducting first training class.
6. Submittal Package 5 (Post-Construction Trend Logs) shall be submitted after demonstration tests are accepted and systems are in full automatic operation. The list of points to be trended shall be submitted for approval 14 days prior to the start of the trend collection period.

7. Submittal Package 6 (End-of-Warranty Trend Logs) shall be submitted 30 days prior to the end of the warranty period.

D. Submission and Resubmission Procedure:

1. Each submittal shall have a unique serial number that includes the associated specification section followed by a number for each sub-part of the submitted for that specification section, such as SUBMITTAL -01.
2. Each resubmittal shall have the original unique serial number plus unique revision number such as SUBMITTAL -01 REVISION 1.
3. Submit one copy of submittal in electronic format specified under each submittal package below. Submissions made in the wrong format will be returned without action.
4. Submit two (2) and only two hardcopies copies of submittals to Architect for review. Any additional copies will be returned without review.
5. Architect will return one copy with comments and corrections noted where required.
6. Make corrections:

    a. Revise initial drawings or data.
    b. Indicate any changes that have been made other than those requested.
    c. Clearly identify resubmittal by original submittal number and revision number.

7. Resubmit two (2) and only two copies of revised submittals to Architect for review until no exceptions are taken.
8. Once submittals are accepted and stamped with no exceptions taken, Contactor shall make photocopies for coordination with other trades, as required by the General Contractor. Photocopies will serve as submittal for record and coordination.

E. Submittals Packages

1. Submittal Package 1 (Hardware and Shop Drawings).

    a. Provide Installer and Key personnel qualifications as specified.
    b. Hardware

        1) Organize by specification section and device tags as tagged in these specifications.
        2) Do not submit products that are not used even if included in specifications.
        3) Include a summary table of contents listing for every submitted device:

            a) Tab of submittal file/binder where submittal is located.

b) Device tag as tagged in these specifications (such as TS-1A, FM-1).
c) Specification section number (down to the lowest applicable heading number).
d) Whether device is per specifications and a listed product or a substitution.
e) Manufacturer.
f) Model Number.
g) Device accuracy (where applicable).
h) Accuracy as installed including wiring and A/D conversion effects (where applicable).

4) Submittal shall include manufacturer's description and technical data, such as performance data, product specification sheets, and installation instructions for all control devices and software.
5) When manufacturer's cut-sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements.
6) A BACnet_ Protocol Implementation Conformance Statement (PICS) for each type of controller and operator interface shall be included submittals.
7) Format: Electronic word-searchable format.

c. Shop Drawings

1) Format

a) Sheets shall be consecutively numbered.
b) Each sheet shall have a title indicating the type of information included and the mechanical/electrical system controlled.
c) Table of Contents listing sheet titles and sheet numbers.
d) Legend and list of abbreviations.
e) Schematics: (AutoCAD compatible format, 17-inch x 11-inch.)
f) Floor plans: None required.

2) System architecture one-line diagram indicating schematic location of all control units, workstations, LAN interface devices, gateways, etc. Indicate address and type for each control unit. Indicate media, protocol, baud rate, and type of each LAN.
3) Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment

and control devices. The schematics provided with bid package shall be the basis on the EMCS Contractor's schematics with respect to control points, but EMCS Contractor may use alternative graphics format.

4) All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.
5) With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type, instance number). See Section Part 3 for additional requirements.
6) Label each control device with setting or adjustable range of control.
7) Label each input and output with the appropriate range.
8) Device table (Bill of Materials). With each schematic, provide a table of all materials and equipment including:

    a) Device tag as indicated in the schematic and actual field labeling (use tag as indicated in these specifications where applicable and practical.)
    b) Device tag as indicated in these specifications where applicable and if it differs from schematic device tag.
    c) Description.
    d) Proposed manufacturer and model number.
    e) Range.

9) With each schematic or on separate valve sheet, provide valve and actuator information including size, C_v, design flow, target pressure drop, actual design pressure drop, manufacturer, model number, close off rating, etc. Indicate normal positions of spring return valves and dampers.
10) Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
11) Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.

d. Do not include sequence of controls on shop drawings or equipment submittals; they are included in Submittal Package 2.

e. Submit along with shop drawings but under separate cover memory allocation projections and calculated and guaranteed response times of the most heavily loaded LAN in the system.

2. Submittal Package 2 (Programming and Graphics).

a. A detailed description of point naming convention conforming to be used for all software and hardware points, integrated with existing database convention.
b. A list of all hardware and software points identifying their text names, device addresses and descriptions.
c. Control Logic Documentation:

1) Submit control logic program listings (graphical programming) consistent with specified English-language Sequences of Operation for all control units.
2) Control logic shall be annotated to describe how it accomplishes the sequence of operation. Annotations shall be sufficient to allow an operator to relate each program component (block or line) to corresponding portions of the specified Sequence of Operation.
3) Include specified English-language Sequences of Operation of each control sequence updated to reflect any suggested changes made by the Contractor to clarify or improve the sequences. Changes shall be clearly marked. SOO shall be fully consistent with the graphical programming. (An electronic version of the sequences of controls on drawings will be provided to the Contractor upon request.)
4) Include control settings, setpoints, throttling ranges, reset schedules, adjustable parameters, and limits.
5) Submit one complete set of programming and operating manuals for all digital controllers concurrently with control logic documentation. This set will count toward the required number of Operation and Maintenance materials specified below.

d. Graphic screens of all required graphics, provided in final colors, one 11” x 8.5” page per screen.
e. Format:

1) Points list: Word-searchable format.
2) Programming: Native electronic file if interpreter is available, otherwise provide pdf files of screen shots.
3) Graphics: Graphical electronic format (pdf, png, etc.).

3. Submittal Package 3 (Functional Testing).

a. Provide pre-functional test forms.

b. Provide functional test forms.
c. Format: Word-searchable format.

4. Submittal Package 4 (Training Materials).

a. Provide training materials.
b. Format: Word-searchable format.

5. Submittal Package 5 and 6 (Trend Logs).

a. Provide a list of points being trended along with trend interval or change-of-value per drawings.
b. Provide trend logs as required by drawings.

1.8 COMPLETION REQUIREMENTS

A. Procedure.

1. Until the documents required in this section are submitted and approved, the system will not be considered “accepted” and final payment to EMCS Contractor will not be made.
2. Before requesting acceptance of work, submit one set of completion documents for review and approval of Owner.
3. After review, furnish quantity of sets indicated below to Owner.

B. Completion Documents.

1. Operation and Maintenance (O & M) Manuals. Provide in both paper and electronic format per paragraph 1.8C.

a. Include all submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual; in accordance with requirements of Division 1.
b. As-built versions of the submittal product data. Submittal data shall be located in tabs along with associated maintenance information.
c. Engineering, Installation, and Maintenance Manual(s) that explain how to design and install new points, panels, and other hardware; preventive maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.
d. Complete original issue documentation, installation, and maintenance information for all third-party hardware and software provided, including computer equipment and sensors.
e. A list of recommended spare parts with part numbers and suppliers.
f. Operators Manual with procedures for operating the control systems, including logging on/off, alarm handling, producing point reports,

trending data, overriding computer control, and changing set points and other variables.

g. Programming Manuals with a description of the programming language, control block descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the programming editor.
h. Recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.
i. A listing and documentation of all custom software for the project created using the programming language, including the set points, tuning parameters, and point and object database.
j. English language control sequences updated to reflect final programming installed in the EMCS at the time of system acceptance.

2. Complete original issue USB drive/CDs for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
3. Project Record Drawings.

a. “As-built” versions of the submittal drawings in reproducible paper and electronic format per paragraph 1.8C.
b. Provide as-built network architecture drawings showing all BACnet nodes including a description field with specific controller/device identification, description, and location information.
c. Record floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, address and drawing reference number.

4. Commissioning Reports. Completed versions of all Pre-functional, Functional, and Demonstration Commissioning Test reports, calibration logs, etc.
5. Copy of inspection certificates provided by the local code authorities.
6. Written guarantee and warranty documents for all equipment and systems, including the start and end date for each.
7. Training materials.
8. Contact information. Names, addresses, and 24-hour telephone numbers of contractors installing equipment, and the control systems and service representatives of each.

C. Format of Completion Documents.

1. Provide the type and quantity of media listed in table below.

2. Documents such as manuals and control sequences shall be in word-searchable electronic format such as MS Word, Adobe Acrobat (pdf), and HTML and broken into separate files for each type of equipment. Record drawings shall be in original format per paragraph 1.06F.
3. Optical media shall be readable on Operator Workstations.

	Document	Paper (binder or bound)	Electronic	
			Read only optical disk	Loaded onto OWSs and POTs
1.	O&M Manual	5	1	1
2.	Original issue software	–	1 per workstation	1
3.	Project Record Drawings	5	1	1
4.	Control sequences	1	1	1
5.	Commissioning Reports	5	–	–
6.	Inspection Certificates	1	–	–
7.	Warranty documents	1	–	–
8.	Training materials	1 per trainee	–	–
9.	Contact information	1	–	1

D. Permanent On-site Documentation.

1. In panels, provide point list of all points in panel in sufficiently permanent manner that list cannot be easily removed (and lost).
2. Mount half size drawings of primary system schematics and network architecture in glass covered frame. The number of drawings will depend on the complexity of the system; compressed or abridged versions of shop drawings are acceptable provided all control points are shown. Mount the drawings in space available in mechanical rooms. Drawings may be mounted in different locations, e.g., air handler schematic may be in fan room, chiller schematic in chiller room, etc.

1.9 SYSTEM ARCHITECTURE

A. General.

1. The system provided shall incorporate hardware resources sufficient to meet the functional requirements of these Specifications. The Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.

2. The control system shall consist of a high-speed, peer-to-peer network of DDC controllers, a control system server, and an operator workstation capable of expansion as specified herein.
3. System software shall be based on a server/thin-client architecture, designed around the open standards of web technology. The control system server shall be accessed using a Web browser over the control system network, the Owner's local area network, and remotely over the Internet (through the Owner's LAN).
4. The intent of the thin-client architecture is to provide operators complete access to the control system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, and trends, configure trends, configure points and controllers, or to edit programming.
5. Performance Monitoring. The EMCS will provide the specified performance monitoring functionality, including required monitoring points and performance metrics, improved through system accuracy, data acquisition and data management capabilities, and required graphical and data displays.
6. Event Response. The EMCS will provide the specified operational changes based on event response from the energy service provider.
7. All control products provided for this project shall comprise an interoperable fully-native BACnet system, including all communication media, connectors, repeaters, hubs, and routers necessary for the network. All control products provided for this project shall conform to ANSI/ASHRAE Standard 135.

B. EMCS network architecture.

1. Supervisory LAN: The LAN shall be an Ethernet-based, 100/1000 Mbps network connecting the control system servers and OWSs to routers in each building. Contractor shall utilize the Owner's Enterprise IT LAN/WAN for this purpose. This network shall be BACnet/IP as defined in Addendum A (Annex J) of the BACnet standard and shall share a common network number for the Ethernet backbone, as defined in BACnet.
2. Primary Controller LAN (Primary LAN): High-speed, peer-to-peer communicating LAN used to connect AACs, ASCs and BCs and communicate exclusively control information. Acceptable technologies include:

    a. Ethernet (IEEE 802.3).

3. Secondary Controller LAN (Secondary LAN or Sub-LAN): Network used to connect AACs and ASCs. These can be Master Slave/ Token Passing or polling, in addition to those allowed for Primary Controller LANs. Network speed vs. the number of controllers on the LAN shall be dictated by the response time and trending requirements.

C. Operator Interfaces and Servers.

1. Control Systems Server (CSS). This shall be a server upon which the systems configuration and programming databases are maintained and serves as web server for operator interface. It shall hold the backup files of the information downloaded into the individual controllers and as such support uploading and downloading that information directly to/from the controllers. It shall also act as a control information server to non-control system based programs. It shall allow secure multiple-access to the control information.
2. The Operator Workstations and Portable Operator Terminals shall provide for overall system supervision, graphical user interface, management report generation, and alarm annunciation.
3. Remote monitoring and control shall be through use of a web browser through the Owner's IT LAN and via the internet through the Owner's IT LAN.

D. Controllers. The BCs, AACs, and ASCs shall monitor, control, and provide the field interface for all points specified. Each BC, AAC, or ASC shall be capable of performing all specified energy management functions, and all DDC functions, independent of other BCs, AACs, or ASCs and operator interface devices.

E. Gateways.

1. Gateways shall be provided only as required for connection to the following:

a. Electrical Power System Controls.
b. Variable Speed Drive Controls.
c. Lighting Controls.
d. Boilers.

2. Where gateways are used, critical points shall be hard-wired from the DDC system to the controlled device, rather than using the gateway, to avoid problems with gateway failures, currently a common problem. Critical points are those that are essential for proper operation and are listed in points list as separate points. Where listed, these points shall be hard-wired even when available through gateway.

1.10 SYSTEM PERFORMANCE

A. The communication speed between the controllers, LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. This includes when system is collecting trend data for commissioning and for long term monitoring. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein, assuming no other simultaneous operator

activity. Contractor shall reconfigure LAN as necessary to accomplish these performance requirements. This does not apply to gateways and their interaction with non-EMCS-vendor equipment.

1. Object Command. The maximum time between an operator command via the operator interface to change an analog or binary point and the subsequent change in the controller shall be less than 5 seconds.
2. Object Scan. All changes of state and change of analog values will be transmitted over the network such that any data used or displayed at a controller or workstation will have been current within the previous 10 seconds.
3. Graphics Scan. The maximum time between an operator's selection of a graphic and it completely painting the screen and updating at least 10 points shall be less than 10 seconds.
4. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation or broadcast to pager (where so programmed) shall not exceed 10 seconds for a Level 1 or 2 alarm, 20 seconds for alarm levels 2 and 3, and 30 seconds for alarm levels 4 and 5. All workstations on the onsite network must receive alarms within 5 seconds of each other.
5. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The EMCS Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
6. Control Loop Performance. Programmable controllers shall be able to execute DDC PID control loops at a selectable frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

1.11 OWNERSHIP OF PROPRIETARY MATERIAL

A. All project-developed software and documentation shall become the property of the Owner. These include, but are not limited to:

1. Project graphic images
2. Record drawings.
3. Project database.
4. Project specific application programming code.
5. All documentation.

1.12 WARRANTY

A. In accordance with Division 1 Guarantees, Warranties, Bonds, Service & Maintenance Contracts, and as follows.

B. At the successful completion of the final testing, commissioning, and demonstration phase in accordance with the terms of this specification, if equipment and systems are operating satisfactorily to the Owner and if all completion requirements per paragraph 1.07 have been fulfilled, the Owner shall certify in writing that the control system has been accepted. The date of acceptance shall be the start of the warranty period.

C. Guarantee all materials, equipment, apparatus, and workmanship (including programming) to be free of defective materials and faulty workmanship for period of one year from date of acceptance.

1. Valve and damper actuators shall carry a manufacturer’s 5-year warranty.

D. Provide new materials, equipment, apparatus, and labor to replace that determined by Owner to be defective or faulty.

E. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner. The EMCS Contractor shall respond to the Owner's request for warranty service within 24 hours during normal business hours.

F. Operator workstation software, project-specific software, graphic software, database software, and firmware updates that resolve known software deficiencies as identified by the EMCS Contractor shall be provided at no charge during the warranty period. Software bugs (both due to programming misinterpretations and sequence errors) shall be corrected and any reasonable control sequence changes required to provide proper system operation shall also be provided at no additional cost during this period.

1.13 WARRANTY MAINTENANCE

A. The Owner reserves the right to make changes to the EMCS during the warranty period. Such changes do not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by the Owner unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the EMCS.

B. At no cost to the Owner, during the warranty period, the Contractor shall provide maintenance services for software and hardware components as specified below:

1. Maintenance services shall be provided for all devices and hardware specified in Division 15C. Service all equipment per the manufacturer’s recommendations.
2. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in

property damage or loss of comfort control shall be corrected and repaired following telephonic notification by the Owner to the Contractor.

3. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by the Owner to the Contractor.
4. Owner’s Telephonic Request for Service: Contractor shall specify a maximum of three telephone numbers for Owner to call in the event of a need for service. At least one of the lines shall be attended continuously (24/7). Alternatively, pagers can be used for technicians trained in system to be serviced. One of the three paged technicians shall respond to every call within 15 minutes.
5. Technical Support: Contractor shall provide technical support by telephone throughout the warranty period.
6. Preventive maintenance shall be provided throughout the warranty period in accordance with the hardware component manufacturer's requirements.
7. Record drawings and software documentation shall be updated as required to reflect any and all changes made to the system or programming during the warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS (PRODUCT LINE)

A. Johnson Controls (Metasys)

2.2 MATERIALS AND EQUIPMENT

A. Materials shall be new, the best of their respective kinds without imperfections or blemishes and shall not be damaged in any way.

B. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer

PART 3 - EXECUTION

3.1 COORDINATION

A. The Contractor shall coordinate work schedule with Architect to complete project on schedule without disruption or delays.

B. The Contractor shall coordinate work with other trades prior to construction.

C. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.

B. Refer to additional requirements in other Sections of this specification.

3.3 DIGITAL CONTROL STATIONS

A. Individual Digital Control Stations referenced on drawings to indicate allocation of points to each DCS and DCS location. Digital control stations shall consist of one or multiple controllers to meet requirements of this specification. It is the Contractor's responsibility to provide enough controllers to ensure a completely functioning system, according to the point list and sequence of operations.

B. Where a DCS is referenced, Contractor shall provide at least one (1) controller, and additional controllers as required, in sufficient quantity to meet the requirements of this Specification. Restrictions in applying controllers are specified in Section EMCS Field Panels.

C. Contractor is responsible for ensuring DCSs do not interfere with other requirements of the project and maintain adequate clearance for maintenance access.

D. DCSs have not been located. The Contractor shall locate DCSs in electrical rooms, mechanical rooms, and adjacent to rooftop equipment where space is available.

E. Contractor is responsible for ensuring DCSs do not interfere with other requirements of the project and maintain adequate clearance for maintenance access.

3.4 CONTROL POWER

A. Division 15C Contractor shall extend power to all EMCS devices, including 120V power to panels, from an acceptable power panel.

1. See Division 16 Electrical drawings for power locations pre-allocated for EMCS system.
2. Where no power source is shown, for bid purposes only, assume a dedicated circuit is available within an average of 50 feet of panel location.

If this is not the case, request additional cost prior to submission of shop drawings or no additional costs will be reimbursed.

3. Coordinate with Division 16 during shop drawing development for final connection location.

B. General requirements for obtaining power include the following:

1. Obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 460V source, obtain power from the electrically most proximate 120v source fed from a common origin.
2. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment's control transformer is large enough and of the correct voltage to supply the controls, it may be used. If the equipment's control transformer is not large enough or of the correct voltage to supply the controls, the Contractor shall provide separate transformer(s).
3. Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, and/or interruptible), the controller shall be powered by the highest level of reliability served.

C. Power line filtering. Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component.

3.5 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons during shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment.

B. Store equipment and materials inside and protect from weather.

3.6 IDENTIFICATION

A. General:

1. Manufacturers' nameplates and UL or CSA labels to be visible and legible after equipment is installed.
2. Identifiers shall match record documents.
3. All plug-in components shall be labeled such that removal of the component does not remove the label.

B. Wiring and Tubing:

1. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2" of termination with the DDC address or termination number.
2. Permanently label or code each point of field terminal strips to show the instrument or item served.
3. All pneumatic tubing shall be labeled at each end within 2" of termination with a descriptive identifier.

C. Equipment and Devices

1. Valve and damper actuators: Provide 2" diameter brass tags and brass chains. Lettering shall be 1/2" high, stamped and painted black. Indicate unique valve or damper identifier from record drawings.
2. Sensors: Provide 1"x 3"x 1/8” black micarta or lamacoid labels with engraved white lettering, 1/4" high. Indicate sensor identifier and function (e.g., “CHWS temp”).
3. Panels: Provide 2"x 5" 1/8” black micarta or lamacoid labels with engraved white lettering, 1/2" high. Indicate panel identifier and service.
4. Identify room sensors relating to terminal box or valves with indelible marker on sensor hidden by cover.

3.7 CUTTING, CORING, PATCHING & PAINTING

A. The EMCS Contractor shall provide canning for openings in concrete walls and floors and other structural elements prior to their construction. Should any openings be missed, the EMCS Contractor shall be responsible for all cutting, coring, and patching that may be required for Division 15C work. Structural elements shall not be cut without the written consent of Owner.

B. Penetrations through rated walls or floors shall be filled with an approved material to provide a code compliant firestop.

C. All damage to and openings in ductwork, piping insulation, and other materials and equipment resulting from Division 15C work shall be properly sealed, repaired, and/or re-insulated by experienced mechanics of the trade involved. Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

D. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired and repainted to original finish.

3.8 CLEANING

A. The EMCS Contractor shall clean up all debris resulting from its activities daily. The EMCS Contractor shall remove all cartons, containers, crates, etc., under its control as soon as their contents have been removed. Waste shall be collected and legally disposed of by EMCS Contractor.

B. At the completion of work in any area, the EMCS Contractor shall clean all of its work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

C. The EMCS Contractor shall use only cleaning materials recommended by the manufacturer of the surfaces to be cleaned and on surfaces recommended by the cleaning material manufacturer.

3.9 FIELD QUALITY CONTROL

A. See Division1 Quality Control.

B. Perform tests as required by authorities having jurisdiction.

C. Repair or replace defective work, as directed by Architect in writing, at no additional cost to the Owner.

D. Restore or replace damaged work due to tests as directed by Architect in writing, at no additional cost to the Owner.

E. Restore or replace damaged work of others, due to tests, as directed by Architect in writing, at no additional cost to the Owner.

F. Remedial work shall be performed to the satisfaction of the Architect, at no additional cost to the Owner, including:

1. Work related to all Division 15C pre-functional, functional, and demonstration tests.
2. Division 15C work related to Section Testing, Adjusting and Balancing for HVAC.

G. Remedial work shall include performing any commissioning or other tests related to remedial work and additional time at no additional cost to the Owner.

END OF SECTION

SECTION 15.913 EMCS BASIC MATERIALS AND DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Provide and install the following:

1. Field devices including control valves, control dampers, sensors, etc.

B. Refer to Section 15900 for general requirements.

C. Refer to Construction Drawings for points list and specific device requirements.

1.3 RELATED WORK AND REQUIREMENTS

A. Other EMCS Sections:

1. Section 15900 Energy Management and Control System (EMCS) - General
2. Section 15916 EMCS Operator Interfaces
3. Section 15919 EMCS Field Panels
4. Section 15923 EMCS Communication Devices
5. Section 15926 EMCS Software and Programming
6. Section 15933 EMCS Commissioning

1.4 GENERAL

A. Sensor selection, wiring method, use of transmitters, A-to-D conversion bits, etc. shall be selected and adjusted to provide end-to-end (fluid to display) accuracy at or better than those listed in the following table.

Measured Variable	Reported Accuracy
Space dry bulb temperature	±1ºF
Ducted air dry bulb temperature	±0.5ºF
Mixed air dry bulb temperature	±1ºF
Outside air dry bulb temperature	±0.5ºF

Measured Variable	Reported Accuracy
Chilled and condenser water temperature at central plant mains only	±0.2ºF
Chilled and condenser water temperature - general	±0.5ºF
Hot water temperature	±1ºF
Chilled water delta-t (supply to return) at central plant main supply or return only	±0.15ºF
Relative humidity – general	±5% RH
Relative humidity – outdoor air	±3% RH
Water and gas flow	±1% of full scale
Airflow (terminal)	±10% of reading
Airflow (measuring stations)	±5% of full scale
Air pressure (ducts)	±0.05 inches
Air pressure (space)	±0.01 inches
Water pressure	±2% of full scale
Electrical power	1% of reading
Carbon Dioxide (CO_2)	±75 ppm

B. The listing of several sensors or devices in each section of Part 2 does not imply that any may be used. Refer to points list in Construction Drawings for device specification. Only where two or more devices are specifically listed in points list (e.g. “FM-1 or FM-4”) may the contractor supply any of the listed products.

PART 2 - PRODUCTS

2.1 AIR TUBING

A. Seamless copper tubing, Type L-ACR, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder joint fittings, ANSI B16.22; except brass compression-type fittings at connections to equipment. Solder shall be 95/5 tin antimony, or other suitable lead free composition solder.

B. Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, and with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.

2.2 ELECTRIC WIRING AND DEVICES

A. General. All electrical work shall comply with Division 16.

B. Power Wiring.

1. Power wiring and wiring connections required for EMCS shall be provided under this section unless specifically shown on drawings or specified to be under Division 16. See Coordination section in Section 15900.
2. See Control Power section of 15900.

C. Communication Wiring.

1. Contractor shall supply all communication wiring between Building Controllers, Routers, Gateways, AAC's, ASC's and local and remote peripherals (e.g., operator workstations, printers, and modems).
2. Supervisory LAN: For any portions of this network required under this section of the specification, contractor shall use Fiber or Category 5 of standard TIA/EIA 68 (10baseT). Network shall be run with no splices and separate from any wiring over thirty (30) volts.
3. Primary and Secondary Controller LANs: Communication wiring shall be individually 100% shielded pairs per manufacturers recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over thirty (30) volts. Shield shall be terminated and wiring shall be grounded as recommended by BC manufacturer.

D. Signal Wiring.

1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gauge wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.
2. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

E. Low Voltage Analog Output Wiring.

1. Low voltage control wiring shall be minimum 16-gauge, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.

2.3 CONTROL CABINETS

A. All control cabinets shall be fully enclosed with hinged door, key-lock latch. A single key shall be common to all field panels and sub-panels within each building. Provide 3 keys.

B. Construction.

1. Indoor: NEMA-1.
2. Outdoor: NEMA 4.

C. Interconnections between internal and face-mounted devices shall be pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for service, individually identified per control/interlock drawings, with adequate clearance for field wiring. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover. Control terminations for field connection shall be individually identified per control drawings.

D. Provide ON/OFF power switch with over-current protection for control power sources to each local panel.

E. Provide with:

1. Framed, plastic-encased point list for all points in cabinet.
2. Nameplates for all devices on face.

2.4 CONTROL VALVES

A. Manufacturers:

1. Belimo
2. Siemens
3. Johnson Controls
4. Invensys
5. Delta
6. Or equal

B. Plug-Type Globe Pattern for Water Service:

1. Valves shall have cage-type trim, providing seating and guiding surfaces for plug on 'top-and-bottom' guided plugs.
2. Temperature Rating: 25˚F minimum, 250˚F maximum.
3. Body:

    a. Bronze, screwed for 1/2" to 2".
    b. Cast Iron, flanged for 2-1/2" and larger.

4. Valve Trim: Bronze; Stem: Polished stainless steel.
5. Packing: Spring Loaded Teflon or Synthetic Elastomer U-cups, self-adjusting.
6. Plug: Brass, bronze or stainless steel, Seat: Brass.
7. Disc: Replaceable Composition or Stainless Steel Filled PTFE.
8. Ambient Operating Temperature Limits: -10 to 150˚F.

C. Butterfly Type:

1. Body: Extended neck epoxy coated cast or ductile iron with full lug pattern, ANSI Class bolt pattern to match specified flanges.
2. Seat: EPDM replaceable, non-collapsible, phenolic backed.
3. Disc: Polished aluminum bronze or stainless steel pinned or mechanically locked to shaft. Sanded castings are not acceptable.
4. Bearings: Bronze or stainless steel.
5. Shaft: 416 stainless steel supported at three locations with PTFE bushings for positive shaft alignment.
6. Close Off: Bubble-tight shutoff at rated differential pressure.
7. Operation: Valve and actuator operation shall be smooth both seating and unseating. Should more than 2 psi deadband be required to seat/unseat the valve, valve shall be replaced at no additional cost to the Owner.
8. Manufacturers in Addition to those listed above:

    a. Jamesbury
    b. Keystone
    c. Dezurik
    d. Or equal

D. Characterized Ball Type:

1. Valves shall be specifically designed for modulating duty in control application with guaranteed average leak-free life span over 200,000 full stroke cycles.
2. Maximum size: 3 inch.
3. Industrial quality with nickel plated forged brass bronze bodies and female NPT threads.
4. Blowout proof stem design, glass-reinforced Teflon thrust seal washer and stuffing box ring with minimum 600 PSI rating (two way valves) or 400 PSI rating (three way valves). The stem packing shall consist of 2 lubricated O-rings designed for on-off, floating, or modulating service and requiring no maintenance.
5. Valves suitable for water or low-pressure steam shall incorporate an anti-condensation cap thermal break in stem design.
6. Ball: stainless steel.
7. Stem: stainless steel.
8. Port: Segmented design with characterizing disk held securely by a keyed ring.

E. Valve assembly pressure ratings:

1. Chilled water: 125 psi at 60˚F.
2. Hot water: 125 psi at 200˚F.
3. Condenser water. 125 psi at 60˚F.

F. Valve Selection:

1. Valve type:

    a. Modulating 2-way or 3-way valves: globe or characterized ball type. Butterfly valves may also be used for applications requiring low valve authority (pressure drop 1 psi and less) such as cooling tower bypass and boiler bypass. Valves (in conjunction with actuator) shall have minimum rangeability of 100 to 1.

        1) 3 inch and less: characterized ball type.
        2) 4 inch and greater: globe type.

    b. Two-position: butterfly or ball valves.

2. Valve Characteristic:

    a. 2-way valves: equal percentage or modified equal percentage.
    b. 3-way valves controlling cooling coils and condenser water heat exchangers: linear.
    c. 3-way valves controlling heating coils: equal percentage or modified equal percentage.
    d. Two-position valves: not applicable.

3. Valve Sizing:

    a. Modulating Water: Size valve to achieve the following full-open pressure drop:

        1) Minimum pressure drop: equal to pressure drop of coil or exchanger.
        2) Maximum pressure drop:

            a) Hot and chilled water at bridge connection: 2 psi.
            b) Hot water at coils: 2 psi.
            c) Chilled water at coils: 5 psi.
            d) Tower bypass: 1 psi.
            e) Boiler bypass: 1 psi.

        3) Three-way valves shall be selected for near minimum pressure drop. Two-way valves shall be selected near maximum pressure drop.
        4) Flow coefficient (C_v) shall not be less than 1.0 (to avoid clogging).

    b. Modulating Steam:

        1) The outlet pressure of valves for converters shall be no less than the inlet pressure required for the converters as given in plans for project.

2) As limited above, size modulating valves for applications of 15 psig or less for 80% of inlet gage pressure unless otherwise indicated.
3) As limited above, modulating valves for applications of greater than 15 psig shall be sized for 42% of inlet absolute pressure unless otherwise indicated.

c. Two-position valves: Line size unless otherwise indicated.

2.5 CONTROL DAMPERS

A. See Section 15820 Air Duct Accessories.

2.6 ACTUATORS

A. Manufacturers:

1. Belimo
2. Siemens
3. Johnson Controls
4. Delta
5. Invensys
6. Or equal

B. Warranty: Valve and damper actuators shall carry a manufacturer's 5-year warranty.

C. Electric Actuators.

1. Entire actuator shall be UL or CSA approved by a National Recognized Testing Laboratory.
2. Dampers. The actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The clamp shall be steel of a "V" bolt design with associated "V" shaped, toothed cradle attaching to the shaft for maximum strength and eliminating slippage via cold weld attachment. Single bolt or set screw type fasteners are not acceptable. Aluminum clamps are unacceptable.
3. Valves. Actuators shall be specifically designed for integral mounting to valves without external couplings.
4. Actuator shall have microprocessor based motor controller providing electronic cut off at full open so that no noise can be generated while holding open. Holding noise level shall be inaudible.
5. Actuators shall provide protection against actuator burnout using an internal current limiting circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to stalled damper or mechanical and electrical paralleling. End switches to deactivate the

actuator at the end of rotation or use of magnetic clutches are not acceptable.

6. Modulating actuators:

    a. General: Actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range. Actuators shall have positive positioning circuit so that controlled device is at same position for a given signal regardless of operating differential pressure.

7. Where shown on Drawings or Points List, actuators shall include:

    a. 2 to 10 VDC position feedback signal.
    b. Limit (end) position switches.

8. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC. Actuators operating on 120 VAC power shall not require more than 10 VA. Actuators operating on 230 VAC power shall not require more than 11 VA.
9. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation.
10. Actuators shall be provided with a conduit fitting an a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
11. Where fail-open or fail-closed position is required, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe are not acceptable. All spring return actuators shall be capable of both, clockwise or counterclockwise spring return operation by simply changing the mounting orientation.
12. Actuators shall be capable of being mechanically and electrically paralleled to increase torque where required.
13. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.
14. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed.
15. Provide limit (end) position switches where indicated on schematics.

D. Electric Actuators for Large Butterfly Valves.

1. Entire actuator shall be UL or CSA approved by a National Recognized Testing Laboratory.
2. The valve actuator shall consist of a capacitor-type reversible electric motor, gear train, limit switches and terminal block, all contained in a die cast aluminum enclosure.

3. Enclosure shall meet NEMA 4 weatherproof requirements for outdoor applications. Unless NEMA-3R indicated elsewhere.
4. Output shaft shall be electroless nickel plated to prevent corrosion.
5. Actuator shall have a motor rated for minimum 75% duty cycle. Duty cycle shall be defined as running time / Installed time at maximum torque.
6. Actuator shall be suitable for operation in ambient temperature ranging from -22˚F to +150˚F.
7. A pre-wired cable shall bring wiring outside enclosure to avoid necessity of opening cover.
8. Gears shall be hardened alloy steel, permanently lubricated. A self-locking gear assembly or a brake shall be supplied.
9. Actuator shall be equipped with a hand wheel for manual override to permit operation of the valve in the event of electrical power failure or system malfunction. Hand wheel must be permanently attached to the actuator. When in manual operation electrical power to the actuator will be permanently interrupted.
10. The hand wheel will not rotate while the actuator is electrically driven.
11. Actuator shall have heater and thermostat to minimize condensation within the actuator housing.
12. Provide limit (end) position switches where indicated on schematics.

E. Normal Position. Actuators shall be spring return to the normal position, unless non-spring style is specifically listed as acceptable in table below. Except as specified otherwise, “normal” positions of control devices shall be as follows:

Device	Normal Position	Spring Return Required
Outside air damper	CLOSED	Yes
Return air damper	OPEN	Yes
Exhaust/relief air damper	CLOSED	Yes
AHU heating coil valves	OPEN	
AHU cooling coil valves	CLOSED	
Equipment isolation valves:	OPEN	
Hot water reheat coil valves	CLOSED	
Fan coil HW and CHW valves	CLOSED	
VAV box dampers	OPEN	

F. Valve Actuator Selection:

1. Modulating actuators for valves shall have minimum rangeability of 50 to 1.
2. Water:

    a. Two way and two-position valves:

        1) Tight closing against 125 percent of system pump shut-off head.

2) Modulating duty against 90 percent of system pump shut-off head.

b. Three-way shall have close-off against twice the full open differential pressure for which they are sized.

G. Damper Actuator Selection:

1. Actuators shall be direct coupled. For multiple sections, provide one actuator for each section; linking or jack-shafting damper sections shall not be allowed.
2. Provide sufficient torque as velocity, static, or side seals require per damper manufacturer's recommendations and the following.

a. Torque shall be a minimum 5 in-lb. per sq. ft. for opposed blade dampers and 7 in-lb. per sq. ft. for parallel blade dampers.
b. The total damper area operated by an actuator shall not exceed 80% of the manufacturer's maximum area rating.

2.7 GENERAL FIELD DEVICES

A. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.

B. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

C. Field devices specified herein are generally ‘two-wire’ type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, or is not designed to work with ‘two-wire’ type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide ‘four-wire’ type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.

E. Accuracy: As used in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis. Sensor accuracy shall be at or better than both that specifically listed for a device and as required herein.

2.8 TEMPERATURE SENSORS (TS)

A. General:

1. Unless otherwise noted, sensors may be platinum RTD, thermistor, or other device that is commonly used for temperature sensing and that meets accuracy, stability, and resolution requirements.
2. When matched with A/D converter of BC, AAC, or ASC, sensor range shall provide a resolution of no worse than 0.3°F (unless noted otherwise).
3. Sensors shall drift no more than 0.3˚F and shall not require calibration over a five-year period.
4. Manufacturers:

    a. Mamac.
    b. Kele Associates
    c. Building Automation Products
    d. Or equal

B. Duct temperature sensors. Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Sensor probe shall be 316 stainless steel.

1. TS-1A. Single point (use where not specifically called out to be averaging in points list).
2. TS-1B. Averaging. Sensor length shall be at least 1 linear foot for each 3 square feet of face area up to 25 feet maximum.

C. Water temperature sensors.

1. TS-2A: Immersion sensors. All piping immersion sensors shall be in brass or stainless steel wells that allow removal from operating system, with lagging extension equal to insulation thickness where installed in insulated piping. Wells shall be rated for maximum system operating pressure, temperature and fluid velocity. The well shall penetrate the pipe by the lesser of half the pipe diameter or four inches. The use of direct immersion or strap-on type sensors is not acceptable.
2. TS-2B. Same as TS-2A except provide matched temperature sensors for differential temperature measurement, e.g. chilled water supply and return temperature.
3. TS-2C. Same as TS-2A or TS-2B (matched pair) with the following added requirements (for extremely high accuracy and stability at central plant main supply/return chilled water temperature sensors): Each assembly shall consist of a 100 Ohm platinum RTD and a solid-state 4-wire, 4-20mA transmitter contained in a housing suitable for pipe mounting, spring-loaded probe to ensure good thermal contact between the sensor and the well. Manufacturer must be certified as meeting the requirements of ISO 9001. RTD shall conform to the DIN 437601980 standards (Ultra precision

DIN RTD). 2 Year NIST traceable guarantee. Manufacturer: Accutech AI-2000, or equal.

D. Room sensors: Shall be an element contained within a ventilated cover, suitable for wall mounting, with insulated base.

1. TS-3A.

a. Thermistor in enclosure with blank cover.
b. Include a USB port for connection of portable Operator Interface.

2. TS-3B. Same as TS-3A except.

a. Setpoints shall be adjustable at wall mounted sensor with setpoint knobs with software limits.
b. Override button capable of being programmed to start system during unscheduled hours.

3. TS-3C. Same as TS-3B except.

a. Integral LCD display of space temperature and active setpoint.

4. Unless otherwise indicated in points list, locate sensors as follows:

a. Lobbies, corridors, break rooms, and other public spaces: TS-3B.
b. Equipment rooms: TS-3A
c. Offices and other spaces not listed above: TS-3C.
d. Others not listed: Confirm with Architect through RFI.

E. TS-4. Outdoor air sensors shall have a sun shield, utility box, and watertight gasket to prevent water seepage.

F. Temperature Transmitters. Where required by Controller, or to meet specified end-to-end accuracy requirements, sensors as specified above shall be matched with transmitters outputting 4-20 mA linearly across the specified temperature range. Transmitters shall have zero and span adjustments, an accuracy of 0.1˚F when applied to the sensor range.

2.9 HUMIDITY TRANSMITTERS (HT)

A. General:

1. Suitable for duct, wall (room) or outdoor mounting as indicated in points list and Construction Drawings.
2. Two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor producing a continuous 4-20 mA output proportional to percent relative humidity (%RH).

3. Input Range: 0 to 100% RH.
4. Accuracy (%RH), NIST Traceable and certified at 77˚F over 20-95% RH including hysteresis, linearity and repeatability:

    a. HT-1: ±2%
    b. HT-2: ±3%

5. Sensor Operating Range:

    a. Humidity: 0-99%, non-condensing, sensor.
    b. Temperature: 32˚F to 122˚F

6. Temperature Effect: Less than 0.06% per ˚F at baseline of 77˚F.
7. Sensitivity: 0.1% RH.
8. Repeatability: 0.5 RH.
9. Hysteresis: Less than 1%.
10. Long Term Stability: Less than 2% drift per 5 years.
11. Manufacturer:

    a. Vaisala HM Series
    b. Automation Components Inc. RH Series
    c. Or equal

2.10 CO_2 SENSORS/TRANSMITTERS (CO2)

A. CO2-1. Wall mounted.

1. Non-dispersive infrared sensor with dual beam technology where a reference channel is used to maintain sensor calibration.
2. Detachable base with all field wiring terminations on base.
3. Accuracy: ±50 ppm or 5% of reading from 0 to 1500 ppm at temperatures from 60°F to 90°F.
4. Factory calibrated and set to 0-2000 ppm range (equals 4-20 mA or 0-10 V).
5. Include elevation adjustment.
6. The sensor shall not require recalibration for a minimum of 5 years, guaranteed. If sensor is found to be out of calibration, supplier shall recalibrate at no additional cost to the Owner within 5 years of purchase date.
7. LCD display.
8. Manufacturers:

    a. Telaire 8102
    b. Vaisala GMV21
    c. AirTest EE80-2CT
    d. Or equal

B. CO2-2. Same as CO2-1 except duct mounted.

2.11 DIFFERENTIAL PRESSURE TRANSMITTERS (DPT)

A. DPT-1. Water, General Purpose.

1. Fast-response capacitance sensor.
2. Two-wire transmitter, 4-20 mA output with zero and span adjustments.
3. Accuracy.
    a. Overall Accuracy (at constant temp) ±0.25% full scale (FS).
    b. Non-Linearity, BFSL ±0.20% FS.
    c. Hysteresis 0.10% FS.
    d. Non-Repeatability 0.05% FS.
4. Long Term Stability 0.5% FS per year.
5. Only 316 stainless steel in contact with fluid.
6. Pressure limits.
    a. 0 to 100 psid range: 250 psig maximum static pressure rating, 250 psig maximum overpressure rating.
    b. 100 to 300 psid range: 450 psig maximum static pressure rating, 450 psig maximum overpressure rating.
7. Include brass 3-valve assembly. See sensor installation specifications below.
8. Manufacturers:
    a. Setra 230
    b. Modus W30
    c. Or equal

B. DPT-2. Air, Duct Pressure:

1. General: Loop powered two-wire differential capacitance cell-type transmitter.
2. Output: two wire 4-20 mA output with zero adjustment.
3. Overall Accuracy: ±1% scale.
4. Minimum Range: 0.5 in. w.c.
5. Maximum Range: 10 inches w.c.
6. Housing: Polymer housing suitable for surface mounting.
7. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301, Davis Instruments, or equal and connecting tubing.
8. Range: Select as specified in points list or, if not listed for specified setpoint to be between 25% and 75% full-scale.
9. DPT-2A: Include LCD display of reading.
10. Manufacturers:

a. Veris
b. Setra
c. Modus
d. Invensys
e. Dwyer
f. Or equal

C. DPT-3. Air, Low Differential Pressure (space pressure).

1. General: Loop powered, two-wire differential capacitance cell type transmitter.
2. Output: Two-wire 4-20 mA output with zero adjustment.
3. Overall Accuracy:

    a. General ±1% FS.
    b. Minimum outdoor air damper DP used for minimum outdoor airflow: ±0.25% FS.

4. Range:

    a. Non-switch selectable.
    b. Minimum Range: 0, -0.1, -0.25, or -0.5 inches w.c.
    c. Maximum Range: +0.1, 0.25, or 0.5 inches w.c.
    d. Range shall be as specified in points list or, if not listed, selected such that specified setpoint is between 25% and 75% full-scale.

5. Housing: Polymer housing suitable for surface mounting.
6. Static Sensing Element:

    a. Ambient sensor: Dwyer A-306.
    b. Space sensor: Kele SPS, BAPI ZPS-ACC-01, Dwyer A-417 or 465, or equal wall plate sensor.
    c. Filter or duct pressure sensor: Dwyer A-301 or equal.
    d. Plenum pressure sensor: Dwyer A-421 or equal.

7. DPT-3A: Include LCD display of reading.
8. Manufacturers:

    a. Setra 267
    b. Air Monitor
    c. Paragon
    d. Or equal

D. DPT-4. VAV Velocity Pressure:

1. General: Loop powered two-wire differential capacitance cell type transmitter.
2. Output: Two-wire, 4-20 mA output with zero adjustment.

3. Flow transducer (including impact of A-to-D conversion) shall be capable of stably controlling to a setpoint of 0.004" differential pressure or lower, shall be capable of sensing 0.002" differential pressure or lower, and shall have a ±0.001" or lower resolution across the entire scale.
4. Minimum Range: 0 in. w.c.
5. Maximum Range: 1.5 inch w.c.
6. Housing: Polymer housing suitable for surface mounting.
7. Manufacturer:

    a. Trane
    b. Johnson Controls
    c. Siemens
    d. Veris
    e. Or equal

2.12 DIFFERENTIAL PRESSURE SWITCHES (DPS)

A. DPS-1. Water: Diaphragm with adjustable setpoint, 2 psig or adjustable differential and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range. 0˚F to 160˚F operating temperature range.

B. DPS-2. Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing.

2.13 WATER LEAK DETECTOR (WLD)

A. WLD-1:

1. Gold plated adjustable sensing probes to detect water from 0 to 1/8 inch above surface.
2. All electronic circuitry encapsulated in epoxy to protect from dirt, fungus and short term immersion in water.
3. DPDT (2 form C) relay contact outputs rated at 1 amp @ 28 VDC.
4. Powered with 12-24 VAC or VDC from EMCS panel. Battery not acceptable.
5. 5 year warranty minimum.
6. Manufacturer:

    a. Dorlen Water Alert SS-4'
    b. Or equal

2.14 CURRENT SWITCHES (CS)

A. CS-1

1. Clamp-on or solid-core
2. Range: 1.5 to 150 amps (or as required by application).
3. Trip Point: Adjustable.
4. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
5. Lower Frequency Limit: 6 Hz.
6. Trip Indication: LED
7. Approvals: UL, CSA
8. May be combined with relay for start/stop.
9. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing with override switch. Kele RIBX, Veris H500, or equal.
10. Manufacturers:

    a. Veris Industries H-608/708/808/908; Inc.
    b. RE Technologies SCS1150A-LED
    c. Or equal

2.15 CURRENT TRANSFORMER (CT)

A. Clamp-On Design Current Transformer (for Motor Current Sensing)

1. Range: 1-10 amps minimum, 20-200 amps maximum.
2. Trip Point: Adjustable.
3. Output: 0-5 VDC.
4. Accuracy: ±0.2% from 20 to 100 Hz.
5. Manufacturers:

    a. Kele SC100
    b. Veris 722
    c. Or equal

2.16 FLOW METER (FM)

A. FM-1. Magnetic Insertion Type Flow Meters for Water Service.

1. Magnetic Faraday point velocity measuring device.
2. Insertion type complete with 'hot-tap' isolation valves to enable sensor removal without water supply system shutdown.
3. 4-20 mA transmitter proportional to flow or velocity.
4. Accuracy: ± 1% of reading from 0.25 to 20 fps.
5. Flow range: 0.25 to 20 fps, bidirectional.
6. Each sensor shall be individually calibrated and tagged accordingly against the manufacturer's primary standards which must be accurate to within 0.1% and traceable to the U.S. National Institute Standards and Technology (NIST).

7. Manufacturers:

    a. Onicon F-3500
    b. FloCat YD20-A
    c. Marsh McBirney MultiMag 284
    d. SeaMetrics 100/200 Series

B. FM-2: Displacement Gas Meter.

1. Positive displacement, rotary type gas meter designed for volumetric measurement of widely varying flow rates of low pressure natural gas.
2. Permanent, non-adjustable calibration, not affected by low or varying line pressure and independent of the gas specific gravity, temperature, and pressure.
3. Manufactured in accordance with ANSI B109.3 for Rotary Type Gas Displacement Meters.
4. Operating temperature range: -40 ˚F to +140 ˚F.
5. Temperature compensating with a corrected reading for temperatures ranging from -20 ˚F to +120 ˚F.
6. Low frequency pulse output.
7. Rangeability at ±1% accuracy: Minimum 40 to 1.
8. Glass enclosed 8 digit totalizer, re-zeroed with on-board device.
9. Manufacturers:

    a. Dresser Roots B3
    b. Or equal

C. FM-3. Compound-type cold water meter.

1. Shall consist of a combination of a turbine-type, mainline meter for measuring high rates of flow and a bypass meter of an appropriate size for measuring low rates of flow. The compound meter shall have an automatic valve mechanism for diverting low rates of flow through the bypass meter.
2. Comply or exceed the latest revision of AWWA C702.
3. Maximum operating pressure of 150 psi and maximum operating temperature of 120 ˚F continuous.
4. Shall provide a pulse output scaled to a selectable unit of measurement; i.e., 1 pulse per gallon. The pulse output needs to retain the lowest flow rate and the accuracy that the meter is capable of. A 3-wire pulse output is required for connection to EMCS. The 3-wires are ground, pulse output, and an optional output voltage. The pulse output shall not require the EMCS to supply power to the meter Pulse Encoder system.
5. Shall have permanently sealed, straight reading local register indicating in gallons, including a center-sweep test hand, a low flow indicator, totalizer, and a glass lens. The registers shall be serviceable without interruption of the meter's operation.

6. Separate magnetic-drive registers shall record the flow of the turbine and disc meters and their total will be the registration of the compound meter. A single pulse output denoting the total high and low flow will be required.
7. Operating characteristics: Shall comply with the operating characteristics shown below:

Size	Normal Operating Range @100% +/- 1.5% accuracy (gpm)	Maximum Continuous Flow (gpm)	Maximum Loss of Head at Max Cont Flow (psi)	Maximum Intermittent Flow (gpm)	Lowest Flow @ 95% accuracy (gpm)	Minimum Accuracy at Crossover (%)
2"	1/2 - 200	160	8	200	1/4	97
3"	1/2 - 450	350	8	450	1/4	97
4"	1 - 1000	700	11	1000	3/8	97
6"	1 1/2 - 2000	1400	10	2000	3/8	95

8. Size: the size shall be determined by: a) Laying Length: nominal size (in inches) of the opening in the inlet and outlet flanges and b) Total Height: nominal size (in inches) from the lowest point of the meter installed for horizontal flow to the highest point. The size of meters shall not exceed:

Meter Size	**Laying Length (in)**	**Total Height (in)**
2"	15 1/4	11
3"	17	12
4"	20	16
6"	24	17

9. Materials: The main case wetted parts shall be cast from an ANSI/NSF 61 certified no lead high copper alloy. A test plug shall be located in the main case or the cover for the purpose of field testing of the meter. Casing bolts shall be made of stainless steel.
10. Manufacturers:

    a. Badger Recordall Compound Meter, Bronze Housing with Pulse Output (two RTR registers and summator/converter)
    b. Or equal

2.17 BTU METER (BTU)

A. BTU-1. BTU meter.

1. Matched RTD or solid state temperature sensors with a differential temperature accuracy of ± 0.15 ˚F.
2. Flow meter: FM-1.

3. Unit accuracy shall be ± 1% factory calibrated, traceable to NIST with certification.
4. NEMA 1 enclosure.
5. UL listed.
6. Provide BACnet MS/TP network connection that will allow all point data to be transmitted to EMCS network.
7. Manufacturers:

    a. Onicon.
    b. Siemens Sitrans.
    c. Or equal.

2.18 AIRFLOW MEASURING STATIONS (AFMS)

A. AFMS-1. Airflow measurement in ducts, plenums and fan inlets.

1. The AFMS shall be an array of sensors mounted across the entire area of the duct, plenum, and fan inlet in which the AFMS is mounted.
2. Include electronic devices or transducers to provide a 4-20 mA or 0-10 Vdc signal proportional to airflow or velocity with specified accuracy over entire range. Additionally, include one isolated RS-485 network connection to communicate with a BACnet MS/TP network.
3. LCD display.
4. Performance:

    a. Sensors shall be calibrated to NIST-traceable standards for airflow/velocity.
    b. Factory tested prior to shipment and shall not require calibration or adjustment over the life of the equipment, when installed in accordance to manufacturer's guidelines.
    c. The installed total accuracy for airflow shall be better than ±3% of reading over the sensor probe operating ranges when installed in accordance with manufacturers' guidelines. Installed accuracy shall include the probe itself plus the electronics for converting probe signal to an electronic signal proportional to airflow and shall be demonstrated at both maximum and minimum airflow rates of operating range.
    d. Operating Range: 50 to 4,000 FPM.

5. Duct & Plenum Mounted Sensor Probes:

    a. Sensor probes shall be constructed of anodized aluminum alloy tube with stainless steel mounting brackets. Probes shall be constructed to provide insertion, internal, or standoff mounting, depending on the applications and field installation requirements.

b. Probe Sensor Density. The number of independent sensing points shall be distributed per duct face area, at a minimum quantity as indicated below.

Area (ft^2)	Sensors
<= 1	2
>1 to <4	4
4 to <8	6
8 to <12	8
12 to <16	12
>=16	16

c. Pressure drop: The maximum allowable unrecovered pressure drop caused by the probes shall not exceed .025" at 2000 FPM, or .085" at 4000 FPM.

6. Fan Inlet Mounted Sensor Probes:

a. Sensor probes shall be constructed of anodized aluminum alloy tube with stainless steel mounting brackets. Probes shall be constructed to provide insertion, internal, or standoff mounting, depending on the applications and field installation requirements.
b. Fan inlet probe size per manufacturer's recommendations.

7. Manufacturers:

a. Ebtron Gold Series
b. Ruskin EAMP
c. Or equal

2.19 POWER METERS

A. (PM-2) Power meter with BACnet Communication.

1. Electronic with multi-line backlit LCD display indicating measured parameters as well as alarm functions and pulse output.

2. Include the following measurements:

a. Accumulated Real Energy (kWh) for each phase and total of all phases.
b. Accumulated Reactive Energy (kVARh) and Apparent Energy (kVAh) totals for all phases.
c. Net Present Demand for Real (kW), Reactive (kVAR) and Apparent (kVA) Power over a user-specified interval (block or sliding window).

d. Maximum (Peak) Real (kW), Reactive (kVAR) and Apparent (kVA) Demand Intervals.
e. Instantaneous Real (kW), Reactive (kVAR) and Apparent Power (kVA), by phase and in total.
f. Current (amps) for each phase and average of all phases.
g. Phase-to-phase voltage for each phase and average of all phase pairs.
h. Phase-to-neutral voltage for each phase pair and average of all phases.
i. Power factor for each phase and average of all phases.
j. AC frequency.

3. BACnet MS/TP communication protocol.
4. UL/CUL listed.
5. Accuracy: Meet both ANSI C12.20 .5% and IEC 62053-22 Class .5S real power and energy accuracy specifications.
6. Phase Loss Alarm contacts with a user configurable phase loss threshold.
7. Manufacturers:

a. Veris E50H2.
b. Or equal.

2.20 ELECTRONIC CONTROL COMPONENTS

A. Limit Switches (LS): Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley, or equal.

B. Line-Voltage Wall Thermostat: Wall-mounted thermostat shall consist of SPDT contacts rated for 120V and current as required for application, temperature setpoint range of 50 to 95□ F, and an adjustable 2-10□F setpoint differential.

C. Low Temperature Detector (Freeze-stat) (LLT-1): Low temperature detector shall consist of a cold spot element that responds only to the lowest temperature along any one foot of entire element, minimum bulb size of 1/8 inch x 20 feet, junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPST (4 wire 2 circuit) with manual reset, Temperature range 15 to 55˚F, factory set at 38˚F.

D. Control Relays: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.

1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:

a. AC coil pull-in voltage range of +10%, -15% or nominal voltage.

b. Coil sealed volt-amperes (VA) not greater than four (4) VA.
c. Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.
d. Pilot light indication of power-to-coil and coil retainer clips.

2. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP, shall be rated to break minimum 10 Amps inductive load.
3. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.

E. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA type 1enclosure. Manufacturer shall be Square 'D', Cutler-Hammer, or equal.

F. Control Transformers and Power Supplies:

1. Control transformers shall be UL Listed. Furnish Class 2 current-limiting type, or furnish over-current protection in both primary and secondary circuits for Class 2 service per NEC requirements. Mount in minimum NEMA-1 enclosure.
2. Transformer shall be proper size for application. Limit connected loads to 80% of rated capacity.
3. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100 microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection, and shall be able to withstand a 150% current overload for at least 3 seconds without trip-out or failure.
4. Unit shall operate between 0°C and 50°C [32°F and 120°F]. EM/RF shall meet FCC Class B and VDE 0871 for Class B, and MIL-STD 810C for shock and vibration.
5. Line voltage units shall be UL Recognized and CSA Approved.

G. Electric Push Button Switch: Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley, Kele, or equal.

H. Alarm Horn: Panel-mounted audible alarm horn shall be continuous tone, 120 Vac Sonalert solid-state electronic signal, as manufactured by Mallory, Kele, or equal.

I. Electric Selector Switch (SS): Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be

rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen-Bradley, Kele, or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Install electrical components and use electrical products complying with requirements of National Electric Code and all local codes.

3.3 ELECTRICAL INSTALLATION

A. Wiring.

1. Comply with Division 16.
2. All NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway per NEC requirements and shall be installed by a licensed electrician.
3. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.) Class 2 wiring shall be installed in UL Listed approved raceway, except where wires are in concealed in accessible locations, approved cables not in raceway may be used, provided that cables are UL Listed for the intended application. For example, cables used in ceiling return plenums shall be UL Listed specifically for that purpose.
4. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
5. Do not install wiring in raceway containing tubing.
6. Where Class 2 wiring is used without raceway, it shall be supported from or anchored to structural members neatly tied at 10 foot intervals. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems and at least 1 foot above ceiling tiles and light fixtures.

7. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
8. All field wiring shall be properly labeled at each end, with self-laminating typed labels indicating device address, for easy reference to the identification schematic. All power wiring shall be neatly labeled to indicate service, voltage, and breaker source.
9. Use coded conductors throughout with different colored conductors.
10. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
11. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the Contractor shall provide step-down transformers.
12. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
13. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
14. Size of raceway and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendation and NEC requirements.
15. Include one pull string in each raceway 1 inch or larger.
16. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
17. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6” from high-temperature equipment (e.g., steam pipes or flues).
18. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
19. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.
20. The EMCS Contractor shall terminate all control and/or interlock wiring, and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
21. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 feet in length and shall be supported at each end. Flexible metal raceway less than ½” electrical trade size shall not be used. In areas exposed to moisture liquid-tight, flexible metal raceways shall be used.
22. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (per code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.
23. Electrical service to controls panels and control devices shall be provided by isolated circuits, with no other loads attached to the circuit, clearly

marked at its source. The location of the breaker shall be clearly identified in each panel served by it. If a spare breaker is not available within an electrical panel, the EMCS Contractor shall be responsible for providing any and all equipment and labor necessary to supply an isolated circuit. Controllers controlling only packaged air conditioning equipment may be powered directly from the packaged units control circuit.

24. Wire digital outputs to either the normally-closed or normally-open contacts of binary output depending on desired action in case of system failure. Unless otherwise indicated, wire to the NO contact except the following shall be wired to the NC contact:

    a. Hot water pumps.
    b. Coil recirc' pumps provided for freeze protection.

25. Hardwire Interlocks.

    a. The devices referenced in this section are hardwire interlocked to ensure equipment shutdown occurs even if control systems are down. Do not use software (alone) for these interlocks.
    b. Hardwire device NC contact to air handler fan starter upstream of HOA switch, or to VFD enable contact.
    c. Where multiple fans (or DDC DI) are controlled off of one device and the device does not have sufficient contacts, provide a relay at the device to provide the required number of contacts.
    d. Provide for the following devices where shown on plans:

        1) Duct smoke detector.
        2) High discharge static pressure.
        3) Low mixing plenum pressure.
        4) Freeze-stats.

B. Communication Wiring.

1. The EMCS Contractor shall adhere to the requirements of paragraph 3.3A in addition to this section.
2. Communication and signal wiring may be run without conduit in concealed, accessible locations as permitted by paragraph 3.3A only if noise immunity is ensured. Contractor will be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance.
3. All cabling shall be installed in a neat and workmanlike manner. Follow all manufacturers' installation recommendations for all communication cabling. Use shielded wiring if recommended by manufacturer.
4. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

5. Maximum pulling, tension, and bend radius for cable installation as specified by the cable manufacturer shall not be exceeded during installation.
6. EMCS Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
7. All runs of communication wiring shall be un-spliced length when that length is commercially available.
8. All communication wiring shall be labeled to indicate origination and destination data.
9. Grounding of coaxial cable shall be in accordance with NEC regulations Article on Communications Circuits, Cable and Protector Grounding.
10. Shielded cable shield shall be grounded only at one end.
11. Power-line carrier signal communication/transmission is not acceptable.

3.4 INSTALLATION OF SENSORS

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

C. Temperature Sensors.

1. Room temperature sensors/thermostats shall be installed on concealed junction boxes properly supported by the wall framing.
2. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
3. Averaging sensors shall be installed in a serpentine manner vertically across duct. Each bend shall be supported with a capillary clip. Where located in front of filters (e.g. mixed air sensors), access for filter removal shall be maintained.
4. For sensors specified to be calibrated using a dry well bath (see points list), install sensors with a sufficient wiring/flexible conduit lead that sensor may be removed from well or duct and placed in an ice bath or dry well for calibration. The spare wiring/flexible conduit shall be no less than 3’ in length.
5. All pipe-mounted temperature sensors shall be installed in wells. Install the sensor in the well with a thermal-conducting grease or mastic. Use a closed-cell insulation patch that is integrated into the pipe insulation system to isolate the top of the well from ambient conditions but allow easy access to the sensor. Install a test plug adjacent to all wells for testing and calibration.
6. Unless otherwise noted, temperature sensors/thermostats, humidity sensors/humidistats, CO_2 sensors, and other room wall mounted sensors shall be installed at same centerline as adjacent electrical switches, 4’-0”

above the finished floor where there are no adjacent electrical switches, and within ADA limitations.

7. Unless otherwise noted, install outdoor air temperature sensors on north wall, complete with sun shield, where they will not be influenced by building exhaust, exfiltration, or solar insolation. Do not install near intake or exhaust air louvers.

D. Differential Pressure Sensors.

1. Supply Duct Static Pressure: Locate transmitter in temperature control panel near or in DDC panel to which it is wired. Connect the low-pressure port to tee in building pressure (high) signal of the building static pressure transmitter. Pipe the high-pressure tap to the duct using a static pressure tip. Locate static pressure tip as shown on drawings; if no location is shown, locate at end of duct riser or main as far out in the system as possible but upstream of all smoke and fire dampers. Install pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions.
2. Filter Differential Pressure:

    a. Install static-pressure tips upstream and downstream of filters with tips oriented in direction of flow.
    b. Mount transmitter on outside of filter housing or filter plenum in an accessible position with LCD display clearly visible. This sensor is used in lieu of an analog gauge and thus must be readily viewable.

3. Building Static Pressure:

    a. Low pressure port of the pressure sensor:

        1) Pipe to the ambient static pressure probe located on the outside and at high point of the building through a high-volume accumulator or otherwise protected from wind fluctuations.

    b. High-pressure port of the pressure sensor:

        1) Pipe to either:

            a) Behind a DDC temperature sensor cover in an interior zone.
            b) Bosco or Dwyer plate sensor mounted in ceiling.

        2) Do not locate near elevators, exterior doors, atria, or (for ceiling sensor applications) near diffusers.

4. All pressure transducers, other than those controlling VAV boxes, shall be located where accessible for service without use of ladders or special

equipment. If required, locate in field device panels and pipe to the equipment monitored or ductwork.

5. The piping to the pressure ports on all pressure transducers (both air and water) shall contain a capped test port located adjacent to the transducer.
6. Piping differential pressure transducers shall have three valve manifold, two valves to allow removal of sensor without disrupting the hydronic system plus an equalizing valve to allow the sensor to be zeroed and to prevent sensor from experiencing full static (as opposed to differential) pressure, plus test plugs on each connection (also used as vents).
7. Copper tubing shall be installed in a neat manner (parallel and perpendicular to the building structure, equipment, piping, etc. from which it is supported) and shall be properly supported. Changes to copper tubing installation resulting from failure to comply with this requirement shall be made at the discretion of the Architect at no additional cost to the Owner.

E. Relative Humidity Sensors: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.

F. Flow Switches: Install in a straight run of pipe at least 10 diameters in length to minimize false indications.

G. Current Switches for Motor Status Monitoring: Adjust so that setpoint is below minimum operating current and above motor no load current.

H. Airflow Measuring Stations: Install per manufacturer's recommendations in an unobstructed straight length of duct both upstream and downstream of sensor, except those installations specifically designed for installation in fan inlet. For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFMS manufacturer.

I. Fluid Flow Sensors: Install per manufacturer's recommendations in an unobstructed straight length of pipe both upstream and downstream of sensor.

3.5 ACTUATORS

A. Type.

1. Actuators for two-position valves may be pneumatic or electric at the option of the Division 15C contractor.
2. Actuators for high pressure (125 psig) steam, both modulating and two-position, shall be pneumatic.
3. Except where listed above, actuators shall be electric.

B. Mount and link control damper actuators per manufacturer's instructions.

C. Dampers:

1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage, or follow manufacturer's instructions to achieve same effect.
2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
3. Provide all mounting hardware and linkages for actuator installation.

D. Control Valves: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.

END OF SECTION

SECTION 15.916 EMCS OPERATOR INTERFACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Provide and install the following:

1. Operator Workstation(s)
2. Servers
3. Portable Operator Terminal
4. Uninterruptible Power Supply
5. Backup Device
6. Printers

B. Refer to Section 15900 for general requirements.

1.3 RELATED WORK AND REQUIREMENTS

A. Other EMCS Sections:

1. Section 15900 Energy Management and Control System (EMCS) - General
2. Section 15913 EMCS Basic Materials and Devices
3. Section 15919 EMCS Field Panels
4. Section 15923 EMCS Communication Devices
5. Section 15926 EMCS Software and Programming
6. Section 15933 EMCS Commissioning

PART 2 - PRODUCTS

2.1 OPERATOR WORKSTATION (OWS)

A. Hardware:

1. 3.2 GHz (minimum)
2. 4 GB SDRAM (minimum)

3. 8X DVD +/- RW Drive
4. 250 GB hard disk (minimum)
5. Ethernet 100 GB internal network card (for connection to Supervisory LAN)
6. 24” LED HD color, 1920 x 1080 pixel display monitor
7. 3-button optical USB mouse
8. USB Keyboard
9. Internal speakers
10. Energy Star configured
11. One spare serial port and one spare USB port in addition to those needed for specified peripherals.
12. 24x7 dedicated technical support service that delivers reduced hold time, direct access to advanced level technicians, and reduced time to resolution, minimum 1 year.

B. Software:

1. By PC Supplier (factory installed):

a. Operating system: Microsoft Windows 8 Professional.
b. Browser: Microsoft Internet Explorer.
c. Office Suite: Microsoft Office Professional.
d. CD Burner Software: Standard software provided by computer supplier.
e. All software shall be at least the latest version available as of the date of purchase.

2. By EMCS Contractor:

a. See Section 15926.

2.2 CONTROL SYSTEM SERVER (CSS)

A. Hardware:

1. Dual Processor 3.2 GHz (minimum)
2. 4 GB DDRAM (minimum)
3. 4 Bay (1x4) Hot Plug SCSI Hard Drive Backplane with dual 500 GB (minimum) SCSI hard disks connected to on-board 128MB Battery Backed Cache, 2 Internal Ch- Embedded RAID controllers
4. 24X (minimum) CD ROM drive
5. One Ethernet 100 GB internal network card (for connection to Supervisory LAN)
6. One Ethernet 1000 Gigabit NIC-Fiber network card (for connection to Owner’s WAN)
7. Redundant AC power supplies

8. 19” color , 1280 x 1024 pixel display
9. 3-button optical USB mouse
10. USB Keyboard
11. Energy Star configured
12. One spare serial port and one spare USB port in addition to those needed for specified peripherals.
13. 24x7 dedicated technical support service that delivers reduced hold time, direct access to advanced level technicians, and reduced time to resolution, minimum 1 year.

B. Software:

1. By PC Supplier (factory installed):

a. Operating system: Microsoft Windows Server 2012.
b. Browser: Microsoft Internet Explorer.
c. All software shall be at least the latest version available as of the date of purchase.

2. By EMCS Contractor:

a. See Section 15926.

C. CSS shall be configured to secure it to the extent practical inside the Supervisory LAN with firewall software provided by the Contractor.

2.3 PORTBLE OPERATORS TERMINAL (POT)

A. Portable Operators Terminal shall support system management by connection to the controllers, by connection via the Supervisory LAN, Owner’s Intranet, or Internet; or by dial-up communications.

B. Hardware:

1. 1.6 GHz (minimum)
2. 4 GB SDRAM (minimum)
3. 250 GB hard disk (minimum)
4. 24X (minimum) CD ROM drive (built-in)
5. Ethernet 100 GB internal network card (for connection to Supervisory LAN)
6. 15.6” color, 1366x768 Anti-Glare WLED-Backlit display
7. Touch pad
8. Rechargeable battery, spare battery and 110V power supply/charger
9. Internal speakers
10. Parallel, Serial and USB port
11. Vinyl carry-bag

12. IEEE 802.11b (DSSS) 2.4GHz-Compliant wireless PCMCIA card (compatible with wireless router; see Section 15923).
13. 24x7 dedicated technical support service that delivers reduced hold time, direct access to advanced level technicians, and reduced time to resolution, minimum 1 year.

C. Software:

1. By PC Supplier (factory installed):

a. Operating system: Microsoft Windows 7 Professional.
b. Browser: Microsoft Internet Explorer
c. Office Suite: Microsoft Office Professional
d. CD burner software: Standard software provided by computer supplier.
e. All software shall be at least the latest version available as of the date of purchase.

2. By EMCS Contractor

a. See Section 15926.

2.4 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Back-UPS ES battery backup and surge protection.

B. EMI/RFI filtering to FCC Class B.

C. Lightning and surge protection for all outlets.

D. Stepped sine wave output.

E. Wide input voltage range.

F. Automatic battery testing.

G. Continuous battery monitoring.

H. Continuous overload monitoring.

I. Sufficient to power all EMCS devices in Central Plant/Mechanical Room at full load for 5 minutes after power failure.

2.5 BACKUP DEVICES

A. Network Laser Printer:

1. Print Quality: 1200 x 1200 dpi resolution.
2. Speed: 25 pages per minute; print time of less than 9 seconds to first page.
3. Cartridge / Printhead Duty Cycle: 5000 pages.
4. Paper Size: 8.5x11.
5. Ethernet Network hardware and software with remote management (configure, monitor and manage printer via network).
6. Compliant Standards:

    a. Energy Star configured.
    b. IEEE 802.3-LAN, IEEE 802.3U-LAN.

B. Color Ink Jet Printer:

1. Print Quality (Color): 1440 x 720 dpi resolution.
2. Speed: 5 pages per minute (color).
3. Cartridge / Printhead Duty Cycle: 300 pages.
4. Paper Size: 11x17, 8.5x11.

PART 3 - EXECUTION

3.1 DEVICE REQUIREMENTS

A. Provide the following Equipment in the Control Room or at location designated by the Owner.

Device	Quantity
Operator Workstation	1
Control System Server	1
Portable Operator's Terminal	2
Interruptible Power Supply	As required
Backup device	1
Network Laser Printer	0
Color Inkjet Printer	1

3.2 INSTALLATION

A. Install all servers and other devices available in a location coordinated with the Owner and Architect.

B. Install all hardware and software and configure all devices in accordance with manufacturer's instructions.

C. Provide all licenses, keys, etc. and all documentation and information required to install, configure, operate, diagnose and maintain the system shall be provided.

D. Network connections:

1. See System Architecture in Section 15900.
2. Connect OWSs and CSS to Supervisory LAN.
3. Connect OWSs and CSS to Owner's IT WAN/LAN. Contractor shall coordinate with the Owner's IT representative to establish IP addresses and communications parameters to assure proper operation.

E. Printers:

1. Connect network laser printer to Supervisory LAN.
2. Connect other printers to an OWS and configure to share with other OWSs.

F. Backup:

1. After completion and acceptance of installation, create a backup of all OWSs and server database and configuration files for permanent record of initial installation.
2. Configure backup software to provide automatic backup of OWS and CSS on a weekly basis.
3. All other backup configuration shall be by the Owner.

G. Anti-virus software and installation shall be by the Owner.

END OF SECTION

SECTION 15.919 EMCS FIELD PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Provide and install the following:

1. Building Controller (BC)
2. Advance Application Specific Controller (AAC)
3. Application Specific Controller (ASC)

B. Refer to Section 15900 for general requirements.

1.3 RELATED WORK AND REQUIREMENTS

A. Other EMCS Sections:

1. Section 15900 Energy Management and Control System (EMCS) - General
2. Section 15913 EMCS Basic Materials and Devices
3. Section 15916 EMCS Operator Interfaces
4. Section 15923 EMCS Communication Devices
5. Section 15926 EMCS Software and Programming
6. Section 15933 EMCS Commissioning

PART 2 - PRODUCTS

2.1 GENERAL

A. Point information from any controller (including BCs, AACs, and ASCs) and from any gateway shall be capable of being used in a control sequence in any other panel. The use of OWS or CSS to serve as a communications server between control panels and gateways is not acceptable.

B. For all controllers, operating configuration and software shall be retained in the event of a power outage without requiring a download from upper level controllers by one or a combination of the following:

1. Volatile RAM shall have a replaceable battery backup using a lithium battery with a rated service life of 10,000 hours continuous, and a rated shelf life of at least 7 years.
2. Volatile RAM shall have a automatically rechargeable battery backup using a lithium battery with a rated service life of 50 hours continuous, and a rated shelf life of at least 10 years.
3. EEPROM, EPROM, or NOVROM non-volatile memory.

C. Controllers shall allow independent operation regardless of the status of the other controllers or OWS or CSS. All energy management logic shall reside in field hardware and shall not be dependent on the OWS or CSS for operation.

D. Each controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

1. Assume a predetermined failure mode.
2. Generate an alarm notification to the master controller and/or Operator Workstation.

E. All input points and output points shall be protected such that shorting of the point to itself — to another point, or to ground — will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller.

F. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 0°F to 150°F.
2. Controllers used in conditioned space shall be mounted in dust--resistant enclosures, and shall be rated for operation at 32°F to 120°F.

G. Programmability. All controllers, including BCs, AACs, and ASCs, shall be fully user programmable. See Section 15926. Configurable pre-programmed logic shall not be acceptable in any controller. (This is required due to non-standard control sequences at AHUs and VAV terminal units.)

2.2 STAND-ALONE FUNCTIONALITY

A. General: These requirements clarify the requirement for stand-alone functionality relative to packaging I/O devices with a controller. Stand-alone functionality is specified with the controller and for each Application Category

specified in Part 3. This item refers to acceptable paradigms for associating the points with the processor.

B. Functional Boundary: Provide controllers so that all points associated with and common to one unit or other complete system/equipment shall reside within a single control unit. The boundaries of a standalone system shall be as dictated in the contract documents. Generally systems specified for the Application Category will dictate the boundary of the standalone control functionality. See related restrictions below. When referring to the controller as pertains to the standalone functionality, reference is specifically made to the processor. One processor shall execute all the related I/O control logic via one operating system that uses a common programming and configuration tool.

C. The following configurations are considered acceptable with reference to a controller's standalone functionality:

1. Points packaged as integral to the controller such that the point configuration is listed as an essential piece of information for ordering the controller (having a unique ordering number).
2. Controllers with processors and modular back planes that allow plug in point modules as an integral part of the controller.
3. I/O point expander boards, plugged directly into the main controller board to expand the point capacity of the controller.

D. The following configurations are considered unacceptable with reference to a controller's standalone functionality:

1. Multiple controllers enclosed in the same control panel to accomplish the point requirement.

2.3 BUILDING CONTROLLER (BC)

A. General Requirements:

1. BCs shall be peer-to-peer devices connected to the Primary Controller LAN.
2. Each BC shall be capable of standalone direct digital operation utilizing its own microprocessor, internal RAM, non-volatile memory, input/output, wiring terminal strips, A/D converters, real-time clock/calendar and voltage transient and lightning protection devices, battery backup, regulated power supply, power conditioning equipment, ports for connection of operating interface devices, and control enclosure.. Refer to standalone functionality specified above.
3. The BC(s) shall provide fully distributed control independent of the operational status of the OWSs and CSS. All necessary calculations

required to achieve control shall be executed within the BC independent of any other device.

4. BCs shall perform overall system coordination, accept control programs, perform automated HVAC functions, control peripheral devices and perform all necessary mathematical and logical functions. BCs shall share information with the entire network of BCs and AACs/ASCs for full global control. Each controller shall permit multi-user operation from multiple workstations and portable operator terminals connected either locally or over the Primary Controller LAN.
5. BC shall contain sufficient memory for all specified global control strategies, user defined reports and trending, communication programs, and central alarming.
6. The BC may provide for point mix flexibility and expandability. This requirement may be met via either a family of expander boards, modular input/output configuration, or a combination thereof. Refer to stand alone functionality specified above.
7. All BC point data, algorithms and application software shall be configurable, and all control strategies performed by the BC shall be both operator definable and modifiable, from Operator Interfaces. The point database and all application programs shall be stored in non-volatile or battery backed volatile memory within the BC and will be able to upload/download to/from the OWS and/or CSS.
8. BC shall provide buffer for holding alarms, messages, trends etc.
9. Each BC shall include self-test diagnostics, which allow the BC to automatically alarm any malfunctions, or alarm conditions that exceed desired parameters as determined by programming input.
10. Each BC shall contain software to perform full DDC/PID control loops.
11. Memory:

    a. Memory for data trending shall reside in BCs; the Operator Workstation shall not need to be connected for data trending to occur. Memory shall be large enough to record 256 records of each hardware point on the panel and an equal number of software points, each record to include both data value and time of occurrence. (See Section 15926 for trending software requirements.)
    b. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of approximately 25% of available memory free for future programming changes.
    c. Provide an additional BC if needed to comply with this section.

12. For systems requiring end-of-line resistors those resistors shall be located in the BC.
13. Input-Output Processing:

    a. Digital Outputs (DO): Outputs shall be rated for a minimum 24 Vac or Vdc, 0.5 amp maximum current. Each shall be configurable as

normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output and a supervised manual hand off or auto (HOA) switch to allow for override. HOA override switches shall be monitored via additional input channels to provide dynamic indication of the switch status at any Operator Interface. Each DO shall be discrete outputs from the BC's board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.

b. Analog Inputs (AI): AI shall be 0-5 Vdc, 0-10 Vdc, and 0-20 mA. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the BC's board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 12 bits.

c. Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board. Software multiplexing of an AI and resistors is unacceptable.

d. Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.

e. Electronic Analog Outputs (AO): Voltage mode: 0-5 Vdc and 0-10 Vdc; Current mode: 4-20 mA. Provide zero and span calibration and circuit protection. Pulse Width Modulated (PWM) analog is not acceptable. D/A converters shall have a minimum resolution of 8 bits. Each output shall have an LED to indicate the operating mode of the output and a supervised manual hand off or auto (HOA) switch and trim potentiometer to allow for override and manual positioning of the output from 0 to 100%. HOA override switches shall be monitored via additional input channels to provide dynamic indication of the switch status at any Operator Interface.

f. Analog Output Pneumatic (AOP), 0-20 psi: Pneumatic outputs via an I/ or V/P transducer. Multiplexed digital to pneumatic transducers are acceptable provided they are supplied as a standard product and part of the BC and provide individual feedback. Multiplexed pneumatic outputs of a separate manufacturer are unacceptable.

g. Pulsed Inputs: Capable of counting up to 8 pulses per second with buffer to accumulate pulse count. Pulses shall be counted at all times.

14. A communication port for operator interface through a terminal shall be provided in each BC. It shall be possible to perform all program and database back-up, system monitoring, control functions, and BC diagnostics through this port. Standalone BC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or workstations.

15. Each BC shall be equipped with loop tuning algorithm for precise proportional, integral, derivative (PID) control. Loop tuning tools provided with the Operator Workstation software is acceptable. In any case, tools to support loop tuning must be provided such that P, I, and D gains are automatically calculated.
16. All analog output points shall have a selectable failure setpoint. The BC shall be capable of maintaining this failure setpoint in the event of a system malfunction, which causes loss of BC control, or loss of output signal, as long as power is available at the BC. The failure setpoint shall be selectable on a per point basis.
17. Slope intercepts and gain adjustments shall be available on a per-point basis.
18. BC Power Loss:

    a. Upon a loss of power to any BC, the other units on the primary controlling network shall not in any way be affected.
    b. Upon a loss of power, all software, database parameters, and data (except trend data) shall be protected from memory loss as described herein.
    c. Upon restoration of power within the specified battery backup period, the BC shall resume full operation without operator intervention. The BC shall automatically reset its clock such that proper operation of any time dependent function is possible without manual reset of the clock. All monitored functions shall be updated.
    d. Should the duration of a loss of power exceed the specified battery back-up period or BC panel memory be lost for any reason, the panel shall automatically report, or CSS shall automatically determine, the condition (upon resumption of power) and be capable of receiving a download via the network, and connected computer. In addition, the Owner shall be able to upload the most current versions of all energy management control programs, Direct Digital Control programs, database parameters, and all other data and programs in the memory of each BC to the operator workstation via the local area network, or via the telephone line dial-up modem where applicable, or to the laptop PC via the local RS-232C port.

19. BC Failure:

    a. Controller LAN Data Transmission Failure: BC shall continue to operate in stand-alone mode. BC shall store loss of communication alarm along with the time of the event. All control functions shall continue with the global values programmable to either last value or a specified value.
    b. BC Hardware Failure: BC shall cease operation and terminate communication with other devices. All outputs shall go to their specified fail position.

20. Each BC shall be equipped with firmware resident or software self-diagnostics for sensors and be capable of assessing an open or shorted sensor circuit and taking an appropriate control action (close valve, damper, etc.).
21. BCs may include LAN communications interface functions for controlling s\Secondary controlling LANs Refer to Section 15923 - EMCS System Communications Devices for requirements if this function is packaged with the BC.
22. BCs shall be mounted on equipment, in packaged equipment enclosures, or locking wall mounted in a NEMA 1 enclosure, as specified elsewhere.

B. BACnet Building Controller Requirements:

1. The BC(s) shall support all BIBBs defined in the BACnet Building Controller (B-BC) device profile as defined in the BACnet standard.
2. Each BC shall be connected to the BACnet Primary Controller LAN communicating to/from other BCs.

2.4 ADVANCED APPLICATION SPECIFIC CONTROLLER (AAC) AND APPLICATION SPECIFIC CONTROLLER (ASC)

A. General Requirements:

1. AACs and ASCs shall be connected to the Primary or Secondary Controller LAN.
2. AACs and ASCs shall provide intelligent, standalone control of HVAC equipment. Each unit shall have its own internal RAM, non-volatile memory and will continue to operate all local control functions in the event of a loss of communications on the Secondary LAN. Refer to standalone requirements by application specified in Part 3 of this section. In addition, it shall be able to share information with every other BC and AAC /ASC on the entire network.
3. Each AAC and ASC shall include self-test diagnostics that allow the AAC /ASC to automatically relay to the BC, LAN Interface Device or workstation, any malfunctions or abnormal conditions within the AAC /ASC or alarm conditions of inputs that exceed desired parameters as determined by programming input.
4. AACs and ASCs shall include sufficient memory to perform the specific control functions required for its application and to communicate with other devices.
5. Each AAC and ASC must be capable of stand-alone direct digital operation utilizing its own processor, non-volatile memory, input/output, voltage transient and lightning protection devices.
6. All point data; algorithms and application software within an AAC /ASC shall be modifiable from Operator Interfaces.
7. Memory:

a. Memory for data trending is not required for AACs and ASCs. If not provided in controller, memory for trend data shall reside in BCs connected to the same Network.
b. Provide sufficient internal memory for the specified sequences of operation. For AACs, there shall be a minimum of approximately 25% of available memory free for future programming changes. Provide additional AACs or a BC if needed to comply with this requirement.

8. AAC Input-Output Processing. Same as BCs (paragraph 2.3A.13) except A/D converters may be 10 bit.
9. ASC Input-Output Processing:

a. Digital Outputs (DO): Outputs shall be rated for a minimum 24 Vac or Vdc, 0.5 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output. Each DO shall be discrete outputs from the ASC's board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.
b. Analog Inputs (AI): AI shall be 0-5 Vdc or direct thermistor connection. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the ASC's board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 10 bits.
c. Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the ASC and shall be isolated from the main board. Software multiplexing of an AI and resistors may only be done in non-critical applications and only with prior approval of the Owner.
d. Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.
e. Electronic Analog Outputs (AO): Voltage mode: 0-5 Vdc and 0-10 Vdc; Current mode: 4-20 mA. Provide zero and span calibration and circuit protection. Pulse Width Modulated (PWM) analog is not acceptable. D/A converters shall have a minimum resolution of 8 bits.
f. Analog Output Pneumatic (AOP), 0-20 psi: Pneumatic outputs via an I/ or V/P transducer. Multiplexed digital to pneumatic transducers are acceptable provided they are supplied as a standard product and part of the ASC and provide individual feedback. Multiplexed pneumatic outputs of a separate manufacturer are unacceptable.

B. BACnet AAC(s) and ASC(s) Requirements:

1. The AAC(s) and ASC(s) shall support all BIBBs defined in the BACnet Building Controller (B-AAC and B-ASC) device profile as defined in the BACnet standard.
2. AAC(s) and ASC(s) shall communicate over the BACnet Primary Controller LAN or the Secondary LAN.

PART 3 - EXECUTION

3.1 GENERAL

A. Install systems and materials in accordance with manufacturer's instructions, specifications roughing-in drawings and details shown on drawings.

3.2 HARDWARE APPLICATION REQUIREMENTS

A. General: The functional intent of this specification is to allow cost effective application of manufacturers standard products while maintain the integrity and reliability of the control functions. A BC as specified above is generally fully featured and customizable whereas the AAC/ASC refers to a more cost-effective unit designed for lower-end applications. Specific requirements indicated below are required for the respective application. Manufacturer may apply the most cost-effective unit that meets the requirement of that application.

B. Software Capability: Regardless of application category listed below, each Control Unit shall be capable of performing the specified sequence of operation for the associated equipment. All physical point data and calculated values required to accomplish the sequence of operation shall originate within the associated CU with only the exceptions enumerated below. Refer to requirements herein above for physical limitations of standalone functionality. Listed below are functional point data and calculated values that shall be allowed to be obtained from or stored by other CUs via LAN.

1. Remote pressure sensors. To meet the requirements of this section, differential pressure sensors controlling fans and pumps shall either be home-run wired back to the CU controlling the fan/pump VFD; or install another DP sensor (not shown in points list) near the fan/pump and connected to the CU controlling the pump, connect remote sensors to remote CUs, and use cascading control loops (remote sensor loops reset setpoint for local sensor loop via the network, and local sensor loop controls the pump/fan).

C. Where associated control functions involve functions from different categories identified below, the requirements for the most restrictive category shall be met.

D. Application Category 0 (Distributed Monitoring).

1. Applications in this category include the following:

    a. Monitoring of variables that are not used in a control loop, sequence logic, or safety. Examples include status of sump pumps or associated float switches, temperatures in monitored electrical rooms.

2. Applicable Controllers: Available points on conveniently located BCs, AACs, and ASCs may be used in these applications.
3. Contractor shall verify and document that the network bandwidth is acceptable to accept specified trends of monitored points.

E. Application Category 1 (Application Specific Controller).

1. Applications in this category include the following:

    a. Fan Coil Units.
    b. Terminal Units (e.g. VAV and Constant Volume Boxes).
    c. Miscellaneous heaters.
    d. Constant speed exhaust fans and pumps.
    e. Unitary single zone units with self-contained controls (Package Terminal AC Units, Package Terminal Heat Pumps, Split-System AC Units, Split-System Heat Pumps, Water-Source Heat Pumps, Computer Room AC units).

2. Applicable Controllers: ASCs may be used in these applications.
3. Standalone Capability: Provide capability to execute control functions for the application for a given setpoint or mode, which shall generally be occupied mode control. Only the following data (as applicable) may be acquired from other controllers via LANs. In the event of a loss of communications with any other controller, or any fault in any system hardware that interrupts the acquisition of any of these values, the ASC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

Physical/Virtual Point	Default Value
Time of day	Occupied
Scheduling Mode	Occupied
Morning Warm-Up	Off (cold discharge air)
Load Shed	Off (no shedding)
Trend Data	N/A

4. Mounting:

a. ASCs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use if ceiling attic is used as a return air plenum.
b. ASCs that control equipment mounted in a mechanical room may either be mounted in/on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.
c. ASCs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.

5. Mounting: LAN Restrictions: Limit the number of nodes on the network to the maximum recommended by the manufacturer.
6. Trending Restrictions: BCs connected to same Network shall be capable of storing trend data for points associated with ASCs and must still meet the requirement of paragraph 2.3A.11, or special purpose trend storage devices meeting the requirement of paragraph 2.3A.11 for ASC points must be added for this purpose.

F. Application Category 2 (Advanced Application Controller).

1. Applications in this category include the following:

a. Unitary VAV AC Unit with self-contained controls.
b. Single Zone Air Handling Units.
c. Constant or variable speed pump station.
d. DHW Converter control/monitoring.

2. Applicable Controllers:

a. BCs may be used in these applications.
b. AACs may be used in these applications provided the AAC meets all requirements specified below and all control functions and physical I/O associated with a given unit resides in one AAC.

3. Standalone Capability: Only the following data (as applicable) may be acquired from other AACs or BCs via LANs. In the event of a loss of communications with any other AACs, or any fault in any system hardware that interrupts the acquisition of any of these values, the AAC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

Physical/Virtual Point	Default Delay Time	Default Value
Outside Air Temperature	3 minutes	80˚F
Trend Data		N/A

4. Trending Restrictions for AACs: BCs connected to same Network shall be capable of storing trend data for points associated with AACs that do not have on-board trend storage capability, and must still meet the requirement of paragraph 2.3A.11, or special purpose trend storage devices meeting the requirement of paragraph 2.3A.11 for AAC points must be added for this purpose.
5. Mounting:

    a. AACs/BCs that control equipment located above accessible ceilings shall be mounted in a NEMA 1, locking enclosure and shall be rated for plenum use if ceiling attic is used as a return air plenum.
    b. AACs/BCs that control equipment located in occupied spaces or outside shall either be mounted within the equipment enclosure (responsibility for physical fit remains with the Contractor) or in a proximate mechanical/utility room in which case it shall be enclosed in a NEMA 1, locking enclosure.

G. Application Category 3 (Building Controller)

1. Applications in this category include the following:

    a. VAV Air Handlers.
    b. Central Cooling Plant.
    c. Central Heating Plant.

2. Applicable Controllers: BCs shall be used in these applications.
3. Mounting: See 3.2F.5

3.3 CONTROL POWER

A. Refer to Section 15900 for power to control panels.

END OF SECTION

SECTION 15.923 EMCS COMMUNICATION DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Provide and install the following:

1. LAN Interface Devices/Routers
2. BACnet Gateways

B. Refer to Section 15900 for general requirements.

1.3 RELATED WORK AND REQUIREMENTS

A. Other EMCS Sections:

1. Section 15900 Energy Management and Control System (EMCS) - General
2. Section 15913 EMCS Basic Materials and Devices
3. Section 15916 EMCS Operator Interfaces
4. Section 15919 EMCS Field Panels
5. Section 15926 EMCS Software and Programming
6. Section 15933 EMCS Commissioning

PART 2 - PRODUCTS

2.1 CONTROLLER LOCAL AREA NETWORK INTERFACE DEVICES (LANID)

A. The Controller LANID shall be a microprocessor-based communications device which acts as a gateway/router between the Primary LAN, Secondary LAN, an operator interface, modem to support remote operator interface, or printer. These may be provided within a BC or as a separate device.

B. The LANID shall perform information translation between the Primary LAN and the Secondary LAN, supervise communications on a polling secondary LAN, and shall be applicable to systems in which the same functionality is not

provided in the BC. In systems where the LANID is a separate device, it shall contain its own microprocessor, RAM, battery, real-time clock, communication ports, and power supply as specified for a BC in Section 15919. Each LANID shall be mounted in a lockable enclosure.

C. Each LANID shall support interrogation, full control, and all utilities associated with all BCs on the Primary LAN, all AACs and ASCs connected to all secondary LANs under the Primary Controller LAN, and all points connected to those PCUs and SCUs.

D. Upon loss of power to a LANID, the battery shall provide for minimum 100-hour backup of all programs and data in RAM. The battery shall be sealed and self-charging.

E. The LANID shall be transparent to control functions and shall not be required to control information routing on the Primary LAN.

2.2 SUPERVISORY LAN ROUTERS

A. The Supervisory Router shall be a microprocessor-based communications device that acts as a router between the Supervisory LAN CSSs or OWS and the Primary LAN.

B. The Supervisory Router shall not perform information translation. Both Primary LAN and the Supervisory LAN shall use BACnet.

C. The Supervisory Router shall contain its own microprocessor, RAM, communication ports, and power supply. Each Supervisory Router shall be mounted in a lockable enclosure.

D. The Supervisory Router shall allow centralized overall system supervision, operator interface, management report generation, alarm annunciation, acquisition of trend data, and communication with control units. It shall allow system operators to perform the following functions from the CSS, OWSs, and POTs:

1. Configure systems.
2. Monitor and supervise control of all points.
3. Change control setpoints.
4. Override input values.
5. Override output values.
6. Enter programmed start/stop time schedules.
7. View and acknowledge alarms and messages.
8. Receive, store and display trend logs and management reports.
9. Upload/Download programs, database, etc. as specified.

E. Upon loss of power to the Supervisory Router, the battery shall provide for minimum 100-hour backup of all programs and data in RAM. The battery shall be sealed and self-charging.

F. The Supervisory Router shall be transparent to control functions and shall not be required to control information routing on the Primary LAN.

2.3 BACnet BROADCAST MESSAGE ROUTING

A. To allow BACnet broadcast messages to be relayed from remote nodes communicating via the internet and connecting to the Supervisory Router through IP protocol, a BACnet/IP Broadcast Management Device (BBMD) shall be provided which conforms to the Annex J definition of the BACnet standard for two-hop distribution. Multicast messaging or one-hop distribution requiring configuration of IP routers which are not part of the EMCS vendor's cope in not acceptable.

2.4 BACNET GATEWAYS

A. Gateways shall be provided to link non-BACnet control products to the BACnet inter-network. All of the functionality described in this section is to be provided by using the BACnet capabilities. Each Gateway shall have the ability to expand the number of BACnet objects of each type supported by 20% to accommodate future system changes.

B. Each Gateway shall provide values for all points on the non-BACnet side of the Gateway to BACnet devices as if the values were originating from BACnet objects. The Gateway shall also provide a way for BACnet devices to modify (write) all points specified by the AOC using standard BACnet services. All points are required to be writable for each site.

C. The Gateway shall implement BACnet schedule objects and permit both read and write access to the schedules from the workstation.

D. Each Gateway shall provide a way to collect and archive or trend (time, value) data pairs.

E. Each Gateway and any devices that the Gateway represents which have time-of-day information shall respond to workstation requests to synchronize the date and time. Each Gateway and any devices that the Gateway represents shall support dynamic device binding and dynamic object binding.

F. All points in the system shall be made network visible through the use of standard BACnet objects or through proprietary BACnet extensions that the workstation also supports. All points shall be writable using standard BACnet services.

G. All devices have a Device Object instance number that is unique throughout the entire inter-network. All BACnet devices shall be configured with a Device Object instance number that is based on the format specified (shown in decimal notation). This includes all physical devices as well as any logical BACnet devices that are physically represented by Gateways.

H. All BACnet Interoperability Building Blocks (BIBBs) are required to be supported for each native BACnet device or Gateway. The Gateway shall support all BIBBs defined in the BACnet Gateway's device profile as defined in the BACnet standard.

I. Upon loss of power to a Gateway, the battery shall provide for minimum 1000-hour backup of all programs and data in RAM. The battery shall be sealed and self-charging.

J. UL 916 CE FCC part 15 Subpart B – Class A with surge and transient protection circuitry for power and communications.

PART 3 - EXECUTION

3.1 GENERAL

A. Install systems and materials in accordance with manufacturer's instructions, specifications roughing-in drawings and details shown on drawings.

B. Contractor shall provide all interface devices and software to provide an integrated system.

C. See Control Power in Section 15900 for device power options and requirements.

3.2 LANID AND LAN ROUTERS

A. Provide as required. See System Architecture in Section 15900.

B. At each building, connect Supervisory LAN to Owner's IT/LAN or dedicated EMCS network (whichever is applicable).

C. Connect networks to both sides of device.

D. Thoroughly test to ensure proper operation.

E. Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other nodes on the network. If a LAN is severed, two separate networks shall be formed and communications within

each network shall continue uninterrupted. The system shall automatically monitor the operation of all network devices and annunciate any device that goes off-line because it is failing to communicate.

3.3 GATEWAYS

A. General.

1. Wire to networks on both sides of device.
2. Map across all monitoring and control points listed in the Construction Drawings.
3. Thoroughly test each point to ensure that mapping is accurate.
4. Initiate trends of points as indication in Construction Drawings.

END OF SECTION

SECTION 15.926 EMCS SOFTWARE AND PROGRAMMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Provide and install the following:

1. System Software
2. Programming Software
3. Graphical User Interface Software

B. Refer to Section 15900 for general requirements.

1.3 RELATED WORK AND REQUIREMENTS

A. Other EMCS Sections:

1. Section 15900 Energy Management and Control System (EMCS) - General
2. Section 15913 EMCS Basic Materials and Devices
3. Section 15916 EMCS Operator Interfaces
4. Section 15919 EMCS Field Panels
5. Section 15923 EMCS Communication Devices
6. Section 15933 EMCS Commissioning

1.4 GENERAL

A. System software shall be based on server/thin-client architecture, designed around the open standards of web technology. Servers shall be accessed using a web browser over the control system Supervisory LAN, the Owner intranet, and remotely over the Internet (through the Owner IT WAN/LAN).

B. The intent of the thin-client architecture is to provide operators complete access to the EMCS via a web browser GUI. No special software other than a web browser (including active-x components or fat java clients) shall be required to be installed on OIs used to access the EMCS graphics, point displays, trends,

and trend configuration. Additional software other than a browser may be used to configure or modify the EMCS and programming.

C. The Contractor shall furnish and install all software and programming necessary to provide a complete and functioning system as specified. The Contractor shall include all software and programming not specifically itemized in these specifications that is necessary to implement, maintain, operate, and diagnose the system in compliance with these specifications.

D. Software Components: All software components of the BAS system software shall be installed and completed in accordance with the specification. BAS system components shall include:

1. Server Software, Database and Web Browser Graphical User Interface
2. System Configuration Utilities for future modifications to the system.
3. Graphical Programming.
4. Direct digital control software.
5. Application Software.

E. Database Open Connectivity: The BAS server database shall be Java DataBase Connectivity (JDBC) compatible, allowing real time access of data via XML/SOAP.

1.5 LICENSING

A. Include licensing and hardware keys for all software packages at all workstations (OWSs and POTs) and servers.

B. Within the limitations of the servers, any number of users shall have web access to the CSS at any given time.

C. All operator interface programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner.

D. All operator software, including that for programming and configuration, shall be available on all workstations. Hardware and software keys to provide all rights shall be installed on all workstations.

PART 2 - PRODUCTS

2.1 CONTROLLER SOFTWARE

A. BC Software Residency: Each BC shall be capable of control and monitoring of all points physically connected to it. All software including the following shall reside and execute at the BC:

1. Real-Time Operating System software.
2. Real-Time Clock/Calendar and network time synchronization.
3. BC diagnostic software.
4. LAN Communication software/firmware.
5. Direct Digital Control software.
6. Alarm Processing and Buffering software.
7. Energy Management software.
8. Data Trending, Reporting, and Buffering software.
9. I/O (physical and virtual) database.
10. Remote Communication software.

B. AAC/ASC Software Residency: Each AAC/ASC shall be capable of control and monitoring of all points physically connected to it. As a minimum, software including the following shall reside and execute at the AAC/ASC. Other software to support other required functions of the AAC/ASC may reside at the BC or LAN interface device (specified in Section 15923) with the restrictions/exceptions per application provided in Section 15919:

1. Real-Time Operating System software.
2. AAC/ASC diagnostic software.
3. LAN Communication software.
4. Control software applicable to the unit it serves that will support a single mode of operation.
5. I/O (physical and virtual) database to support one mode of operation.

C. Stand Alone Capability: BC shall continue to perform all functions independent of a failure in other BC/AAC/ASC or other communication links to other BCs/AACs/ASCs. Trends and runtime totalization shall be retained in memory. Runtime totalization shall be available on all digital input points that monitor electric motor status. Refer also to Section 15919 for other aspects of stand alone functionality.

D. Operating System: Controllers shall include a real-time operating system resident in ROM or EEPROM. This software shall execute independently from any other devices in the system. It shall support all specified functions. It shall provide a command prioritization scheme to allow functional override of control functions. Refer also to Section 15919 for other aspects of the controller’s operating system.

E. Network Communications: Each controller shall include software/firmware that supports the networking of CUs on a common communications trunk that forms the respective LAN. Network support shall include the following:

1. Building Controller/Primary LAN shall be a high-speed network designed and optimized for control system communication. If a Primary LAN communications trunk is severed, BCs shall reconfigure into two separate LANs and continue operations without interruption or Operator intervention.
2. Controller communication software shall include error detection, correction, and re-transmission to ensure data integrity.
3. Operator/System communication software shall facilitate communications between other BCs, all subordinate AACs/ASCs, Gateways and LAN Interface Devices or Operator Workstations. Software shall allow point interrogation, adjustment, addition/deletion, and programming while the controller is on line and functioning without disruption to unaffected points. The software architecture shall allow networked controllers to share selected physical and virtual point information throughout the entire system.

F. Diagnostic Software: Controller software shall include diagnostic software that checks memory and communications and reports any malfunctions.

G. Alarm/Messaging Software: Controller software shall support alarm/message processing and buffering software as specified below.

H. Application Programs: CUs shall support and execute application programs specified.

I. Updating/Storing Application Data: Site-specific programming residing in volatile memory shall be up-loadable/downloadable from an OWS or CSS using BACnet services connected locally, to the Primary LAN, to the Local Supervisory LAN and remotely via modem and telephone lines as applicable but all must be available. Initiation of an upload or download shall include all of the following methods; Manually, Scheduled and Automatically upon detection of a loss or change.

J. Power Loss and Restart: System software shall provide for orderly shutdown upon loss of power. Volatile memory shall be retained. Outputs shall go to programmed fail position, which as a default shall be set to their position in unoccupied mode. Equipment restart shall be automatic upon power restoration and shall include a user definable time delay on each piece of equipment to stagger the restart. Loss of power shall be alarmed at operator interface indicating date and time.

K. Time Synchronization: Operators shall be able to set the time and date in any device on the network that supports time-of-day functionality. The operator shall

be able to select to set the time and date for an individual device, devices on a single network, or all devices simultaneously. Automatic time synchronization shall be provided using BACnet services.

L. Anti-dithering. In order to improve the life expectancy of modulating electronic actuators, software shall limit the number of re-positions. This can be accomplished by providing anti-dithering software, a small deadband for fully proportioning actuators, and by ensuring that floating actuators do not receive control pulses of excessively short duration.

2.2 GRAPHICAL USER INTERFACE SOFTWARE

A. A web browser installed on each OWS, POT, and server (see Section 15916) shall serve as the graphical user interface to the EMCS. Communication between the web server GUI and EMCS server shall be encrypted using 128-bit encryption technology within Secure Socket Layers. Communication protocol shall be Hyper-Text Transfer Protocol.

B. The GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to “feel” like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish all features specified in this section.

C. The GUI shall (as a minimum) provide a Navigation Pane for navigation, and a Action Pane for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic setpoint controls, configuration menus for operator access, reports, and reporting actions for events.

D. Login. Upon launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and password. Navigation in the system shall be dependent on the operator’s role privileges, and geographic area of responsibility. See Security Access below.

E. Navigation Pane

1. The Navigation Pane shall comprise a Navigation Tree which defines a geographic hierarchy of the EMCS system. Navigation through the GUI shall be accomplished by clicking on appropriate level of a navigation tree (consisting of expandable and collapsible tree control like Microsoft’s Explorer program), and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane defined below shall be displayed simultaneously, enabling the operator to select a specific system or equipment, and view the corresponding graphic. The navigation tree shall as a minimum provide the following views:

a. Geographic View shall display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and BACnet objects.
b. Network View shall display the hierarchy of the actual BACnet IP Intranet network. This can include: Systems, Site, Networks, Routers, Half-Routers, Devices, Equipment and all the BACnet Objects in a device.
c. Groups View shall display Scheduled Groups and custom reports.
d. Configuration View shall display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).

2. Alternative interface structures will also be accepted if they provide similar ease of navigation through the system hierarchy.

F. Action Pane. The Action Pane shall provide several functional views for each HVAC or mechanical/electrical subsystem specified. A functional view shall be accessed by clicking on the corresponding button:

1. Graphics: Using animated gifs or other graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic setpoint controls, web content, and other valid HTML elements. The data on each graphic page shall automatically refresh as frequently as 6 updates per minute.
2. Properties: Shall include graphic controls and text for the following: Locking or overriding BACnet objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the operator to depress a ‘accept/cancel’ button.
3. Schedules: Shall be used to create, modify/edit and view schedules based on the systems geographical hierarchy and in compliance with paragraph 2.2H.
4. Events: Shall be used to view alarm event information geographically (using the navigation tree), acknowledge events, sort events by category, actions and verify reporting actions.
5. Trends: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling.
6. Logic - Live Graphic Programs: Shall be used to display a ‘live’ graphic programs of the control algorithm for the mechanical/electrical system selected in the navigation tree.

G. Graphics:

1. The GUI shall make extensive use of color in the graphic pane to communicate information related to setpoints and comfort. Animated graphics and active setpoint graphic controls shall be used to enhance usability.

2. Graphics tools used to create Web Browser graphics shall be non-proprietary and provided and installed on each OWS.
3. Graphical display shall be 1280 x 1024 pixels or denser, 256 color minimum.
4. Links:

    a. Graphics shall include hyperlinks which when selected (i.e. clicked on with mouse) launch applications, initiate other graphics etc.
    b. Screen Penetration: Links shall be provided to allow user to navigate graphics logically without having to navigate back to the home graphic. See additional discussion in Paragraph 3.5.
    c. Informational Links:

        1) On each MEP system and subsystem graphic, provide links to display in a new window the information listed below.

            a) English-language control sequence associated with the system. See Construction Drawings.
            b) O&M and submittal information for the devices on the graphic. See Section 15900 and Section 15010.

        2) The display shall identify the target of the link by file name/address.
        3) Information shall be displayed in electronic format that is text searchable.
        4) Window shall include software tools so that text, model numbers, or point names may be found. Source documents shall be read-only (not be editable) with this software, however.

5. Point Override Feature:

    a. Every real output or virtual point displayed on a graphic shall be capable of being overridden by the user (subject to security level access) by mouse point-and-click from the graphic without having to open another program or view.
    b. When the point is selected to be commanded:

        1) Dialog box opens to allow user to override the point (place in “operator mode”) or release the point (“automatic mode”). Operator mode will override automatic control of the point from normal control programs.
        2) Dialog box shall have buttons (for digital points) or a text box and/or slide bar (for analog points) to allow user to set the point’s value when in operator mode. These are grayed out when in automatic mode.
        3) When dialog box is closed, mode and value are sent to controller.

4) Graphic is updated upon next upload scan of the actual point value.

c. A list of points that are currently in an operator mode shall be available through menu selection.

6. Point override status (if a digital point is overridden by the supervised manual override per Section 15919 or if a point is in operator mode per 2.2G.5) shall be clearly displayed for each point, e.g. by changing color or flag.
7. The color of symbols representing equipment shall change color or become animated based on status of binary point to graphically represent on/off status.
8. On floor plan displays of spaces, temperature shall be graphically displayed by coloring the zone area in accordance with or similar to the following:

   a. Red: space temperature above cooling setpoint by 2°F (adj.) or more. This condition can be programmed to generate an alarm.
   b. Yellow: space temperature between cooling setpoint and 2°F (adj.) above setpoint.
   c. Green: space temperature between cooling and heating setpoints and space is in occupied mode.
   d. Gray: space temperature between cooling and heating setpoints and space is in unoccupied mode.
   e. Light blue: space temperature between heating setpoint and 2°F (adj.) below setpoint.
   f. Dark blue: space temperature below heating setpoint by 2°F (adj.) or more. This condition can be programmed to generate an alarm.

9. On floor plan displays of spaces, lighting shall be graphically displayed by coloring the lighting zone area in accordance with or similar to the following:

   a. Yellow: lights on by timed override.
   b. Red: lights on by manual override in lighting panel.
   c. Green: lights on by schedule.
   d. Gray: lights off.

10. Floor plans shall include final room names and room numbers as confirmed by the Owner. Room names and room numbers included in Construction Documents are not necessarily the final room names and room numbers. Division 15C Contractor shall be responsible for obtaining and confirming the final room names and room numbers from Owner. Changes to floor plan graphics resulting from wrong room names and room numbers shall be made at no additional charge to the Owner.

H. Graphics Development Package:

1. Graphic development and generation software shall be provided to allow the user to add, modify, or delete system graphic displays.
2. Provide capability to store graphic symbols in a symbol directory and incorporate these symbols into graphics.
3. Provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), mechanical system components (e.g., pumps, chillers, cooling towers, boilers, etc.), complete mechanical subsystems (e.g. VAV reheat zone, etc.) and electrical symbols.
4. The Graphic Development Package shall use a mouse or similar pointing device to allow the user to perform the following:

    a. Define symbols.
    b. Position items on graphic screens.
    c. Attach physical or virtual points to a graphic.
    d. Define background screens.
    e. Define connecting lines and curves.
    f. Locate, orient and size descriptive text.
    g. Define and display colors for all elements.
    h. Establish correlation between symbols or text and associated system points or other displays.
    i. Create hot spots or link triggers to other graphic displays or other functions in the software.

5. A single graphic file shall be used for common control applications (e.g. VAV box) so that any updates to the graphic may be done once and automatically applied to all applications. Displayed points shall be automatically populated based on “wild card” entry of point name in graphic definition.

I. Time and Schedules:

1. Provide a time master that is installed and configured to synchronize the clocks of all BACnet devices supporting time synchronization. Synchronization shall be done using Coordinated Universal Time. All trend sample times shall be able to be synchronized. The frequency of time synchronization message transmission shall be selectable by the operator.
2. System shall automatically change time/date for Daylight Savings Time and leap years.
3. An operator (with password access) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor “isolation” area. For example, Independence Day ‘Holiday’ for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator

intervention would be required and every control module in the system with would be automatically downloaded with the ‘Independence Day’ Holiday.

4. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.
5. Schedules shall comply with the BACnet standard, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:

    a. Types of schedule shall be Normal, Holiday or Override.
    b. A specific date.
    c. A range of dates.
    d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
    e. Wildcard (example, allow combinations like second Tuesday of every month).

6. Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of “things” to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
7. Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an ‘individual tenant’ group – who may occupy different areas within a building or buildings. Schedules applied to the ‘tenant group’ shall automatically be downloaded to control modules affecting spaces occupied by the ‘tenant group’.
8. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the operator (example: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
9. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules, and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.
10. Schedule Distribution: For reliability and performance, instead of maintaining a single schedule in a field device that writes over the network to notify other devices when a scheduled event occurs, field devices will only keep their part of the schedule locally. The EMCS server software shall determine which nodes a hierarchical schedule applies to and will create/modify the necessary schedule objects in each field device as necessary.

J. Events and Alarms:

1. Events and alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an 'Events' view.
2. Events View: Each event shall display an Event Category (using a different icon for each event category), date/time of occurrence, current status, and event report. An operator shall be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
3. Event Categories (Alarm Levels): The operator shall be able to create, edit or delete event categories (alarm level). An icon shall be associated with each Event category, enabling the operator to easily sort through multiple events displayed. Alarm levels shall be initially configured by the Contractor as follows:

    a. Level 1: Critical/life safety.
    b. Level 2: Significant equipment failure.
    c. Level 3: Non-critical equipment failure/operation.
    d. Level 4: Energy conservation monitor.
    e. Level 5: Maintenance indication, notification.

4. BACnet Event Templates: BACnet Event template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of event, acknowledgement requirements, high/low limit and out of range information.
5. Event Areas (Actions): Each Event Categories (Alarm Level) shall be configured to specific Event Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance events on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Event Areas in the Graphic Pane. For initial setup, contractor shall configure events as follows:

    a. Levels 1 and 2: Print to alarm printer and call/text two engineers.
    b. Level 3: Print to alarm printer and email engineer responsible for building/system.
    c. Levels 4 and 5: Email engineer responsible for building/system

6. Event Reporting Actions: Event Reporting Actions specified shall be automatically launched (under certain conditions) after an event is received by the EMCS server software. Operators shall be able to define these Reporting Actions using the Navigation Tree and Graphic Pane through the GUI. Reporting Actions shall be as follows:

    a. GUI dialog box: Provide visual and optional audible alarm indication. The alarm dialog box shall always become the top dialog box upon receipt of an alarm irrespective of the foreground application.

b. Print: Alarm/Event information shall be printed to the any network accessible printer.
c. Email: Alarm/Event information shall be via email to a POP3 address on the Owner's intranet or through this intranet to the internet.
d. Call/Text: Alarm/Event information shall be sent via alphanumeric call/text via email to internet alphanumeric call/text services.
e. File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
f. Write Property: The write property reporting action updates a property value in a hardware module.
g. Run External Program: The Run External Program reporting action launches specified program in response to an event.

7. Event Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
8. Event Configuration: Operators shall be able to define the type of events generated per BACnet object. A 'network' view of the Navigation Tree shall expose all BACnet objects and their respective Event Configuration. Configuration shall include assignment of event, alarm, type of Acknowledgement and notification for return to normal or fault status.
9. Event Summary Counter: The view of events in the Graphic Pane shall provide a numeric counter, indicating how many events are active (in alarm), require acknowledgement, and total number of events in the EMCS Server database.
10. Event Auto-Deletion: Events that are acknowledged and closed, shall be auto-deleted from the database and archived to a text file after an operator defined period. The file shall be stored in file on the CSS with no limit to quantity or age of alarms, other than limitations of hard disk. The file can be archived to tape and deleted by operator to clear disk space.
11. Data Format. The system shall allow for external systems to access the event instance data. Event data shall be stored and queried in the database in a relational manner. At a minimum, the fields to be stored in the database are:

    a. Event Source.
    b. Event Generation Tie.
    c. Acknowledge Required Flag.
    d. Delivery Priority.
    e. BACnet Event Type.
    f. Event Message Text.

g. BACnet Event Parameter.
h. Classification of Event.
i. Event Acknowledgement Time.
j. Return to Normal Time.
k. Operator Comments.
l. Who Acknowledged the Event.

12. Event Simulator: The GUI user shall provide an Event Simulator to test assigned Reporting Actions. The operator shall have the option of using current time or scheduling a specific time to generate the Event. Utilizing the Navigation Tree and drop-down menus in the Graphic Pane, the operator shall be able to select the Event Type, Status, Notification, Priority, Message, and whether acknowledgement is required.

K. Trends:

1. Trending and trend analysis capabilities are considered critical to system performance. The system shall be designed to upload and record large amounts of point data without causing network bottlenecks or affecting proper system operation. A separate server (Historical Trend Server) shall be provided (see Section 15916) in order to reduce network traffic to and disk activity on the CSS. The system as a whole shall be designed to comply with the trending capability test defined in Section 15933.
2. Every point, both real and virtual, shall be available for data trending.
3. Trending software shall be capable of recording point values and time on a user specified regular time step and on a change-of-value (COV) basis (data is recorded when point changes by a specified amount for analog points or by changes of state for binary points), at the user's option. Sampling intervals shall be as small as one second. Each trended point shall have the ability to be trended at a different sampling interval.
4. Trend data shall be sampled and stored in control panel memory (see Section 15919). If historical trending is enabled for the BACnet object, trend data shall be uploaded from control panels to the OWS or CSS on a user-defined interval, manual command, or automatically when the trend buffer becomes full.. There shall be no limit to the amount of trend data stored at the OWS or CSS other than hard disk limitations.
5. Trends shall conform to the BACnet Trend Log Object specification. Trends shall both be displayed and user configurable through the GUI. Trend logs may comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.
6. Viewing Trends:

a. Trend data shall be displayed graphically by the GUI. This shall be a capability internal to the workstation software and not a capability resulting from download of trend data on a third-party spreadsheet program unless such transfer is automatic and transparent to the

operation and the third-party software is included with the workstation software package.

b. The software shall be capable of dynamically graphing the trend logged object data by creating two-axis (x, y) graphs that simultaneously display values relative to time for at least eight objects in different colors, even if objects have been trended at different time intervals. Where trended values are COV, software shall automatically fill the trend samples between COV entries. A graph legend shall identify each variable plotted.
c. Multiple scales shall be possible, one for each object, with range set automatically by the software but capable of being manually adjusted by the operator.
d. Trend format, displayed points, etc. shall be capable of being saved as a template for future trend displays.
e. Trends shall be able to dynamically update at operator-defined intervals, including on a 1 second interval for loop tuning.
f. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and 'pan through' historical data by simply scrolling the mouse.
g. It shall be possible to pick (or float mouse over) any sample on a trend and have the numerical value displayed.
h. The operator shall have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard Windows keystrokes.

7. Trend Data Storage

a. The database shall allow applications to access the data while the database is running. The database shall not require shutting down in order to provide read-write access to the data. Data shall be able to be read from the database without interrupting the continuous storage of trend data being carried by the EMCS.
b. Provide a single licensed copy of Microsoft SQL Server and install on the OWS.
c. Data shall be accessible to off-site SQL compliant database software through the Owner's intranet and/or internet.

L. Security Access:

1. Security access from the GUI to EMCS servers shall require a Login Name and Password.
2. Access to different areas of the EMCS shall be defined in terms of roles and geographic area of responsibility as specified.
3. Roles shall reflect the actual roles of different types of operators. Roles shall be defined in terms of View, Edit and Function Privileges.

a. View Privileges: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
b. Edit Privileges: Setpoint, Tuning and Logic, Manual Override, and Point Assignment Parameters.
c. Function Privileges: Alarm/Event Acknowledgement, Control Module Configuration, Memory Download, and Upload, Schedules, Schedule Groups, Manual Commands, Print, and Alarm/Event Maintenance.

4. Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.
5. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected for an adjustable period of time. This auto logoff time shall be set individually per operator.
6. Provide an audit trail of actions taken by any user, including the user name and time. Store in secure file in database format on the CSS. Provide software to view and print audit trail.

M. Report Software:

1. Provide software to create standard and custom reports of point status, alarms, etc. Report format, displayed points, time period (daily, weekly, monthly, or annual), etc. shall be capable of being saved as a template for future reports. Reports shall be time and date stamped and shall contain a report title editable by the user.
2. Reports shall be capable of being sent to a printer or export to Word or ASCII format to a file, and shall be capable of being generated automatically based on date and time of day.
3. Standard reports. Prepare the following standard reports for each building and the Owner as a whole, accessible automatically without requiring definition by user:

a. Tenant after-hour usage. System must be capable of monitoring tenant override requests and generating a monthly report showing the daily total time in hours that each tenant has requested after-hours HVAC services.
b. Monthly and annual energy usage and cost.
c. Alarm events and status.
d. Points in “hand” (operator override) via Workstation command (including name of operator who made the command) or via supervised HOA switch at output, including date and time.
e. Position reset: Where zones or system valve or damper positions are used to reset supply air/water temperature or differential pressure setpoints:

1) EMCS shall record the following on an hourly basis: the descriptors of the zones/systems that have dampers/valves at the highest cooling/heating position, i.e. the control point that is being used in the reset loop. The information shall be accumulated in a report format for periodic printing upon operator command.
2) Configure a tabular report using real-time or trend data with the following column headings: ZONE [SYSTEM] DESCRIPTION, VALVE [DAMPER] POSITION (0 to 100%), LOOP OUTPUT %, [CHWST, CHWDP, SAT, etc.] SETPOINT. At the top of the table, list building number, floor or area description if applicable, air handling unit or HW/CHW pump system designation.

2.3 CONTROL PROGRAMMING SOFTWARE

A. Points:

1. Provide templates customized for point type, to support input of individual point information using standard BACnet Objects, including long-name field.
2. All real and virtual points shall be accessible to any control panel for use in any control sequences regardless of physical location.

B. Programming Language:

1. All controllers must be fully user-programmable using a single programming language for all control devices. Use of “canned” (preprogrammed, burned-in) software is not acceptable.
2. The control programming language must allow virtually any control sequences to be written. Software shall be capable of the sequences specified in the Construction Drawings without exception.
3. All custom programs shall be modifiable from Operator Workstations without having to “burn chips”. Software shall allow the user to modify and input control sequence software and to download to panels via the control network.
4. The programming language shall support floating point arithmetic using the following operators and functions: +, -, /, x, square root, and x-to-the-y-power, natural log, log, trigonometric functions (sine, cosine, etc.), absolute value, minimum/maximum value from a list of values, and psychrometric parameters (wetbulb, dewpoint, and enthalpy) from temperature and relative humidity.
5. The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by

the language so that interval timing functions can stopped and started within a program.

6. The system must be capable of supporting software (“virtual”) points to be used in control sequences and monitored just as if they were real digital or analog points.
7. Control programming shall employ the BACnet protocols for Standard Command Priorities.
8. A PID (proportional-integral-derivative) algorithm with adjustable gains and anti-windup shall be included as an integral part (subroutine) of the programming language, not requiring special programming or hardware.
9. The programming language shall be graphical. BASIC-like or other line- or block-type programming languages are not acceptable. With the graphical programming language, a sequence of operations shall be created by drag-and-drop assembling on screen of graphic blocks that represent each of the commands or functions necessary to complete a control sequence. Blocks represent common logical control devices such as relays, switches, high signal selectors, PID loops, optimum start, etc. Blocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of graphic blocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.
10. The graphic programming software shall support a ‘live’ mode, where all input/output data, calculated data, and setpoints shall be displayed in a ‘live’ real-time mode. For each piece of HVAC equipment, the entire graphic program shall be displayed through the GUI. The operator must have the ability to scroll through the entire ‘live’ graphic program as necessary.

C. Debugging Software:

1. Provide a search capability that will search all control sequences for a given point name to determine all sequences that use or control the point.
2. The control programs shall be capable of being tested on-line or off-line (prior to installation in field panels). The program and results of programming tests shall be displayed graphically using graphical programming language with parameter values displayed in appropriate locations. Simulation capabilities shall include step-by-step, accelerated time, and operator defined simulation criteria like outside weather, demand, and communication status.

2.4 MISCELLANEOUS SOFTWARE

A. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all

applications and shall provide relevant data for the application or object that help is being called from.

B. Provide software for viewing (but not editing) electronic versions of as-built shop drawings of:

1. Mechanical, electrical, and plumbing systems in AutoCAD Release 14 or 2000+ format.
2. EMCS drawings in format selected by contractor (see limitations in Section 15900).

PART 3 - EXECUTION

3.1 SYSTEM CONFIGURATION

A. Contractor shall thoroughly and completely configure EMCS system software, supplemental software, network software etc. on CSS, POTs, and servers.

3.2 POINT STRUCTURING AND NAMING

A. The intent of this section is to require a consistent means of naming points across the Campus EMCS. Contractor shall configure the systems from the perspective of the Campus EMCS, not solely the local project. The following requirement establishes a standard for naming points and addressing Buildings, Networks, Devices, Instances, etc.

B. Point Summary Table:

1. The term ‘Point’ includes all physical I/O points, virtual points, and all application program parameters.
2. With each schematic, Contractor shall provide a Point Summary Table listing:

a. Building number and abbreviation.
b. System type.
c. Equipment type.
d. Point suffix.
e. Full point name (see Point Naming Convention paragraph).
f. Point description.
g. Ethernet backbone network number.
h. Network number.
i. Device ID.
j. Device MAC address.
k. Object ID (object type, instance number).
l. Engineering units.

m. Device make and model #. Include range of device if model number does not so indentify.
n. Device physical location description. Include floor and column line intersection to one decimal place (e.g. line 6.2 and line A.3)

3. Point Summary Table shall be provided in both hard copy and in a relational database electronic format (ODBC-compliant).
4. The EMCS Contractor shall coordinate with the Owner's representative and compile and submit a proposed Point Summary Table for review prior to any object programming or project startup.
5. The Point Summary Table shall be kept current throughout the duration of the project by the Contractor as the Master List of all points for the project. Project closeout documents shall include an up-to-date accurate Point Summary Table. The Contractor shall deliver to the Owner the final Point Summary Table prior to final acceptance of the system. The Point Summary Table shall be used as a reference and guide during the commissioning process.

C. Point Naming Convention:

1. All point names shall adhere to the format as established below, unless otherwise agreed to by the Owner. New categories and descriptors may be created with approval of the Owner.
2. Format:

a. Building.Category.System.EquipmentTag.Component.Property.
b. Example: 001LIB.HVAC.Heatplant.B-1.HWS.Temperature.

Building	Category	System	Equip-ment Tag	Component	Property	Typical units
Building number	ELCT	Lighting Plug Generator MIsc	(from equipment schedules)	SWITCH PHOTO CB	Command Status Light Power	On/off On/off Footcan-dles Watts
	HVAC	Air handling Exhaust Heatplant Coolplant Misc		CWS CWR HWS HWR CHWS	Voltage Current ValvePos DamperPo s Tempera-ture	Volts Amps %open %open °F
	PLMB	Dom water Air		CHWR OA	Humidity Pressure	%RH Psig, “ H_2O

Building	Category	System	Equip-ment Tag	Component	Property	Typical units
		Nat gas N2 O2 Irrigation Waste Misc		SA RA EA GAS FLUID	Flow Energy Speed Signal	Cfm, gpm Btu %, Hz Hz
	MISC	Weather				

D. Device Addressing Convention:

1. BACnet network numbers and Device Object IDs shall be unique throughout the network.
2. All assignment of network numbers and Device Object IDs shall be coordinated with the Owner.
3. Each Network number shall be unique throughout all facilities and shall be assigned in the following manner unless specified otherwise:

   BBBFF, where: BBB = 1-655 assigned to each building, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building.

4. Each Device Object Identifier property shall be unique throughout the system and shall be assigned in the following manner unless specified otherwise:

   XXFFBBB, where: XX = number 0 to 40, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building. BBB = 1-655 assigned to each building.

5. The EMCS Contractor shall coordinate with the Owner or a designated representative to ensure that no duplicate Device Object IDs occur.
6. Alternative Device ID schemes or cross project Device ID duplication if allowed shall be approved before project commencement by the Owner.

E. I/O Point Physical Description:

1. Each point associated with a hardware device shall have its BACnet long-name point description field filled out with:

   a. The device manufacturer and model #. Include range of device if model number does not so identify.
   b. For space sensors (temperature, CO_2, etc.), include room number in which sensor is located.

3.3 POINT PARAMETERS

A. Provide the following minimum programming for each analog input:

1. Name.
2. Address.
3. Scanning frequency or COV threshold.
4. Engineering units.
5. Offset calibration and scaling factor for engineering units.
6. High and low alarm values and alarm differentials for return to normal condition
7. High and low value reporting limits (reasonableness values), which shall prevent control logic from using shorted or open circuit values.
8. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the primary and/or secondary controlling networks and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides, or failure of any network over which the point value is transferred.
9. Selectable averaging function that shall average the measured value over a user selected number of scans for reporting.

B. Provide the following minimum programming for each analog output:

1. Name.
2. Address.
3. Output updating frequency.
4. Engineering units.
5. Offset calibration and scaling factor for engineering units.
6. Output range.
7. Default value to be used when the normal controlling value is not reporting.

C. Provide the following minimum programming for each digital input:

1. Name.
2. Address.
3. Engineering units (on/off, open/closed, freeze/normal, etc.)
4. Debounce time delay.
5. Message and alarm reporting as specified.
6. Reporting of each change of state, and memory storage of the time of the last change of state.
7. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.

D. Provide the following minimum programming for each digital input:

1. Name.
2. Address.
3. Output updated frequency.
4. Engineering units (on/off, open/closed, freeze/normal, etc.)
5. Direct or Reverse action selection.
6. Minimum on-time.
7. Minimum off-time.
8. Status association with a DI and failure alarming (as applicable).
9. Reporting of each change of state and memory storage of the time of the last change of state.
10. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
11. Default value to be used when the normal controlling value is not reporting.

3.4 SITE-SPECIFIC APPLICATION PROGRAMMING

A. All site specific application programming shall be written in a manner that will ensure programming quality and uniformity among the various buildings. The EMCS Contractor will ensure:

1. Programs for all buildings are developed by one programmer, or a small group of programmers with rigid programming standards, to ensure a uniform style.
2. Programs for like functions are identical, to reduce debugging time and to ease maintainability.
3. Programs are thoroughly debugged before they are installed in the field.

B. Massage and tune application programming for a fully functioning system. It is the Contractor's responsibility to request clarification on sequences of operation that require such clarification.

C. All site-specific programming shall be fully documented and submitted for review and approval:

1. Prior to downloading into the panel (see Submittal Package 2 in Section 15900.)
2. At the completion of functional performance testing, and.
3. At the end of the warranty period (see Warranty Maintenance in Section 15900).

D. All programming, graphics and data files must be maintained in a logical system of directories with self-explanatory file names. All files developed for the project will be the property of the Owner and shall remain on the workstations/servers at the completion of the project.

3.5 GRAPHIC SCREENS

A. All site specific graphics shall be developed in a manner that will ensure programming quality and uniformity among the various buildings.

B. Schematics of MEP systems.

1. Schematics shall be 3-D and shall be based substantially on the schematics provided on design drawings.
2. All relevant I/O points and setpoints being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation or color changes shall be used to indicate on/off status of mechanical components. Include appropriate engineering units for each displayed point value. Verbose names (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a pop-up window accessed by selecting the displayed point with the mouse.
3. Animation or equipment graphic color changes shall be used to indicate on/off status of mechanical components.
4. Indicate all adjustable setpoints and setpoint high and low limits (for automatically reset setpoints), on the applicable system schematic graphic or, if space does not allow, on a supplemental linked-setpoint screen.

C. Displays shall show all points relevant to the operation of the system, including setpoints and setpoint limits for setpoints that are automatically reset.

D. The current value and point name of every I/O point and setpoint shall be shown on at least one graphic and in its appropriate physical location relative to building and mechanical systems.

E. Show weather conditions (local building outside air temperature ands humidity, wind speed, and wind direction) in the upper left hand corner of every graphic.

F. CAD Files: The contract document drawings will be made available to the Contractor in AutoCAD 2010+ format upon request for use in developing backgrounds for specified graphic screens, such as floor plans and schematics. However the Owner does not guarantee the suitability of these drawings for the Contractor’s purpose.

G. Provide graphics for the following as a minimum:

1. Homepage (Campus, District or Facility Homepage). Background shall be a campus map, approximately to scale. Include links to each building, central plant, domestic water pumping station, etc. Include real-time site utility data such as: building electrical demand, domestic cold water flow, and natural gas demand shown roughly on the map where the utilities

connect to the site. Also include kW demand limit values and demand limit level.

2. Building homepage. Background shall be a bldg. footprint, approximately to scale, oriented as in the campus homepage. Include links to each floor and mechanical room/roof, and to summary graphics described below. Include real-time building utility data such as: building electrical demand, chilled water demand (flow and Btu/h), hot water demand (flow and Btu/h), domestic cold water demand, steam demand (if applicable), and natural gas demand (if applicable) shown roughly on the building footprint where the utilities connect to the building.
3. Each occupied floor plan, to scale.

    a. HVAC. Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, which provide a visual display of temperature relative to their respective setpoints (see paragraph 2.2G.8). The colors shall be updated dynamically as a zone's actual comfort condition changes. In each zone, provide links to associated terminal equipment.
    b. Lighting. Floor plan graphics shall show lighting control zones throughout the buildings in a range of colors, which provide a visual display of temperature relative to their respective setpoints (see paragraph 2.2G.9). The colors shall be updated dynamically as a zone's actual lighting condition changes. In each zone, provide links to associated lighting panel screen to allow manual overrides.
    c. If multiple floor plans are necessary to show all areas, provide a graphic building key plan. Use elevation views and/or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan screen to the building key plan and to each of the other graphic floor plan screens.

4. Each equipment floor/roof plan, to scale, with links to graphics of all DDC controlled/monitored equipment.
5. Each air handler and fan-coil. Provide link to associated HW and CHW pumping stations where applicable.
6. Each zone terminal. Provide link to associated air handling unit where applicable and to floor plan where terminal is located.
7. Each building pumping station. Provide link to central plant for heating and cooling systems.
8. Plumbing, potable water pumping and domestic water heating system.
9. Potable water, irrigation and natural gas meter.
10. Lighting panels. Indicate status of each relay and provide links to allow override.
11. Electrical power monitoring system.

a. Site: Show site single line diagram up to each building ATS, in order to illustrate the 12 KV power distribution and connection of each building to one of the two site circuits. The power flow would change on the diagram (by changing line color and/or width) to show which power line is active into each building as the ATS position is changed. Show ATS status at each building and a link to each building's electrical system graphic.
b. For each building: Show a schematic of the electrical system based on one-line diagrams. Show status and power of each switch, breaker, meter, etc. and override buttons for overriding switch positions.

12. Central plant equipment including chilled water system, cooling tower system, hot water system, steam system, generators, etc. The flow path shall change on the diagram (by changing piping line color and/or width) to show which piping has active flow into each boiler, chiller, tower, etc. as valve positions change.
13. Weather station. Show actual, daily, month-to-date, year-to-date, and historical high and low peaks and average temperature, humidity, wind speed, wind direction (average only), and solar radiation.
14. Summary graphics. Provide a single text-based page (or as few as possible) for each of the following summary screens showing key variables listed in columns for all listed equipment:

    a. For each building:

        1) Air handling units: operating mode, on/off status, supply air temperature, supply air temperature setpoint, fan speed, duct static pressure, duct static pressure setpoint, outdoor air damper position, coil valve positions
        2) Zone terminal units: operating mode, airflow rate, zone temperature, zone temperature setpoint, damper position, supply air temperature (reheat boxes), supply air temperature setpoint (reheat boxes), fan status (fan-powered boxes), fume hood status and exhaust airflow rate (laboratory).
        3) Electrical meters and switches: Volts, current, kW, switch positions.

15. All other DDC controlled/monitored equipment.

H. Alarms: Each programmed alarm shall appear on at least one graphic screen. In general, alarms shall be displayed on the graphic system schematic screen for the system that the alarm is associated with (for example, chiller alarm shall be shown on graphic cooling system schematic screen). For all graphic screens, display analog values that are in a 'high alarm' condition in a red color, 'low alarm' condition in a blue color. Indicate digital values that are in alarm condition in a red color.

3.6 POT SOFTWARE

A. Direct Panel Access:

1. One of the POTs shall be configured to access BCs and AACs by directly connecting to these panels without having to connect to the CSS via the network. The purpose of this requirement is to provide access to building EMCS panels in case the Supervisory LAN is down.
2. At the end of commissioning and then again at the end of the warranty period, fully synchronize the database on this POT with that on the CSS.

B. Temporary Interface prior to Acceptance:

1. Point database and control programming shall not be installed on and merged with that on the CSS until the system is fully commissioned and accepted by the Owner. During this phase, the Contractor shall provide a temporary POT configured with proper software for this purpose, connected to the EMCS locally at the building.
2. Once the EMCS has been accepted by the Owner, merge the database and control programming with existing systems on the CSS.

C. TAB Coordination:

1. Software shall be provided free of charge on at least a temporary basis to the TAB contractor to allow them to calibrate terminal box airflow controls and other work specified under Section 15950 Testing, Adjusting, and Balancing..
2. Software may be provided for installation on POT provided by TAB contractor or Contractor shall loan a POT or hand held device with software installed to the TAB contractor for the duration of TAB work.
3. Provide sufficient training to the TAB contractor to allow them to use the software for balancing and airflow calibration purposes. Contractor shall include a single training session; additional training due to changes in TAB personnel shall be paid for by the TAB contractor.

END OF SECTION

SECTION 15.933 EMCS COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Provide the following:

1. EMCS and equipment testing and start-up.
2. Validation of proper and thorough installation of EMCS and equipment.
3. Functional testing of control systems.
4. Demonstration testing of control systems.
5. Documentation of tests, procedures, and installations.
6. Coordination of EMCS training.
7. Documentation of EMCS Operation and Maintenance materials.

B. Refer to Section 15900 for general requirements.

1.3 RELATED WORK AND REQUIREMENTS

A. Other EMCS Sections:

1. Section 15900 Energy Management and Control System (EMCS) - General
2. Section 15913 EMCS Basic Materials and Devices
3. Section 15916 EMCS Operator Interfaces
4. Section 15919 EMCS Field Panels
5. Section 15923 EMCS Communication Devices
6. Section 15926 EMCS Software and Programming

1.4 COORDINATION

A. Assist Architect (or Commissioning Coordinator), including attending commissioning meetings.

B. Testing, Adjusting, and Balancing:

1. Coordinate with TAB contractors in test and balance work as specified in Section 15950 Testing, Adjusting, and Balancing for HVAC. A significant number of balancing procedures require the EMCS to be operational and require Contractor time to assist the TAB contractor in their work.

2. Terminal unit calibration:

    a. Provide software and/or portable devices for terminal unit calibration per Section 15926.
    b. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connection of the operator's terminal shall be either at the sensor or at the terminal box.

C. Coordinate with Division 15 and 16 contractors in the performance of pre-functional, functional, and post-occupancy commissioning activities.

1.5 SEQUENCING

A. The following list outlines the general sequence of events for submittals and commissioning:

1. Submit Submittal Package 1 (Hardware and Shop Drawings) and receive approval.
2. Initiate installation of EMCS hardware, devices and wiring.
3. Develop point database and application software.
4. Simulate sequencing and debug programming off-line to the extent practical.
5. Submit Submittal Package 2 (Programming and Graphics) and receive approval.
6. Complete installation of EMCS hardware, devices and wiring.
7. Install point database and application software in field panels.
8. Submit Submittal Package 3 (Functional Testing) and receive approval.
9. Perform EMCS Pre-functional Tests (start up, calibration and tuning) and submit Pre-functional Tests for approval.
10. Field test application programs prior to functional testing.
11. Receive EMCS Pre-functional Test Report approval and approval to schedule Functional Tests.
12. Prepare and initiate commissioning Trend Logs.
13. Assist TAB contractor in TAB tests and determining setpoints as specified in Section 15950.
14. Perform and record functional tests and submit Functional Test Report for approval.

    a. Some tests may not be possible due to weather conditions. These tests may be deferred to post-occupancy period.

15. Submit Package 4 (Training Materials) and receive approval.
16. Receive EMCS Functional Test Report approval and approval to schedule Demonstration Tests.
17. Perform Demonstration Tests to Commissioning Coordinator and Architect and submit Demonstration Test Report.
18. Receive acceptance of Demonstration Tests.
19. Train Owner personnel on EMCS operation and maintenance.
20. Substantial Completion.
21. Submit Package 5 (Post-Construction Trend Logs) in format specified for review and approval.

22. Receive approval of successful Trend Log tests, or retest as required.
23. Complete all items in Completion Requirements per Section 15900.
24. Provide administration level password access to the Owner.
25. Final Acceptance.
26. Begin Warranty Period.
27. Prepare and initiate post-occupancy Trend Logs.
28. Perform deferred alternate season functional tests and submit amended Functional Test Report for approval.
29. Receive amended EMCS Functional Test Report approval.
30. Two months prior to end of Warranty Period, submit Package 6 (End-of-Warranty Trend Logs) in format specified for review and approval.
31. Receive approval of successful Trend Log tests, or retest as required.
32. Revise and submit record documents and O&M Manuals.
33. Update all software as specified.
34. End of Warranty Period.

1.6 FUNCTIONAL TEST DOCUMENTATION

A. Pre-functional Tests:

1. Prepare forms to document the proper startup of the EMCS.
2. All equipment shall be included test forms including but not limited to:

    a. Wiring: End-to-end checkout of all wiring at terminations. Power to all controllers and actuators. Confirmation of emergency power where specified.
    b. Digital Outputs: proper installation, normal position, response to command at CU
    c. Digital Inputs: proper installation, device test, response at CU.
    d. Analog Outputs: proper installation of devices, verification of maximum and minimum stroke.
    e. Analog Inputs: proper installation of sensors, calibration.
    f. Panels: Confirmation of location, power source (electrical circuit used), confirmation of emergency power where specified.
    g. Alarms and Safeties: Verification of alarm routing to all specified devices and correct hierarchy. Example: confirm alarm routing to cell phones, email, servers, remote workstations. Confirm that appropriate alarm levels are routed to appropriate devices.
    h. Loop Tuning: Document setting of P/I parameters for all loops, chosen setpoints, time delays, loop execution speed.
    i. Network Traffic: Document speed of screen generation, alarm and signal propagation in system with all required commissioning trends active.

3. Each form shall have a header or footer where the technician performing the test can indicate his/her name and the date of the test.
4. Submit forms for approval in Submittal Package 3.
5. Complete work, document results on forms, and submit for approval as Pre-Functional Test Report.

B. Functional Tests:

1. Architect will prepare functional testing forms after Submittal Package 2 has been reviewed and approved. Tests will be designed to test all sequences in a formal manner with simulations and expected outcomes.
2. Review tests and recommend changes that will improve ease of testing or avoid possible system damage, etc.
3. Adapt forms from Architect into electronic format. Each form shall have a header or footer where the technician performing the test can indicate his/her name and the date of the test.
4. Complete work, document results on forms, and submit for approval as Functional Test Report.

C. Assist Commissioning Coordinator/Architect as specified including attending commissioning meetings.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Instrumentation required to verify readings, calibrate sensors, and test the system and equipment performance shall be provided by Contractor.

B. All equipment used for testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 6-month period. Certificates of calibration shall be submitted.

C. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is ±0.5% accurate, test equipment shall be ±0.25% accurate over same range).

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL TESTS

A. General:

1. Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.
2. Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
3. Verify integrity/safety of all electrical connections.
4. Verify that shielded cables are grounded only at one end.
5. Verify that all sensor locations are as indicated on drawings and are away from causes of erratic operation.
6. Ensure that minimum speed settings programmed into variable speed drive are at or below the minimum speed settings in control sequences.

B. Digital Outputs:

1. Verify that all digital output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.

C. Digital Inputs:

1. Adjust setpoints, where applicable.

    a. For current switches used as status on fans, adjust current setpoint so that fan status is “off” when fan discharge damper (if present) is fully closed and when belt is broken (temporarily remove belt).
    b. For current switches used as status on pumps, adjust current setpoint so that pump status is “off” when pump is dead-headed (temporarily close discharge valve).
    c. For differential pressure sensors on pumps and fans, set so that status is on when pump operating with all valves open (out on its curve).

D. Analog Outputs:

1. Verify start and span are correct and control action is correct.
2. Check all control valves and automatic dampers to ensure proper action and closure. Make any necessary adjustments to valve stem and damper blade travel.
3. Check all normal positions of actuators with spring return.
4. For outputs to reset other manufacturer’s devices (for example, chiller setpoint) and for feedback from them, calibrate ranges to establish proper parameters.

E. Analog Input Calibration:

1. Sensors shall be calibrated as specified on the points list. Calibration methods shall be one of the following:

    a. Factory. Calibration by factory, to standard factory specifications. Field calibration is not required.
    b. Handheld. Field calibrate using a handheld device with accuracy meeting the requirements of Paragraph 2.1.
    c. Drywell Bath. Field calibrate using a 2-point procedure, using a drywell calibrator block constructed for that purpose, or an ice bath with a reference standard.

2. The calibrating parameters in software (e.g. slope and intercept) shall be adjusted as required. A calibration log shall be kept and initialed by the technician showing date and time, sensor and hand-held readings, and calibration constant adjustments and included in the Pre-functional Test Report.
3. Inaccurate sensors must be replaced if calibration is not possible.

F. Alarms and Interlocks:

1. A log shall be kept and initialed by the technician showing date and time,

alarm/interlock description, action taken to initiate the alarm/interlock, and resulting action, and included in the Pre-functional Test Report.

2. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
3. Coordinate with Division 16 to test fire and life safety systems alarm contacts.
4. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
5. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

G. Variable Frequency Drive Minimum Speed:

1. Minimum speed for VFD-driven fans and pumps shall be determined in accordance with this Paragraph. Tests shall be done for each piece of equipment, except that for multiple pieces of identical equipment used for identical applications, only one piece of equipment need be tested with results applied to all. Note that for fans and pumps, there is no minimum speed required for motor cooling. Power drops with cube of speed, causing motor losses to be minimal at low speeds.
2. The work shall be done only after fan/pump system is fully installed and operational.
3. Determine the minimum speed setpoint as follows:

    a. Start the fan or pump.
    b. Manually set speed to 6 Hz (10%) unless otherwise indicated in control sequences. For cooling towers with gear boxes, use 20% or whatever minimum speed is recommended by tower manufacturer.
    c. Observe fan/pump in field to ensure it is visibly rotating.

        1) If not, gradually increase speed until it is.

    d. The speed at this point shall be the minimum speed setpoint for this piece of equipment.
    e. Record minimum speeds in log and store in software point as indicated in the Construction Drawings.

H. Tuning:

1. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the Pre-functional Test Report. Except from a startup, maximum allowable variance from set point for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained (exceptions noted):

Controlled Variable	Control Accuracy
Duct Pressure	±0.1" w.g.
Building and relief ple-	±0.01" w.g.

num	
Airflow and waterflow	±10%
Space Temperature	±1.5ºF
Chilled Water Temperature	±1ºF
Hot Water Temperature	±3ºF
Duct Temperature	±2ºF
Water Differential Pressure	±1.5 psi
Others	±2 times reported accuracy

I. Interface and Control Panels:

1. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the Record Drawings.
2. Ensure that terminations are safe, secure and labeled in accordance with the Record Drawings.
3. Check power supplies for proper voltage ranges and loading.
4. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
5. Check for adequate signal strength on communication networks.
6. Check for standalone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
7. Ensure that buffered and/or volatile information is held through power outage.
8. With all system and communications operating normally, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.
9. Check for adequate grounding of all DDC panels and devices.

J. Operator Interfaces:

1. Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.
2. Verify that the alarm printing, logging, paging, emailing etc. is functional and per requirements.

K. Trending/Network Traffic Test. Perform this test to verify that system has been design adequately to simultaneously capture trends and allow proper operation of the control system.

1. The test shall be performed after the verification trends (see paragraph 3.5A) have been set up and are operational.
2. Test 1:

a. Randomly select a device whose failure will generate a Level 1 or 2 alarm and manually shut it off. The status points for the device must indicate the change of state of the device at the Operator Workstation within 5 seconds.
b. The test shall be repeated for four devices in each building.

3. Test 2:

a. A clock signal from a field controller randomly selected will be sent as a programmable point to up to 3 BCs. The clock signal stored in BCs shall be sampled with the rest of the trend data. The system shall be considered acceptable if these clock signals are no more than 2 seconds off of the system clock as sampled concurrently during data collection.

4. If the system fails any test, the system architecture shall be revised as required (e.g. more trend memory, more controllers with trend storage capability, network repeaters to allow an increase in network speed, etc.) followed by additional tests.

3.2 TESTING, ADJUSTING, AND BALANCING (TAB) COORDINATION

A. Coordinate with Work performed under Section 15950 Testing, Adjusting, and Balancing for HVAC. Some balancing procedures require the EMCS to be operational and require Contractor time and assistance.

B. Calibration Software:

1. Software shall be provided free of charge on at least a temporary basis to allow calibration of terminal box airflow controls and other Work specified under Section 15950 Testing, Adjusting and Balancing for HVAC.
2. Software shall be provided for installation on POT(s) provided by Others or Contractor shall loan a POT or handheld device with software installed for the duration of Work specified under Section 15950Testing, Adjusting, and Balancing for HVAC.
3. Provide sufficient training to those performing Work specified under Section 15950 Testing, Adjusting, and Balancing for HVAC to allow them to use the software for balancing and airflow calibration purposes. Contractor shall include a single training session for this purpose.

C. Setpoint Determination:

1. Perform pre-functional tests described in the specifications before assisting in setpoint determination.
2. Coordinate with Work performed under Section 15950 Testing, Adjusting, and Balancing for HVAC to determine fan and pump differential pressure setpoints, outdoor air damper minimum positions and DP setpoints, etc. as indicated in Section 15950 Testing, Adjusting and Balancing for HVAC.

D. Coil Valve Leak Check:

1. Coordinate test procedures with those outlined in Section 15950 Testing, Adjusting and Balancing for HVAC to provide control valve leak check tests.
2. Test conditions for each hydronic system:

    a. Tests shall be done when central plant cooling and heating systems are operational.
    b. Close all control valves.
    c. Start all fans associated with control valves.
    d. Open bridge connection control valve.
    e. Start both pumps.
    f. Observe flow meter. If reading changes after pumps start, there is a leaking valve.
    g. Observe supply air temperature at each coil after test starts.
    h. Should any supply air temperature rise, close the isolation valves to the coil to see if temperature changes. If so, this validates the valve is not fully closing.
    i. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

3.3 FUNCTIONAL TESTS

A. Test schedule shall be coordinated with the Commissioning Authority, Commissioning Coordinator and/or Architect.

B. Functional tests may be witnessed by the Architect at the Owner's option.

C. All approved Functional Tests shall be conducted by the Contractor with results confirmed and signed by the Contractor's start-up technician.

1. Seasonal Impacts: It shall be assumed that not all tests will be possible due to weather conditions. Those that are not possible shall be deferred until the next season, performed during the warranty period.

D. Test documentation shall be submitted to the Owner for review and approval.

3.4 DEMONSTRATION TEST

A. Demonstration tests consist of a small representative sample of functional tests and systems randomly selected by the Owner. Tests will be designed to occur over no longer than ***2*** days.

B. Schedule the demonstration with the Architect 1 week in advance. Demonstration shall not be scheduled until the Functional Test Report has been approved.

C. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etc. Contractor-supplied personnel shall be those who conducted the Functional tests or who are

otherwise competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems.

D. The system will be demonstrated following procedures that are the same or similar to those used in the Pre-Functional and Functional Tests. The Architect will supply the test forms at the site at the start of the tests.

E. Demonstration tests may be witnessed by the Architect at the Owner's option.

F. Contractor shall conduct tests as directed by and in the presence of the Architect and complete test forms. Completed forms shall be submitted as the Demonstration Test Report to the Owner and Commissioning Coordinator after tests are complete.

G. Demonstration Tests shall be successfully completed and approved prior to Substantial Completion.

3.5 TREND LOG TESTS

A. Trends shall be fully configured to record and store data to the OWS or server for the points and at the interval listed in the Construction Drawins as follows:

1. Commissioning: Configure trends prior to functional testing phase. Retain configuration until post-construction trend review has been completed successfully and accepted by the Architect. Trends shall be deactivated after acceptance.
2. Continuous: After system acceptance, configure trends for the purpose of long term future diagnostics. Configure trends to overwrite the oldest trends at the longest interval possible without filling the server hard disk beyond 80%.

B. Commissioning (Post Construction) Trend Test.

1. Trend logging shall not commence until Demonstration Tests are successfully completed.
2. Hardware Points: Contractor shall configure points to trend as indicated in the Commissioning Trend column listed in the Construction Drawings points list with the following qualifications.

    a. For equipment of identical function, such as VAV zones and AHUs with identical components and control sequences, only a sample of such equipment need be trended. The sampling shall be 10% of the identical components, but no more than 10 and no less than three. Review with Architect before setting up trends.
    b. All points trended for one HVAC subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended during the same trend period and the same time intervals so that data may be easily plotted using a spreadsheet.

3. Software Points: Include the following in trends of systems and zones whose hardware points are being trended as called for above. Time

interval shall be the same as associated hardware point.

a. All setpoints and limits that are automatically reset, such as supply air temperature and fan static pressure setpoints, plus the points that are driving the reset, such as zone level cooling and static pressure requests.
b. All setpoints that are adjustable by occupants.
c. Outputs of all control loops, other than those driving a single AO point that is already being trended.
d. System mode points (e.g. Warm-up, Occupied, etc.).
e. Global overrides such as demand shed signals.
f. Calculated performance monitoring points, such as chiller efficiency.

4. Submit for review and approval by the Commissioning Authority and/or Architect a table of points to be trended along with trend intervals or change-of-value a minimum of 14 days prior to trend collection period.
5. Trends shall be uploaded to the OWS or Server in data format specified in Section 15926.
6. Trend logs of all points indicated above shall be collected for a 3 week Trend Period.
7. At the completion of the Trend Period, data shall be reviewed by the Contractor to ensure that the system is operating properly. If so, data shall be submitted to the Architect in an electronic format agreed to by the Owner and Contractor (e.g. CD-ROM or via direct access to the OWS or server via the internet).
8. Data will be analyzed over approximately a two- to three-week period by the Commissioning Authority and/or Architect.
9. The system shall be accepted only if the trend review indicates proper system operation without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications. If any but very minor glitches are indicated in the trends, steps 4 to 6 above shall be repeated for the same Trend Period until there is a complete Trend Period of error free operation.

C. Post Occupancy Trend Tests.

1. After successfully completing the Commissioning Trend Tests, the Contractor shall configure all points to trend as indicated in the Continuous Trend column listed in the Construction Drawings points list.
2. Archive trends up to the OWS or server without overwriting stored data for the entire Warranty Period.
3. The system shall be accepted and warranty period considered complete only if the trend review indicates proper operation without malfunction without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications. If any but very minor glitches are indicated in the trends, steps above shall be repeated until there is a complete Trend Period of error free operation.

3.6 REMEDIAL WORK

A. Repair or replace defective Work, as directed by Architect in writing, at no additional cost to the Owner.

B. Restore or replace damaged Work due to tests as directed by Architect in writing, at no additional cost to the Owner.

C. Restore or replace damaged Work of others, due to tests, as directed by Architect in writing, at no additional cost to the Owner.

D. Remedial work identified by site reviews, review of submittals, demonstration test, trend reviews, etc. shall be performed to the satisfaction of the Architect, at no additional cost to the Owner.

E. Contractor shall compensate Architect and Commissioning Authority on a time and material basis at standard billing rates for any additional time required to witness additional demonstration tests or to review additional EMCS trends beyond the initial tests, at no additional cost to the Owner.

3.7 TRAINING

A. Coordinate schedule and materials with Architect and/or Commissioning Authority.

B. Interim Training:

1. Provide minimal training so the operating staff can respond to occupant needs and other operating requirements during start-up and commissioning phase.

C. Formal Training:

1. Provide training sessions at locations and for personnel indicated below.
2. Training shall be conducted after all commissioning is complete and systems are fully operational.
3. The length of each training period will depend on the complexity of the system and the audience, described below. Minimum training shall be as listed below, but period shall be longer if required to complete the training tasks described below.

    a. On site job training: Include 40 hours total of on-site training to assist personnel in becoming familiar with site-specific issues, systems, control sequences, etc. (including general EMCS system training).

4. Training may be in non-contiguous days at the request of the Owner.
5. Contractor shall be video training sessions, see Section 15010 Mechanical General Provisions.
6. During the warranty period, provide unlimited telephone support for all trained operators.

D. Operators are divided into three categories and shall receive training including but not limited to the tasks listed.

1. Day-to-day Operators shall be trained to:

   a. Proficiently operate the system.
   b. Understand control system architecture and configuration.
   c. Understand EMCS system components.
   d. Understand system operation and control sequences.
   e. Operate the workstation and peripherals.
   f. Log on and off the system.
   g. Access graphics, point reports, and logs.
   h. Adjust and change system set points, time schedules, and holiday schedules.
   i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
   j. Understand and acknowledge alarms.
   k. Understand system drawings, and Operation and Maintenance manual.
   l. Understand the Project layout and location of control components.
   m. Print point and predefined reports.

2. Advanced Operators shall be trained to do all items for Day-to-day operators plus:

   a. Make and change graphics on the workstation.
   b. Create, delete, and modify alarms, including annunciation and routing.
   c. Create, delete, and modify point trend logs, and graph or print these both on an ad-hoc basis and at user-definable time intervals.
   d. Create, delete, and modify reports.
   e. Add, remove, and modify system's physical points.
   f. Create, modify, and delete programming.
   g. Add control panels.
   h. Add Operator Workstations.
   i. Create, delete, and modify system displays — both graphical and otherwise.
   j. Perform EMCS system field checkout procedures.
   k. Perform EMCS controller unit operation and maintenance procedures.
   l. Perform workstation and peripheral operation and maintenance procedures.
   m. Perform EMCS system diagnostic procedures.
   n. Configure hardware including PC boards, switches, communication, and I/O points.
   o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware.
   p. Adjust, calibrate, and replace system components.
   q. Maintain software and prepare backups.

3. System Managers/Administrators shall be trained to do all items for Day-to-day operators plus:

a. Maintain software and prepare backups.
b. Create and print custom reports, including tenant billing summaries.
c. Interface with job-specific, third-party operator software.
d. Add new users and understand password security procedures.

E. Training materials shall include step-by-step instructions (including illustrations, screen captures, etc.) for how to perform all task identified in herein such that a new Operator, who has not attended the training in person and has minimal familiarity with this EMCS system, can easily follow the instructions and successfully perform all of the identified tasks. One copy of training material shall be provided per student. An electronic copy of the materials shall be stored on the OWS.

F. The instructor(s) shall be factory-trained instructors experienced in presenting this material.

G. The type and number of personnel and location for training shall include.

1. Day-to-day Operator: 2.
2. Advanced Operator: 1.
3. System Managers/Administrators: 1.

END OF SECTION

SECTION 15.950 TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

    a. Operational testing and adjusting of air handling equipment.
    b. Balancing of air distribution systems.
    c. Testing and adjustment of air terminal devices.

2. Balancing HVAC Hydronic Piping Systems:

    a. Flow testing and adjusting of hydronic systems.

3. Balancing Potable Hot Water Systems:

    a. Flow testing and adjusting of system balance valves.
    b. Recirculating pump TAB
    c. Verify tepid water delivery for all new and existing modified fixtures and specialties.

4. Witnessing and certification of duct air leakage tests.
5. Control system verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.4 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. "R" means required.
2. "R2" means required only for products and equipment differing for the specified manufacturer and model and for "or equals" where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
AABC or NEBB certification	R			
Report forms	R			
List of instrumentation	R			
Final hydronic water balancing report		R		
Final air balancing report		R		
Final potable hot water balancing report				
Final potable hot water temperature verification report on all mixing valves and fixtures/appliances				

C. Final Test & Balance Report.

1. At least 15 days prior to Contractor's request for final inspection, submit electronic copy of final reports on approved reporting forms, and certifications for review and approval by Architect. Once approved, provide required quantity of paper and electronic copies per 230010 "Mechanical General Provisions."
2. Form of final reports.

a. Fully completed report forms for all systems specified to be tested and balanced including at a minimum all data specified herein to be recorded.
b. Each individual final reporting form must bear:
c. Identify instruments of all types that were used and last date of calibration of each.
d. Certifications.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC or NEBB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC or NEBB.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. Prior to start of testing, adjusting, and balancing, verify that required Project conditions are met:

1. System and control system installation is complete and in full operation.
2. All pre-functional tests have been performed.
3. Equipment has been started and tested in accordance with manufacturer's installation instructions.
4. Doors and windows are in place and closed or under normal traffic conditions.
5. Proper mostly clean air filters are in place.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

E. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT REVIEW

A. Construction Review.

1. Make on-site visits during progress of construction: Number and timing of visits to be as required to perform the functions specified below.
2. Purpose of review.

a. Identify potential problem for performing total system balance.
b. Identify modifications that will affect air total system balance.
c. Schedule and coordinate total system balance with other work.
d. Identify conditions that could create hazardous environment for building occupants.

3. Typical activities.

a. Check that necessary balancing and measuring hardware is:

1) In place.
2) Located properly and accessibly.
3) Installed correctly.

b. Identify and evaluate variations from system design.
c. Record data from equipment nameplates.

d. Identify and report possible restrictions in systems, such as:

1) Closed fire dampers.
2) Long runs of flexible duct.
3) Poorly designed duct fittings.
4) Questionable piping connections.
5) Others as may arise or based on Agency's experience.

e. Verify that construction progress will not delay total and/or phased project system balance.
f. Identify best location for duct Pitot tube traverses.
g. Identify scaffolding and other access needs.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified herein. If not otherwise noted, the following minimum requirements apply.

1. Voltmeter: plus, or minus 1 percent scale.
2. Ammeter: plus, or minus 1 percent scale.
3. Ohmmeter: plus, or minus 0.1 percent scale for calibrating plus or minus 0.4 degrees Fahrenheit resistance temperature sensors, plus or minus 0.25 percent scale for calibrating plus or minus 1 degrees Fahrenheit temperature sensors, plus or minus 1 percent scale for measuring motor current.
4. Ultrasonic time-of-travel strap-on flow sensor: plus, or minus 5 percent of reading.
5. Other flow sensors: plus, or minus 2 percent of reading.
6. Water pressure gauge: plus, or minus1/2 percent scale, ASME Grade 2A.
7. Watt meter, plus, or minus1/2 percent scale: 3 phase split core current transducers.
8. Temperature: plus, or minus 0.4 degrees Fahrenheit.
9. Calibrated balance valve manufacturer's test kit and required instrumentation.

B. All equipment shall be calibrated within 6 months of use, or according to the manufacturer's recommended interval, whichever is shorter, and when dropped or damaged. Calibration tags shall be affixed or certificates readily available and proof of calibration shall be included reports.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate with work of other trades.

B. Report to Professional any discrepancies or items not installed in accordance with the Contract Drawings pertaining to proper balance and operation of air and water distribution systems.

C. Perform testing, adjusting, and balancing in accordance with AABC or NEBB standards.

D. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to Section 230713 “Duct Insulation” and Section 230719 “Piping and Equipment Insulation.”.

E. Mark equipment settings with paint or other suitable, permanent identification material, including damper control positions, valve indicators, and similar controls and devices, to show final settings.

3.2 CONTROL SYSTEM COORDINATION

A. See Section 230900 “Energy Management & Control Systems (EMCS).”

B. System balance techniques in this Section rely on the operation of the EMCS. Test and balance agency shall coordinate schedule of work with EMCS installer to ensure test and balance work can be executed and completed in a timely manner.

C. Cooperate with EMCS installer in determining operating conditions and setpoints, as indicated in this Section.

D. Cooperate with EMCS installer in calibrating all airflow measuring devices.

E. Obtain and receive training for required software from controls system vendor for setting calibration constants in terminal devices.

F. Test and balance is responsible for ensuring all thermostats are programmed per Owners schedule with proper setpoints.

3.3 AIR SYSTEMS BALANCING

A. General.

1. Do not operate fan systems for test or balance until spaces served have been cleaned of dust and debris, to avoid contamination of supply air or return air paths and equipment.
2. Filters.

    a. Check that proper specified filters are installed, oriented in the proper airflow direction, free of bypass, and clean.
    b. Make no adjustment for dirty filters, fans were selected for clean filters at design airflow.
    c. Adjust airflows to within 5% of scheduled quantities.

3. In cooperation with EMCS installer, set adjustments of automatically operated dampers and valves to operate as indicated.
4. Balance hydronic systems prior to air balance and have operational during air balance for air temperature measurements.
5. Coordinate balancing of dampers for minimum ventilation.

B. Air Outlets.

1. Adjust diffusers' throw pattern, grilles and registers to pattern indicated on the Drawings. Review manufacturer's instructions for proper diffuser blade or weir gate positions to provide this throw pattern as it is not always intuitive. It is TAB agency's responsibility to adjust throw patterns for all adjustable throw diffusers. If diffuser has a fixed throw pattern and is incorrectly installed, HVAC contractor shall correct pattern prior to balance.

    a. Ceiling diffusers: As indicated on the Drawings.

        1) Star pattern diffuser deflectors shall be adjusted for corner blow pattern unless otherwise indicated on Drawings.

    b. Double-deflection grilles: Adjust rear blades horizontal 22 degree upward and splay front blades in 45-degree pattern at each end gradually rotating to almost straight at blades in center of grille.
    c. Floor grilles: Not applicable.

2. Test and adjust each diffuser, grille and register to within plus or minus 10 percent of design requirements.

    a. Start with all dampers wide open.
    b. Adjust dampers, starting with nearest to terminal unit or fan. Make adjustments using duct mounted volume dampers rather than dampers at diffuser face (if any) unless absolutely required.

c. At least one damper shall remain wide open at end of balance.

3. Plenum return air grilles or slots in lights: No balance required.
4. Report.

    a. Tag each grille, diffuser and register and mark tag on copy of floor plan.
    b. For each grille, diffuser, and register, indicate tag, size, type, and effective area (where applicable).
    c. Required velocity/cubic feet per minute.
    d. Initially tested velocity/cubic feet per minute.
    e. Finally tested cubic feet per minute after adjustments.

C. Terminal Boxes.

1. Balancing Agency shall provide laptop computer or other device for communicating with EMCS system, using software provided by EMCS installer. Cooperate with EMCS installer to learn how to use software to calibrate EMCS zone controller.
2. Terminal box calibration procedure listed below may be modified based on specific features or limitations of digital controller and recommendations of the controller manufacturer. Submit revised procedure for approval by Architect.
3. Use EMCS terminal “commissioning” software where available and record all calibration and test data through the EMCS.
4. Zero transmitter prior to each test.
5. Adjust EMCS calibration constants so that the VAV box controller and measured air flow rate at air outlets matches EMCS reading within range listed at all of the following conditions at a minimum:

    a. Zero airflow.
    b. Maximum airflow setpoint, ±5%.
    c. Minimum airflow setpoint, ±10%.

        1) If EMCS can only calibrate to one point, adjust VAV box controller minimum volume setpoint so that measured air flow rate at air outlets equals desired minimum, even though this will cause EMCS to read improperly.

6. Report:

    a. Tag, manufacturer, and model.
    b. VAV maximum cooling flow rate, design, and measured.
    c. VAV minimum flow rate, design, and measured.
    d. EMCS calibration coefficients at all calibration points.

D. EMCS airflow measuring stations (AFMS).

1. Measure and report airflow and concurrent EMCS AFMS readings at a minimum of three conditions.

2. For factory calibrated AFMS: if measured airflow and EMCS readings differ by more than 10%, consult with Architect for recalibration instructions. Do not change factory calibration without written direction.

3. For field calibrated AFMS: Work with EMCS installer to adjust calibration coefficients. Report coefficients in air balance report.

E. Air Handling Units, Blower Coil Units, Fan Coil Units, Packaged Equipment Air Flow Rate Readings.

1. Total supply air quantities shall be determined at all of the following where applicable:

   a. Pitot traverse in the supply duct downstream, positive pressure side of the fan.
   b. Pitot traverse at coil or filter bank.
   c. Totaling the readings of individual air outlets.
   d. Totaling the readings of individual terminals as read through the EMCS.

2. Total return air quantities shall be determined at all of the following where applicable:

   a. Pitot traverse in the return air duct or damper entering air handler.
   b. Totaling the readings of individual air outlets if ducted return system.
   c. Totaling reading of each return air shaft inlet, if multi-story plenum return system.

3. Outside air quantities shall be determined by all of the following where applicable:

   a. Subtracting pitot traverses of supply and return ducts.
   b. Pitot traverse of outdoor air intake duct.
   c. Outdoor airflow sensor reading as read through the EMCS.
   d. Note: Balance by measurement of return air, outside air, and mixed air temperatures shall not be used due to inherent inaccuracy.

4. For systems with airflow measuring stations, measure airflow and coordinate with EMCS installer to calibrate airflow stations at a minimum of three conditions:

   a. Design air flow.
   b. 50 percent of design air flow.
   c. Minimum air flow.

F. Variable Air Volume Air Handling Equipment.

1. Adjust fan speed using manual adjustment of variable speed drive for testing only. Do not change or adjust sheaves.
2. Supply fan DP Setpoint.

    a. Establish maximum static pressure setpoint (DPmax) in conjunction with the EMCS installer as follows. All adjustments made via the EMCS, not field measurements except as noted.
    b. Test conditions.

        1) Set all boxes to operate at maximum airflow setpoints: allow controls to stabilize.
        2) For cooling systems only to account for diversity: Shut off boxes, starting with boxes whose dampers are the most closed, as indicated by the EMCS, and upstream of the DP sensor, until the airflow equals scheduled design airflow rate.

    c. Procedure.

        1) Manually lower fan speed slowly while observing VAV box airflow rates downstream of the static pressure sensor. Stop lowering speed when one or more VAV box airflow rates drops 10 percent below maximum airflow rate setpoint.
        2) Once flow condition in previous step is achieved, note the EMCS system static pressure reading at the duct static pressure sensor.

            a) This reading becomes the maximum static pressure setpoint.
            b) Using pressure taps at differential pressure sensor and handheld digital pressure sensor, verify accuracy of EMCS reading.

    d. Convey to the EMCS installer.

        1) Static pressure setpoints.
        2) Any discrepancy between EMCS differential pressure reading and handheld measurement.

    e. Report.

        1) Static pressure setpoint and concurrent reading of handheld measurement: Initials of EMCS installer to indicate that the information was transmitted to them.
        2) Tag of VAV boxes that dropped below design maximum airflow rate in tests above. These are the critical boxes, those requiring the largest static pressure.

3) Concurrent fan data.

a) Volts and amps.
b) Amps and kilowatts from VFD.
c) VFD speed in hertz.
d) Entering and leaving fan static pressure.
e) Flow rate, summed from EMCS terminals.
f) Fan airflow sensor reading from EMCS, where applicable.

3. Minimum outside air flow.

a. Supply air fan and return air fan (if any) shall first be operating at design airflow. For VAV systems with diversity, close enough boxes close to fan to reduce supply airflow to scheduled design condition.

1) For systems without a separate two-position outdoor air damper.

a) Open return air damper fully.
b) Adjust the outdoor air damper signal through the EMCS until the minimum outdoor airflow rate is achieved.
c) Convey this minimum outdoor air damper signal to EMCS installer and note on air balance report.

2) Note differential pressure across the outdoor air damper. This value becomes the minimum outdoor air differential pressure setpoint in the EMCS. Convey this setpoint to EMCS installer and note on air balance report.

3) For systems with CO_2 demand-controlled ventilation.

a) With the system at the minimum outdoor air position, reduce supply air fan speed until the outdoor air rate is equal to [0.15 cfm/ft^2 of floor area served by the system] [the absolute minimum outdoor air rate on AHU schedule].
b) Note differential pressure across the outdoor air damper. This value becomes the absolute minimum outdoor air differential pressure setpoint in the EMCS. Convey this setpoint to EMCS installer and note on air balance report.

b. For systems with outdoor airflow measuring stations:

1) See EMCS AFMS paragraph herein.

4. Test with system operating at design fan and minimum outside air flow conditions described above and record the following on a schematic of the system:

a. Tags of all equipment.

b. Manufacturer and model of fan and motor.
c. Motor horsepower, rpm, volts, phase, full load amps.
d. Sheave data at motor and fan; belt data.
e. Fan airflow rate at all locations measured, as listed above.
f. Final measured fan speed and amps.
g. Amps and kilowatts, from VFDs.
h. VFD speed in hertz.
i. Static pressures measured at:

1) Return air plenum.
2) Mixed air plenum.
3) Downstream of relief fan (where applicable).
4) Downstream of filter.
5) Downstream of coil.
6) Discharge of supply fans.
7) At static pressure sensor.

j. Concurrent airflow rate readings from EMCS airflow sensors, including sum of VAV box airflow rates.
k. Minimum EMCS outdoor air control setpoints and signals, where applicable.

G. Constant Volume Air Handling Units, Fan Coil Units, Package Equipment.

1. Total air quantities shall be obtained within 10 percent of design by adjustment of fan speed.

a. Adjust sheaves on fans with adjustable sheaves.
b. Change sheaves on fans with fixed sheaves.
c. Adjust speed potentiometer for EC motors.
d. Adjust SCR for direct drive PSC motors.

2. Test and adjust minimum outdoor air flow.

a. Supply air fan shall first be operating at design airflow.
b. For systems with economizers.

1) Open return air damper fully.
2) Adjust the outdoor air damper signal through the EMCS until the minimum outdoor airflow rate is achieved.
3) Convey this minimum signal to EMCS installer and note on air balance report.

c. For systems without economizers.

1) Adjust minimum outdoor air or return air damper balancing damper position or linkage to deliver design minimum outdoor airflow rate.

2) Clearly mark minimum damper position on damper housing.

3. Test with system operating at minimum outside air flow condition described above and record the following on a schematic of the system.

a. Tag.
b. Manufacturer and model of fan and motor.
c. Sheave data at motor and fan; belt data.
d. Motor horsepower, rpm, volts, phase, FLA.
e. Fan airflow rate at all locations measured, as listed above.
f. Final measured amps.
g. Static pressure measured at:

1) Return air plenum.
2) Mixed air plenum.
3) Downstream of filter.
4) Downstream of coil.
5) Discharge of fans.

h. Concurrent airflow rate readings from EMCS airflow sensors, where applicable.
i. Minimum EMCS outdoor air control signal, where applicable.

H. Constant Volume & Variable Volume Exhaust Fans.

1. See herein for air outlet balancing.
2. Total air quantities for fan shall be determined by both:

a. Pitot tube traverse of main ducts near the fan inlet, and.
b. Totaling the readings of individual air outlets (or inlets).

3. Total air quantities shall be obtained within 10 percent of design by adjustment of fan speed.

a. Constant speed fans:

1) Adjust sheaves on fans with adjustable sheaves.
2) Change sheaves on fans with fixed sheaves.
3) Adjust speed potentiometer for EC motors.

b. Variable speed fans:

1) Adjust maximum fan speed at ECM or VFD.

4. Report.

a. Tag.
b. Manufacturer and model of fan and motor.

c. Sheave data at motor and fan; belt data.
d. Motor horsepower, rpm, volts, phase, full load amps.
e. Fan airflow rate at all locations measured, as listed above.
f. Final measured amps.
g. Inlet and outlet static pressure.

3.4 AIR PURIFICATION SYSTEMS

1. Testing:

   a. Use a portable handheld, ion counter with a calibrated range of 0 to 20,000 ions/cm3 and an accuracy of +/- 25% within the specified range. Ion counter shall have automatic zeroing capability on 10-minute intervals.

   b. Ion generator to be provided by supplier of ion generators on project and ion counter to be turned over to owner after TAB is complete.

2. Report:

   a. Tag of unit
   b. Confirmation that ion generator is provided.
   c. Model and serial number of ion generator installed.
   d. Voltage and amps from ion generator.
   e. Amount of ions at discharge of units at supply.

3.5 HYDRONIC WATER SYSTEMS BALANCING

A. Prepare water systems for balancing in following manner.

1. Verify the following conditions:

   a. Piping systems have been flushed and treated in accordance with Section 232113 “Hydronic Piping.”
   b. Strainers have been cleaned.
   c. Piping systems are completely full of water, all air properly vented.
   d. All coil and heat exchanger isolation shut-off and balance valves are fully open.

2. Check Pump.

   a. Rotation.
   b. Pump factory impeller trimming by comparing shut-off heads with pump curves from approved submittals.

1) Note that impellers on variable speed pumps should not be trimmed to design flow and head conditions. See 232123 “Hydronic Pumps.”
2) Report discrepancy in shut-off head to Architect and if impeller does not appear to be properly trimmed, wait for direction before proceeding with pump test and balance.

3. EMCS and Central Plant Operability.

a. Do not proceed with any of the following balancing procedures until the EMCS is capable of operating equipment such as fans, pumps, VAV boxes, control valves, and the like, in manual and automatic modes and capable of reading sensors such as differential pressure, flow rates, temperatures, and the like, of air and hydronic systems to be tested and adjusted.
b. Do not proceed with air handler and fan-coil testing until chilled and hot water at design temperatures are available from the central plant.

B. Pumps.

1. Test and report for each pump at test conditions indicated in Paragraphs below.

a. Tag.
b. Manufacturer and model of pump and motor.
c. Motor horsepower, volts, phase, full load amps.
d. Pump shut-off head from curves, measured shut-off head, and resulting impeller diameter from pump curve.
e. At test condition specified.

1) Volts and amps.
2) Calculated brake horsepower.
3) Entering and leaving gauge pressure and difference in feet.
4) Flow rate deduced from pump curve.
5) For pump with VFD:

a) Speed (Hz).
b) Kilowatts.

C. Heating Water and Chilled Water Distribution System.

1. Coil Test & Balance.

a. System is self-balancing. Two-way control valves at coils prevent each coil from being over-supplied with water, other than minor excursions during transients such as cool-down or warm-up. Conventional balancing (throttling of balancing valves) will increase pump energy use by not allowing aggressive differential pressure

setpoint reset. Hence, do not adjust any valves on any coil or pump, except temporary adjustments where noted. Calibrated balancing valves may be provided for flow measurement and diagnostics, but they shall not be modulated for flow balancing. All manual valves at coils and pumps shall be wide open when test and balance work is complete.

b. Report with all control valves open to coil and all pumps (except standby pumps, where applicable) operating at full speed.

1) See Air Balance below for coil temperature data.
2) See Pump test data above for pump data.
3) Coils with modulating two-way or three-way control valves.

a) Terminal tag.
b) Control valve model number and serial number.
c) Pressure drop across coil.
d) Flow as measured by calibrated balancing valve (where applicable).

2. Variable Speed Drive Setpoint Determination.

a. For systems with VFD, determine maximum differential pressure setpoint (DPmax) in conjunction with the EMCS installer as follows:

1) Fully open all control valves serving coils that are located downstream of the differential pressure sensor.
2) Fully close all control valves serving coils that are located upstream of the differential pressure sensor.
3) Start pump(s). Manually adjust speed slowly until design flow (or design pressure drop, for coils without calibrated balance valves) is just achieved through all open coils without modulating any balance valves. One coil should be just at design flow, while others should be at or above design flow.
4) Once flow condition in previous step is achieved, note the EMCS system differential pressure reading at the differential pressure sensor. This reading becomes the differential pressure setpoint. Using pressure taps at differential pressure sensor and handheld digital pressure sensor, verify accuracy of EMCS reading.
5) If there are multiple differential pressure sensors, repeat steps above for each sensor.

b. Convey to the EMCS installer.

1) Differential pressure setpoint.
2) Any discrepancy between EMCS differential pressure reading and handheld measurement.

c. Report at condition described above.

1) Differential pressure setpoint and concurrent reading of handheld measurement. Initials of EMCS contractor to indicate that the information was transmitted to them.
2) Tag of coils downstream of differential pressure sensor, along with the following for each:

a) Design flow rate and pressure drop.
b) Tested flow rate and pressure drop with differential pressure at setpoint determined above.

3) Water flow rate through flow meter (where applicable), through EMCS.
4) See Pump test data above for pump data.

3. Control Valve Shut-Off Test.

a. Close all control valves in the system through the EMCS. Close bypass balance valves of 3-way valves (where applicable). Run all pumps (except stand-by pump, if any) at full speed:

1) Verify that all control valves remain shut with no measurable flow, as indicated by pump differential pressure, flow meters, and any temperature rise across coils.
2) Do not run pumps deadheaded for more than 5-minutes at any one time.
3) After test, return 3-way valve balance valves to prior position and release control valves to automatic operation through the EMCS.

b. Report at condition described above.

1) Tag of coils where flow is detected. Initials of EMCS contractor to indicate that this information was transmitted to them.
2) Measured pump inlet and outlet pressures, and difference converted to feet.
3) Differential pressure reading at all differential pressure sensors, through EMCS.
4) Water flow rate from flow meter, through EMCS.

D. Hot Water Plant.

1. Boiler Balancing.

a. Test and proportionally balance flow to boilers:

1) Start with all balance valves at boilers wide open.

2) Open all coil control valves through EMCS.
3) Run all pumps (except stand-by pump, if any).
4) Adjust balance valves at boilers, starting with nearest to pump, to provide flow rates proportional to design rates (deduced from pressure drop or calibrated balance valve) through each. At least one boiler balance valve shall remain wide open at end of balance.

b. Report at condition described above.

1) Design and final flow rate at each boiler.
2) Design and final inlet and outlet pressure at each boiler.
3) Balance valve position (% open).

2. Boiler Firing Test.

a. Ensure that no gas fired equipment other than the boilers is in operation.
b. Start with the system cold enough so the system does not heat to setpoint within test period.
c. Verify gas manifold pressure downstream of gas valves meets boiler manufacturer's requirements.
d. Open all heating coil control valves.
e. Run all hot water pumps (except stand-by pump, if any).
f. Run each boiler, one at a time, at high fire by raising the HW supply temperature setpoint.
g. Clock the gas meter for a minimum of 10 minutes.
h. Concurrently record natural gas flow meter reading from EMCS (if applicable).
i. Measure the gas pressure at inlet to meter.
j. Determine conversion factor of (Btu per cubic foot) from gas pressure chart, and then calculate the boiler firing rate in Btu/h.
k. Determine boiler flow rate from calibrated balancing valve at boiler or EMCS flow meter.
l. Use flow and temperature rise across each boiler to calculate heat transferred to water ($Q = 490*GPM*\triangle T$).
m. Report.

1) Gas meter test start and stop readings.
2) Boiler input gas rate in cubic feet per hour calculated from gas meter and measured by EMCS.
3) Each boiler.

a) Boiler firing input rate in Btu/h, design and calculated from utility gas meter and from EMCS gas meter.
b) Hot water return temperature.
c) Hot water supply temperature.

d) Flow rate.
e) Calculated heating energy transferred to water Btu/h.
f) Calculated efficiency, heat transferred to water divided by gas energy input.

E. Bypass Balancing at 3-Way Valves.

1. At all 3-way valves serving coils with a design coil pressure drop exceeding 2 feet, adjust balance valve in bypass leg as required to make pressure drop across the coil-valve assembly when valve is in full-bypass position equal to that when control valve is in through-coil position.
2. Report.

a. Differential pressure across coil-valve assembly when control valve is in full-bypass position.
b. Differential pressure across coil-valve assembly when control valve is in through-coil position.
c. Position of bypass valve (% open).

F. Balancing Main Bypass Valves

1. Coordinate and test operation of hydronic system piping main bypass control valves to maintain 10% excess on minimum flow required of equipment served.

3.6 POTABLE HOT WATER BALANCING AND VERIFICATION

A. The recirculating pump flowrate shall be set and verified to be within 10% of scheduled amount.

B. Where multiple zone manual calibrated balance valves exist, the recirculating flow shall be set per flowrates shown on plans, or proportional to the overall flowrate of the recirculating pump/system.

C. The recirculating flowrate of the water heater and master mixing valves shall be set using manual calibrated balance valves, in accordance with information shown on drawings, or details.

D. The master and point-of-use mixing valves shall be set to provide the scheduled temperatures on the drawings, or details.

E. The TAB shall indicate in the final report:

1. Pump flowrate and head.
2. Temperature setpoint of water heater(s).
3. Temperature at outlet of master mixing valve.

4. Tepid temperature at all plumbing fixtures/appliances, and safety equipment with hot, or tepid temperature service.

3.7 DUCT AIR LEAKAGE TESTS

A. TAB Agency shall witness duct air leakage tests once Division 23 HVAC contractor confirms in writing that all ductwork has passed the pretest.

B. TAB Agency shall initial Duct Air Leakage Test Log for each section of duct tested certifying that duct passed the maximum permitted air leakage test as specified in Section 233113 – Metal Ducts.

3.8 TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan speed and the face velocity of filters and coils.

2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.9 ADDITIONAL COST

A. Fans: If drives are not capable of being adjusted to meet required performance, inform Architect, and replace sheaves as required.

B. Pumps: Do not trim pump impellers. Adjust flow with pump speed via VFD.

3.10 SPOT CHECKING

A. Spot checks shall take place after test and balance work is complete and reports have been prepared and approved.

B. Spot checks shall be witnessed by the Architect. Schedule spot checks with Architect at least 1 week prior to proposed test date.

C. Architect shall select subsets of any tested and balanced air or hydronic system to be spot-checked on the day of tests without prior notice to the Contractor.

1. Spot-checking will not require more than one working day.
2. If additional spot checks are requested by the Architect causing the time limit above to be exceeded, inform Architect, and indicate added price to perform the additional tests. Do not include additional tests in initial bid.

D. Discrepancies.

1. If any of the spot-check measurements differ more than 25 percent from those documented in test and balance reports, the Agency shall completely rebalance the associated system. For balance discrepancies at or downstream of a VAV box, rebalance only is required at or downstream of that box.
2. If discrepancies as described above are found on more than 25 percent of the spot-checks for air systems, all air systems shall be rebalanced.
3. If discrepancies as described above are found on more than 25 percent of the spot-checks for hydronic systems, all hydronic systems shall be rebalanced.
4. Rebalance work shall be witnessed by the Architect at the option of the Architect.

5. All rebalance work shall be documented, and documentation shall be resubmitted as specified above.
6. All rebalance work shall be provided at no additional cost to the Owner.

3.11 TRAINING OWNER PERSONNEL

A. Go over the final Testing, Adjusting and Balancing Report, explaining the layout and the meanings of each data type.

B. Discuss any outstanding deficient items in control, ducting, piping, or design that may affect the delivery of air or water.

C. Identify and discuss any systems or system components that are not meeting their design capacities.

D. Discuss any temporary settings and steps to finalize them for any areas that are not finished or fully occupied.

E. Any other appropriate points that may be helpful for facilities operations, relative to testing, adjusting, and balancing or the mechanical systems.

END OF SECTION

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Provisions of Division 01 apply to this section

B. Section Includes: This section provides basic electrical requirements.

1.02 BASIC ELECTRICAL REQUIREMENTS

A. Quality Assurance:

1. Workers possessing the skills and experience obtained in performing work of similar scope and complexity shall perform the Work of this Division.

2. Refer to other sections of the Specifications for other qualification requirements.

B. Drawings and Specifications Coordination:

1. For purposes of clearness and legibility, Drawings are essentially diagrammatic and the size and location of equipment is indicated to scale whenever possible. Verify conditions, dimensions, indicated equipment sizes, and manufacturer's data and information as necessary to install the Work of this Division. Coordinate location and layout with other Work.

2. Drawings indicate required size and points of termination of conduits, number and size of conductors, and diagrammatic routing of conduit. Install conduits with minimum number of bends to conform to structure, avoid obstructions, preserve headroom, keep openings and passageways clear, and comply with applicable code requirements.

3. Routing of conduits may be changed provided that the length of any conduit run is not increased more than 10 percent of length indicated on the Drawings.

4. Outlet locations shall be coordinated with architectural elements prior to start of construction. Locations indicated on the Drawings may be distorted for clarity.

5. Coordinate electrical Work with all other Work.

6. The scope of the electrical work includes furnishing, installing testing and warranty of all Electrical work and complete electrical systems shown on the electrical drawings and specified herein.

7. The drawings and specifications complement each other and together complete the contract documents for the electrical work included in this project. Neither the drawings or the specifications are complete without the other. Any item mentioned in either document is binding. Where conflicts arise between the drawings and the specifications, the more stringent requirement shall prevail.

8. The contractor shall provide and install all electrical systems to provide a complete package as indicated by the contract documents. The documents are intended to provide an outline for the required installations. The contractor shall ultimately provide a complete and operational system at the conclusion of the project.

9. Details are provided as they relate to the installation. Contractor shall provide and install all miscellaneous components, parts, materials, fasteners, splices, and any other incidental items necessary to provide a complete installation.

10. Free standing electrical equipment and transformers shall be installed on housekeeping pads. Pads shall be a minimum of 3" thick with #2 rebar grid at 6" on-center. Pads shall be a minimum of 2" larger in each direction than the width and depth of the equipment. All pads shall have a minimum of ¾" chamfer on all edges and broom finished. Crown pads slightly so as not to hold water where they are installed outdoors. Adjust pads dimensions and construction details where noted specifically on drawings.

C. Terminology:

1. Signal Systems: Applies to clock, bell, fire alarm, annunciator, sound, public address, buzzer, telephone, television, inter-communication, and security systems.

2. Low Voltage: Applies to signal systems operating at 120 volts and less, and power systems operating at less than 600 volts.

3. UL: Underwriter's Laboratories Inc, Nationally Recognized Testing Laboratory (NRTL), or equal.

D. Regulations: Work shall comply with the requirements of authorities having jurisdiction and the Electrical and Building Codes. Material shall conform to regulations of the National Board of Fire Underwriters for electrical wiring and apparatus. Materials shall be new and listed by UL, or another NRTL.

E. Structural Considerations for Conduit Routing:

1. Where conduits pass through or interfere with any structural member, or where notching, boring or cutting of the structure is necessary, or where special openings are required through walls, floors, footings, or other buildings elements, contractor shall submit shop drawings to the architect for approval.

F. Electrically Operated Equipment and Appliances:

1. Furnished Equipment and Appliances:

a. Work shall include furnishing and installing wiring enclosures for, and the complete connection of electrically operated equipment and appliances and electrical control devices which are specified to be furnished and installed in this or other sections of the Specifications, wiring enclosures shall be concealed except where exposed Work is indicated on the Drawings.

b. Connections shall be provided as necessary to install equipment ready for use. Equipment shall be tested for proper operation and, if motorized, for proper rotation. If outlets are of incorrect electrical characteristics or any specified equipment fails to operate properly, repair and/or replace the outlet and/or equipment.

2. Equipment and Appliances Furnished by Others:

a. Equipment and appliances indicated on Drawings as "not in contract" (NIC), "furnished by others," or "furnished by the Owner," will be delivered to the Project site. Required electrical connections shall be performed for such equipment and appliances. Motorized equipment will be furnished factory-wired to a control panel or junction box unless otherwise indicated. Appliances will be furnished equipped with portable cord and cap. Provide disconnect switches where required.

b. Connections to equipment furnished under this Division shall be part of the Work of this section. Work shall include internal wiring, installation, connection and adjustment of bolted drive motors in which the motor is supplied as a separate unit, and connections only for equipment furnished with factory installed internal wiring, except as further limited by Drawings and this Specification. Work shall include furnishing and installing suitable outlets, disconnecting devices, starters, push-button stations, selector switches, conduit, junction boxes, and wiring necessary for a complete electrical installation. Work shall also include furnishing and installing conduit and boxes for HVAC control systems, furnished under Division 15. Devices and equipment furnished shall be of same type used elsewhere on the Work or as specified.

c. Electrical equipment furnished under other sections, for installation and connection under Work of this section, will be delivered to the Project site ready for installation.

d. Equipment furnished under other sections, and requiring electrical connection under this section, will be set in place as part of the Work of the section

furnishing such equipment unless noted otherwise. If electrical connections exceed the requirements of the specified equipment, it shall be the responsibility of the contractor or vendor supplying the equipment to compensate the electrical contractor for any and all work to make the electrical connections to the equipment being supplied. Any discrepancies shall immediately be brought to the engineers' attention for coordination between all other disciplines. All increased costs shall be the responsibility of the contractors, not the owner, architect, or engineer.

e. Suitability and condition of equipment furnished under other sections shall be determined in advance of installation. Immediate notice of damage, unsuitability, or lack of parts shall be given to the entity providing such equipment.

G. Protection of Materials:

1. Protect materials and equipment from damage and provide adequate and proper storage facilities during progress of the Work. Damaged materials and/or equipment shall be replaced.

H. Cleaning:

1. Exposed parts of Work shall be left in a neat, clean, usable condition. Finished painted surfaces shall be unblemished and metal surfaces shall be polished.

2. Thoroughly clean parts of apparatus and equipment. Exposed parts to be painted shall be thoroughly cleaned of cement, plaster, and other materials. Remove grease and oil spots with solvent. Such surfaces shall be wiped and corners and cracks scraped out. Exposed rough metal shall be smooth, free of sharp edges, carefully steel brushed to remove rust and other spots, and left in proper condition to receive finish painting.

3. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

I. Permits and Regulations:

1. Include payment of all permit and inspection fees applicable the work in this Division.

2. Work must conform to the National Electric Code, National Electrical Safety Code, and other applicable local, state, and federal laws, ordinances, and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. No work shall be installed which is less than minimum legal standards.

3. All work performed under this Division shall be inspected and approved by the Local Authority having Jurisdiction.

J. Site Inspection:

1. Each and all bidders shall inspect the project site prior to bidding.

2. Existing site conditions shall be compared with the information shown on the drawings. Immediately report any discrepancies to the Architect. After project bid date, no allowances will be made for failure to have made inspections.

3. During construction, the contractor shall exercise care and take appropriate precautionary measures to prevent any damage to the existing structures, sidewalks, utilities, communications, etc. during the project. The Contractor shall correct all damage caused by or during the project. Contractor shall provide not less than (2) and not more than (10) working days advance written, electronic, or telephonic notice of the commencement, extent, location and duration of the excavation work to Mississippi One-Call System, Inc. (1-800-227-6477) and any nonmembers operator(s) of any underground utility lines or underground facilities in and near the excavation area, so that Mississippi One-Call System, Inc operator(s) and any non-member operator(s) may locate and mark the location of underground utility lines and underground facilities in the excavation area.

K. Utility Coordination:

1. Contractor shall inspect and verify the existing utilities at the project site prior to bidding.

L. Temporary Lighting and Power for Construction:

1. The electrical contractor shall provide and install temporary lighting during the period of construction. Temporary lighting shall be provided to meet all local ordinances, codes, and safety requirements. Lighting shall be installed in all open, general, and thoroughfare areas of construction. This shall not include any task lighting specifically required by any trade to complete their work or installations.

2. The electrical contractor shall provide and install temporary power during the construction period as required to complete the project installation. Contractor shall coordinate with the general contractor, utility company, and/or owner to provide 120/240 volt power for the project. All devices shall be provided with ground fault circuit protection. Power shall be provided in central work area(s). This shall not include any remote power needs for any specific trades. For power requirements at voltages other than those listed above, the contractor shall coordinate connection requirements with the local utility company.

3. All temporary lighting and power installations shall meet local and national codes and be approved by the local authority having jurisdiction.

4. Temporary services shall be removed at completion of the project. Permanent utilities shall not be used during the Project except with the written permission of the Owner.

1.03 SUBMITTALS

A. Where indicated submit to architect, (7) copies of Shop Drawings including control diagrams, list of materials, catalog cuts, technical data, manufacturer's specifications, and applicable installation details.

1.04 RECORD DRAWINGS

A. The Electrical Contractor shall maintain, at the project site, a separate set of prints of the contract documents and shall show all changes and variations, in a neat and clearly discernible manner, which are made during construction. Upon completion of the work, these drawings shall be turned over to the Architect. Provide the following as-built documents including all contract drawings regardless of whether corrections were necessary and include in the transmittal: “2 sets of CDs and prints for Owner’s use, one set of CDs, prints for Architect / Engineers Records”. Delivery of these as-built electronic files and prints are a condition of final acceptance.

1.05 OPERATION AND MAINTENANCE MANUALS

A. The Electrical Contractor shall submit to architect (3) copies each of operating and maintenance manuals for each piece of equipment applicable to the project.

B. All shop drawings, installation, operation, and maintenance manuals, wiring diagrams, parts lists, and other information including warranties and technical support, shall be obtained from each manufacturer.

C. Assemble all information into three-ring binders or other suitable binding. Add an index and/or tabbed and labeled sections of all items submitted.

D. The Electrical Contractor shall at all times, maintain a clean set of construction document plans on site. Any and all deviations from the construction documents shall be marked, and clearly noted in red ink. All changes shall exactly indicate the revisions or changes to the design documents. Upon completion of the project, (2) clean sets of "red-line" construction as-built documents shall be submitted to the architect. Unclear, illegible, or inaccurate plans will be returned to the contractor for correction and resubmission. As-built documents shall be corrected by the Electrical Contractor and resubmitted at no additional cost.

1.06 INSPECTIONS AND PUNCH LIST

A. The Electrical Contractor shall survey and inspect his work and develop his own punch list to confirm that work is complete and finished. He shall then notify the General Contractor that work is complete and ready for inspection by the Architect. It is not the Architects or Engineers obligation to perform a final inspection until the contractor states his work has been inspected and is complete and ready for final inspection.

B. Request to the Architect, Engineer, or Owner for final inspection may be accompanied by a limited list of known deficiencies with a brief explanation or status of deficiencies and schedule for completion of each. Correction of these items shall be completed within (30) days of inspection or before final acceptance of occupancy.

1.07 WARRANTY

A. The Electrical Contractor shall warrant all workmanship, equipment, and materials installed under this contract for a period of (1) year minimum from the date of final acceptance as agreed between the Contractor and the Architect, unless indicated by other sections of these specifications.

B. Any equipment, materials, etc. proving to be defective during the warranty period shall be corrected or replaced without any expense to the Owner or other parties. This provision shall not be construed to include general maintenance items or luminaire lamps or correcting errors on the part of the owner, owner's personnel, or owner's representative.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and Equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more items of equal and similar materials and construction are required, they shall be of the same manufacturer.

B. All electrical equipment and materials shall bear the Underwriters Laboratories, Inc. label, and shall comply with the NEC and NFPA requirements as applicable.

2.02 MATERIALS AND EQUIPMENT SELECTION

A. Selection of Materials and Equipment furnished under this contract shall be determined by the following:

1. Where trade names, brands, and manufacturer's part numbers are listed, the exact equipment listed shall be furnished. Where more than one name is used, the contractor shall have the option of selecting between those specified. All products used shall be equal to that specified and shall be of best quality.

2. When the words "or equal" appear, specific approval must be obtained from the Architect during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.

3. Alternate materials and/or equipment must be submitted for approval a minimum 2 weeks prior to project bid date.

B. Before bidding, when preparing shop drawings, and prior to rough-in for installation, the contractor shall verify that adequate space is available for entry and installation of the item including any accessories. Also that adequate space is available for servicing equipment and required code clearances are satisfied.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. Advise the general contractor or architect before starting the Work of this Division.

B. Exposed conduits shall be painted to match the surfaces adjacent to installation. Refer to painting and coating section of specifications.

C. Salvaged materials, if applicable, removed from buildings shall be removed from the Project site as required by the general contractor.

D. Trenches outside of barricade limits shall be backfilled and paved within 24 hours after being inspected. Provide traffic plates during the time that trenches are open in traffic areas and in areas accessible to nonconstruction personnel.

E. Where structural walls are cored for new conduit runs, separation between cored holes shall be 3 inches edge to edge, unless otherwise required by the Architect. All coring to be laid out and reviewed by Architect prior to drilling. Contractor to verify location of structural steel, rebar, stress cabling, or similar prior to lay out.

F. Electrical equipment shall be braced and anchored as indicated on the Drawings.

3.02 CLEANUP

A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

3.03 PROTECTION

A. Protect the Work of this section until Substantial Completion.

END OF SECTION

SECTION 16011

WORK IN EXISTING FACILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. Provisions of Division 01 apply to this section

B. Section Includes: This section provides electrical requirements for demolition or rework of existing systems. Work shall include all existing electrical including auxiliary systems. Coordinate with owner and General Contractor for removal and rework of all electrical systems.

1.02 DEMOLITION OF EXISTING ELECTRICAL SYSTEMS

A. In reworked and renovated areas, remove all electrical equipment (AS NOTED) including but not limited to: Light fixtures, panelboards, switches, receptacles, auxiliary system devices, telephone outlets, life safety devices, and fire alarm; unless otherwise noted. Remove existing branch circuits, conduits, wiring, junction boxes, hangers, fittings, etc. serving equipment to be removed. Abandon conduits concealed in concrete, but remove conductors. Leave existing branch circuits and feeders which run through reworked areas and serve existing equipment to remain in service, continuous and uninterrupted. Repair, reterminate, re-support, etc., any damaged circuits.

B. Abandon junction boxes where devices are located in block walls. Remove any plates or extension rings. Fill box with grout and finish over to match adjacent wall. Remove any wiring and cut off flush any conduits protruding from wall.

C. Where below grade conduits are abandoned, cut off 2-3" below slab, grout over and finish smooth to match adjacent flooring, or finish ready to accept floor covering.

1.03 CUTTING, PATCHING, AND REPAIRING

A. Electrical contractor shall coordinate with General Contractor for all cutting, patching, and repairing. Electrical contractor shall perform all cutting or allow general contractor to perform cutting in a professional manner. Flooring and walls shall be cut in straight lines and parallel or perpendicular to walls. Electrical contractor shall coordinate and notify General Contractor of all cutting prior to bid and shall be responsible for any costs associated with cutting, patching, and repairing.

B. Do not pierce or cut any existing walls below grade.

C. Do not cut any structural walls or structural members, unless receiving approval in writing from the architect and structural engineer.

D. All new work shall match and be comparable to existing conditions or new adjacent finishes. Architect and engineer reserve the right to reject any unsuitable work.

1.04 ELECTRICAL SYSTEMS

A. Electrical, low voltage, systems wiring, life safety, etc. in areas outside of work area shall remain in service at all times. Provide and install necessary temporary wiring as required to maintain continuity of all electrical systems outside of the work area.

B. Where service interruptions are required, obtain approval for interruption in writing from Owner 10 days prior to interruption. Include schedule of work to be performed and the time required to accomplish work in request for interruption. Work during service interruptions may be required after normal working hours. Include premium (overtime) time labor in bid. No service interruptions shall occur until written approval is granted from the owner.

1.05 MATERIAL TO BE REMOVED/SALVAGED

A. Where noted, salvaged materials are to be reused. Clean any reused materials prior to reinstalling and at the completion of the project.

B. When materials are demolished and shown to be removed, the owner has the right to retain any desired/salvageable materials.

C. Discard or remove from site any materials not retained by the owner.

PART 2 - PRODUCTS (not applicable)

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. Advise the general contractor or architect before starting the Work of this Division.

B. Demolished or Salvaged materials, if applicable, removed from buildings shall be removed from the Project site as required by the general contractor.

3.02 CLEANUP

A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

A. Provisions of Division 01 apply to this section

B. Section Includes:

1. Boxes, enclosures, keys and locks.

2. Identifications and signs.

3. Floor boxes.

C. Related Sections:

1. Section 16010: Basic Electrical Requirements.

PART 2 - PRODUCTS

2.01 BOXES, ENCLOSURES, KEYS AND LOCKS

A. Outlet Boxes and Fittings:

1. Outlet boxes installed in concealed Work shall be galvanized steel, pressed, or welded type, with knockouts.

2. In exposed Work, where conduit runs change direction or size, outlet boxes and conduit fittings shall be cast metal with threaded hubs cast integral with box or fitting.

3. Fittings shall be cast metal and non-corrosive. Ferrous metal fittings shall be cadmium-plated or zinc galvanized. Castings shall be true to pattern, smooth, straight, with even edges and corners, of uniform thickness of metal, and shall be free of defects.

4. Covers for fittings shall be galvanized steel or non-corrosive aluminum and shall be designed for particular fitting installed.

5. Light fixture outlets shall be 4-inch octagon, 4-inch square, 2-1/8 inches deep or larger, depending upon number of conductors or conduits therein. Plaster or tile rings shall be furnished for suitable mounting of light fixture.

6. For local device outlets provide 4-inch square 2-1/8 inch deep, boxes for single gang, 4-11/16 inch square boxes for two-gang, and special solid gang boxes with gang plaster ring for more than 2 switches.

7. For fire alarm devices and horns and strobes provide manufacturers supplied back box as needed.

8. For television outlets, provide 4-inch square 2-1/8 inch deep boxes with plaster or tile rings suitable for television device outlet(s).

9. Plaster or tile rings shall be provided on flush-mounted outlet boxes except where otherwise indicated or specified. Plaster or tile rings shall be same depth as finished surface. Install approved ring extension to obtain depth to finish surface.

10. In plywood wall or drywall construction, and where flexible steel conduit is fished into walls, one-gang and 2-gang outlets for wiring devices may be sectional steel boxes with plaster ears. Boxes shall be fastened to plywood with flat-head screws in each plaster ear screw hole.

11. Factory made knockout seals shall be installed to seal box knockouts, which are not intact.

12. Where flexible conduit is extended from flush outlet boxes, provide and install weatherproof universal box extension adapters.

B. Junction and Pull boxes:

1. Junction and pull boxes, in addition to those indicated, shall only be used in compliance with codes, recognized standards, and Contract Documents.

2. Interior and non-weatherproof boxes shall be constructed of blue or galvanized steel with ample laps, spot welded, and shall be rigid under torsion and deflecting forces. Boxes shall be furnished with auxiliary angle iron framing where necessary to ensure rigidity.

3. Covers shall be fastened to box with a sufficient number of brass machine screws to ensure continuous contact all around. Flush type boxes shall be drilled and tapped for cover screws if boxes are not installed plumb. Surfaces of pull and junction boxes and covers shall be labeled in black marker ink designating system, panelboard and circuit designation contained in box. In exposed Work, designation shall be installed on inside of pull box or junction box cover.

4. Weatherproof NEMA 3R pull and junction boxes shall conform to foregoing for interior boxes with following modifications:

a. Cover of flush mounting boxes shall be furnished with a weather-tight gasket cemented to, and trimmed even with, cover all around.

b. Surface or semi-flush mounting pull and junction boxes shall be UL, or another Nationally Recognized Testing Laboratory (NRTL) listed as rain-tight and shall be furnished complete with threaded conduit hubs.

c. Exposed portions of boxes shall be galvanized and finished with one prime coat and one coat of baked-on gray enamel, unless already furnished with factory baked-on finish.

5. Junction and pull boxes shall be rigidly fastened to structure and shall not depend on conduits for support.

6. Polymer Concrete Boxes:

a. Polymer concrete boxes are to be made from aggregates in combination with polymer resin, combined and processed by mixing, molding, and curing, and reinforced with fiberglass.

b. Boxes are to be high strength, impact resistant, corrosion resistant, nonflammable, and noncorrosive.

c. Enclosures, boxes and covers are required to conform to all test provisions of the most current ANSI/SCTE 77 “Specification For Underground Enclosure Integrity”

d. All components in an assembly (box & cover) are manufactured using matched surface tooling.

e. Covers shall be marked as electrical, power, communications, fiber, signal, etc. as required.

f. Bottom of box shall be filled with 6" of pea gravel.

C. Keys and Locks:

1. Provide 2 keys with furnished door locks, including cabinet door locks and switchboard locks, 2 keys for lock switches on switchboards or control panels, and 2 keys with interlocks or other furnished lock switches.

D. Floor Outlets and Boxes:

1. Devices are noted to be removed from Floor boxes. Contractor shall provide and install blank floor box cover plates to cover existing boxes. New covers shall be brass and shall fit existing boxes.

2.02 IDENTIFICATION AND SIGNS

A. Identification Plates:

1. Provide identification plates on new equipment for the following unless otherwise specified, for push-button stations, time switches, contactors, disconnect switches, motor starters, motor switches, panelboards, and terminal cabinets.

2. Identification plates shall be of plastic stock and shall adequately describe function, voltage and phase of identified equipment. Where identification plates are detailed or described on Drawings, inscription and size of letters shall be as indicated. For lighting and power panels, identification plates shall indicate panel designation, voltage, and phase of panel. For terminal cabinets, identification plates shall indicate system contained in terminal cabinet.

3. Identification plates shall be black-and-white nameplate stock of bakelite with characters cut through black exposing white. Plates shall be furnished with beveled edges and shall be securely fastened in place with No. 4 Phillips-head, cadmium-plated steel, self-tapping screws. Characters shall be 3/16 inch high, unless otherwise indicated.

B. Markings:

1. Install identification markings to surface-mounted starters, switches, disconnect switches, contactors, and other devices controlling motors and appliances. Provide abbreviations required along with an identifying number. Markings to be provided with locking type stencils using paint of a contrasting color. Figures shall be 3/8 inch high unless otherwise indicated. Self-sticking plastic labels, with embossed characters made with a typewriter may be installed instead of stencils and paint; self adhesive plastic, or self sticking laminated plastic labels may be installed.

PART 3 - EXECUTION

3.01 INSTALLATION AND SUPPORT OF BOXES

A. Install outlet boxes flush with finished surface of wall or ceiling. Install plumb and securely fastened to structure, independent of conduit. Except where otherwise indicated, provide factory-fabricated bar hangers to support outlet boxes. When installation is performed in fire rated walls, maintain the wall's rating integrity by means of approved fire stop methods.

B. Do not install junction boxes back-to-back in walls. Maintain a minimum of 4" separation measured edge-to-edge between boxes. Where separation is not possible, install sound proofing material in boxes to minimize noise transfer between rooms. In fire rated walls, boxes may be no larger than 4" x 4" and are to be separated 24" minimum, measured edge-to-edge.

C. Outlet boxes installed in suspended or furred ceilings with steel runner or furring channels shall be supported.

D. Heights of outlets and equipment indicated on Drawings shall govern. In absence of such indications and if applicable to the project, the following heights shall be maintained with heights measured to centerline unless otherwise noted:

1. Install wall-mounted telephones, light switches, other switches, and fire alarm pull stations, 48 inches above finished floor. Refer to other Division 16 Sections.

2. Install power receptacle outlets, telephone outlets, and data outlets 18 inches above finished floor.

3. Install panelboards and terminal cabinets 6 feet-6 inches from finish floor to top of cabinet.

4. Install television outlets at a height corresponding to location of television monitor, or a minimum of 18 inches above finished floor. Refer to other Division 16 sections.

5. Install fire alarm horn/strobe or strobe lights 96 inches to top of light above finished floor.

3.02 IDENTIFICATION OF CIRCUITS AND EQUIPMENT

A. Provide descriptive nameplates or tags permanently attached to panelboards, circuit breakers, disconnect switches, starters, pushbutton control stations and other apparatus installed for operation or control of circuits, appliances, fire alarm control panel(s), fire alarm annunciator(s), power supplies, terminal cabinets, energy management control units, and Information technology system backbone and distribution equipment points.

B. Provide nameplates of engraved laminated plastic, or etched metal. Submit Shop Drawings denoting dimensions and format to Architect before installation. Fasten to equipment with escutcheon pins, rivets, self-tapping screws, or machine screws. Self-adhering or adhesive backed nameplates are not permitted.

C. Fasten tags to feeder wiring in conduits at every point where runs are broken or terminated, including pull wires in empty conduits. Indicate circuit, phase, and function. Tag branch circuits in panel boards and motor control centers. Tags may be manufactured of pressure-sensitive plastic or embossed self-attached stainless steel or brass ribbon.

D. Provide circuit identification cards and cardholders in all panel boards. Cardholders shall consist of metal frame retaining a clear plastic cover permanently attached to inside of panel door. List of circuits shall be typewritten on a card. Circuit description shall include name or number of circuit, area and connected load.

E. Junction and pull boxes shall have covers stenciled with box number when indicated on Drawings, or circuit numbers according to panel schedules. Data shall be lettered in a visible manner with a color contrasting with finish.

F. Name shall be correctly engraved, with a legend indicating function or areas, when required by codes or indicated on Drawings.

G. Provide wire marker indicating circuit number for each conductor located within each electrical panel, switchboard, starter, disconnect, MCC, large junction box or trough, etc.

3.03 PROTECTION

A. Protect Work of this section until Substantial Completion.

3.04 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off Project site.

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 - GENERAL

1.01 SUMMARY

A. Provisions of Division 01 apply to this section

B. Section Includes: Provide and install grounding system as indicated or required.

C. Related Sections:

1. Refer to related sections for their system grounding requirements.

2. Section 16010: Basic Electrical Requirements.

1.02 QUALITY ASSURANCE

A. Reference Standards:

1. IEEE 142 Green Book.
2. Underwriter's Laboratories (UL).
3. National Electrical Code.
4. Building Industry Consultant Services International (BICSI) (Signal).
5. EIA/TIA (Signal and power).
6. Nationally Recognized Testing Laboratory (NRTL) or equal.

1.03 SYSTEM DESCRIPTION

A. Metallic objects on the Project site that enclose electrical conductors, or that are likely to be energized by electrical currents, shall be effectively grounded.

B. Metal equipment parts, such as enclosures, raceways, and equipment grounding conductors, and earth grounding electrodes shall be solidly joined together into a continuous electrically conductive system.

C. Metallic systems shall be effectively bonded to the main grounding electrode system.

D. A separately derived AC source shall be grounded to the equipment grounding conductor, and to separate “made” electrode of building grounding electrode system.

E. Electrical continuity to ground metal raceways and enclosures, isolated from equipment ground by installation of non-metallic conduit or fittings, shall be provided by a green insulated grounding conductor of required size within each raceway connected to isolated metallic raceways, or enclosures at each end. Each flexible conduit over 6 feet in length shall be provided with a green insulated grounding conductor of required size.

F. Cold water, or other utility piping systems, shall not be utilized as grounding electrodes due to the installation of insulating couplings and non-metallic pipe in such installations.

G. Non-current carrying metal parts of equipment enclosures, power conduits, switchboard and panelboard enclosures, motor frames, equipment cabinets, and metal frames of buildings shall be permanently and effectively grounded. Provide a NEC sized grounding conductor in every raceway.

H. Neutral of service conductors shall be grounded as follows:

1. Neutral shall be grounded at only one point within the Project site for that particular service. Preferable location of grounding point shall be at the service switchboard or panelboard, or main switch.

2. Equipment and conduit grounding conductors shall be bonded to that grounding point.

3. If other buildings or structures on the Project site are served from a switchboard or panelboard in another building, power supply is classified as a feeder and not as a

service. Provide and install a properly sized grounding conductor to a separately derived grounding electrode at each remote building, per the NEC.

4. Equipment grounding conductor is installed from switchboard to each individual building. At building, grounding conductor is bonded with power equipment enclosures, metal frames of building, etc., to electrode for that building.

5. Feeder neutrals shall be bonded at service entrance point only, neutrals of separately derived systems shall be bonded at the source only.

I. Within every building, the main switchboard or panelboard, shall be bonded to the cold water line. Metallic piping systems such as gas, fire sprinkler, or other systems shall be bonded to the cold water line.

1.04 SUBMITTALS

A. None.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Electrodes shall be copper-clad steel ground rods, minimum ¾-inch diameter by 10 feet long.

B. Grounding conductors shall be copper, #12 minimum with green insulation, unless noted otherwise.

C. Ground tails shall be copper, #12 minimum with green insulation, installed in all metallic junction boxes where devices are being installed. Branch circuit ground, junction box, and devices shall be bonded at each junction box.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All grounding shall be installed in accordance with details on drawings and per NEC 250.

B. Bond panelboards and all electrical boxes and enclosures.

C. All conduits shall have a grounding conductor, minimum #12 copper. Conductor size shall be increased based on ampacity and/or phase conductors of the circuit.

D. Install grounding conductors at each panelboard location as noted on drawings.

E. All branch circuit, device, and switch junction boxes shall contain a grounding conductor, minimum #12 copper with green insulation, to bond the one or more equipment grounding conductors and the metal box. Connections shall be made to splice the equipment grounding conductors, grounding pig-tail, and metal box by means of a grounding screw or listed grounding device.

F. Grounding electrodes shall be installed in the nearest suitable planting area, where not otherwise indicated on Drawings.

G. Grounding electrode conductors shall be installed in conduit from the service disconnecting means and extended to the connection point of the grounding electrode.

H. Grounding rods shall be driven to a depth of not less than 10 feet. If necessary, permanent ground enhancement material, as manufactured by Erico Electrical Products, or equal, shall be installed at each ground rod to improve grounding effectiveness. Install in accordance with manufacture's installation instructions.

I. Grounding electrodes shall provide a resistance to ground of not more than 25 ohms.

J. When installing grounding rods, if resistance to ground exceeds 25 ohms, 2 or more rods connected in parallel, or coupled together shall be provided to meet grounding resistance requirements.

K. Ground rods shall be separated from one another by not less than 10 feet.

L. Parallel grounding rods shall be connected together with recognized fittings and grounding conductors in galvanized rigid steel conduit, buried not less than 12 inches below finish grade.

3.02 TESTING

A. Test grounding resistance of electrodes, ground rods, bonding of building steel, water pipes, gas pipes and other utility piping. Tests shall be performed as follows:

1. Visually and mechanically examine ground system connections for completeness and adequacy.

3.03 PROTECTION

A. Protect the Work of this section until Substantial Completion.

3.04 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 16120

LOW-VOLTAGE CONDUCTORS (600 VOLT AC)

PART 1 - GENERAL

1.01 SUMMARY

A. Provisions of Division 01 apply to this section

B. Section Includes: Low-voltage wire, splices, terminations and installation.

1.02 SUBMITTALS

A. None.

PART 2 - PRODUCTS

2.01 WIRES

A. Wires shall be single conductor type THHN or THWN insulated with polyvinyl chloride and covered with a protective sheath of nylon, rated at 600 volts. Wires may be operated at 90 degrees C. maximum continuous conductor temperature in dry locations, and 75 degrees C. in wet locations and shall be listed by UL Standard 83 for thermoplastic insulated wires, listed by Underwriter's Laboratories (UL) for installation in accordance with Article 310 of the National Electrical Code (NEC). Conductors shall be solid or stranded copper for 12 AWG and smaller conductors, and stranded copper for 10 AWG and larger conductors. Conductors shall be insulated with PVC and sheathed with nylon. Wires shall be identified by surface markings indicating manufacturer's identification, conductor size and metal, voltage rating, UL symbol, type designations and optional rating. Indentations for lettering is not permitted. Wires shall be tested in accordance with the requirements of UL standard for types THWN, or THHN.

B. Conductors shall be solid Class B or stranded Class C, annealed uncoated copper in accordance with UL standards, or another Nationally Recognized Testing Laboratory (NRTL).

2.02 STANDARDS

A. THWN/THHN wires shall comply with the following standards:

1. UL 83 for thermoplastic insulated wires.

2. UL 1063 for machine tool wires and cables.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Wires shall not be installed until debris and moisture is removed from conduits, boxes, and cabinets. Wires stored at site shall be protected from physical damage until they are installed and walls are completed.

B. Wire-pulling compounds furnished as lubricants for installation of conductors in raceways shall be compounds approved and listed by UL, NRTL, or equal. Oil, grease, graphite, or similar substances are not permitted. Pulling of 2 AWG or larger conductors shall be performed with a cable pull machine. Any runs shorter than 50 feet are exempt. When pulling conductors, do not exceed manufacturer’s recommended values

C. At outlets for light, power, and signal equipment, pigtail splices with 8-inch circuit conductor leads for connection to fixtures, equipment, and devices.

D. Pressure cable connectors, pre-insulated Scotchlok, 3M, or equal, Y, R or B spring-loaded twist-on type, may be furnished in splicing number 8 AWG or smaller wires for wiring systems; except public address and telephone systems.

E. All Joints, splices, taps, and connections to switchboard neutral, bonding or grounding conductors, conductors to ground busses, and transformer connections for wires 6 gauge and larger shall be performed with high-pressure cable connectors approved for installation with copper conductors. Connectors shall be insulated with heavy wall heat shrink WCSM, or cold-applied roll-on sleeve RVS. Insulation level shall be a minimum of 600V and joints, splices, and taps shall be qualified to ANSI C 119.2, UL, NRTL, or equal listed mechanical pressure connections.

F. Connections to any bussing and high-press cable connectors shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade 5 machine screws secured with constant pressure-type locking devices.

G. Connection of any bonding or grounding conductors shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade 5 machine screws secured with constant pressure-type locking devices.

H. Wiring in panelboards, panel cabinets, pull boxes, and other cabinets, shall be neatly grouped and tied in bundles with nylon ties at 10-inch intervals. In panelboards, panels and terminal blocks, wires shall be fanned out to terminals. If bundles are longer than 24 inches, a maximum of 9 current carrying conductors may be bundled together.

I. Install conductor lengths with a minimum length within the wiring space. Conductors must be long enough to reach the terminal location in a manner that avoids strain on the connecting lug.

J. Maintain the conductor required bending radius.

K. Neutral conductors larger than 6 gauge, which are not color identified throughout their entire length, shall be taped, painted white or natural gray, or taped white where they appear in panelboards, cabinet, gutters or pull boxes. Neutral conductors 6 gauge and smaller shall be white color identified throughout their entire length.

L. Fire alarm and clock wiring shall be continuous from terminal cabinets or from equipment to each device. Splices are not permitted between devices and/or terminal cabinets at junction and pull boxes. Wiring shall be terminated at terminal blocks or devices only.

M. Wiring systems shall be free from short circuits and grounds, other than required grounds.

3.02 COLOR CODES

A. General Wiring:

1. Color code conductor insulation as follows:

SYSTEM VOLTAGE		
Conductor	208Y/120	480Y/277
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White or Gray	White with colored stripe

Neutrals shall be colored-distinguished if circuits of two voltage systems are used in the same raceway.

2. For phase and neutral conductors 6 gauge or larger, permanent plastic-colored tape may be furnished to mark conductor end instead of coded insulation. Tape shall cover not less than 2 inches of conductor insulation within enclosure.

3.03 FEEDER IDENTIFICATION

A. Feeder wires and cables shall be identified at each point the conduit run is broken by a cabinet, box, gutter, etc. Where terminal ends are available, identification shall be by means of heat shrink wire markers, which provide terminal strain relief. Markers shall be Brady Perma-Sleeve, or equal. Identification in other areas shall be by means of wrap-around tape markers Brady Perma-Code or equal. Markers shall include feeder designation, size, and description.

3.04 TAPE AND SPLICE KITS

A. Splices, joints, and connectors joining conductors in dry and wet locations shall be covered with insulation equivalent to that provided on conductors. Free ends of conductors connected to energized sources shall be taped. Voids in irregular connectors shall be filled with insulating compound before taping. Thermoplastic insulating tape approved by UL, NRTL, or equal for installation as sole insulation of splices shall be furnished and shall be installed according to manufacturer's printed specifications.

3.05 PROTECTION

A. Protect the Work of this section until Substantial Completion.

3.06 CLEANUP

A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 16130

RACEWAYS, FITTINGS, AND SUPPORTS

PART 1 - GENERAL

1.01 SUMMARY

A. Provisions of Division 01 apply to this section

B. Section Includes:

1. Raceways and wire ways
2. Conduit installation.
3. Underground requirements.

C. Related Sections:

1. Section 16010: Basic Electrical Requirements.
2. Section 16050: Basic Electrical Materials and Methods

D. Applicable Standards and Codes

1. EIA/TIA 569 Standards.
2. National American Standards Institute (ANSI)
3. National Electrical Manufacturer’s Association (NEMA)
4. Nationally Recognized Testing Laboratory (NRTL)
5. National Electrical Code (NEC)
6. Underwriters Laboratory (UL)

1.02 SUBMITTALS

A. None.

PART 2 - PRODUCTS

2.01 RACEWAYS

A. Conduit Materials:

1. Metallic conduit, and tubing shall be manufactured under the supervision of an UL, or another NRTL factory inspection and label service program. Each 10-foot length of conduit and tubing shall bear the UL or another NRTL label and manufacturer's name.
2. Rigid metallic conduit shall be rigid steel, heavy wall, mild steel, zinc-coated, with an inside and outside protective coating manufactured in accordance with ANSI C 80.1. Couplings, elbows, bends, condulets, bushings and other fittings shall be the same materials and finish as the rigid metallic conduit. Fittings, connectors, and couplings shall be threaded type, manufactured in accordance with ANSI C 80.1 and UL 6.
3. Electrical metallic tubing shall be steel tubing, zinc-coated with a protective enamel coating inside, manufactured in accordance with NEMA C 80.3. Fittings, couplings, and connectors less than 2" shall be steel, gland compression type. Fittings, couplings, and connectors 2" and larger shall be steel, set screw type or gland compression type. All parts shall be manufactured in accordance with NEMA C80.3 and UL 6A Electrical metallic tubing is designated hereinafter as EMT. Steel and rain tight fittings shall be approved and listed for the intended application.

4. Flexible metallic conduit shall be of flexible interlocking strip construction with continuous zinc coating on strips, manufactured in accordance with UL 1.

   a. Connectors and couplings shall be required fittings of the type, which threads into convolutions of flexible conduit.

   b. Nonmetallic flexible conduit is not allowed.

5. Liquid-tight flexible metal conduit shall be galvanized heavy wall, flexible locked metallic strip construction, UV rated, with smooth moisture and oil-proof, abrasion-resistant, extruded plastic jacket. Connectors shall be as required for installation with liquid-tight flexible conduit and shall be installed to provide a liquid-tight connection.

6. Non-metallic conduit shall be rigid PVC electrical conduit extruded to schedule 40 dimensions of Type II. Grade 1 high impact, polyvinyl chloride, sweeps, couplings, reducers and terminating fittings shall be listed under the UL, or another NRTL, and shall bear the manufacturer's listed marking.

7. Conduit size shall be 1/2" minimum for above grade installations and 3/4" minimum for below grade or in-slab installations.

8. Metal Clad (MC) cable system is not allowed except for flex connections to light fixtures, maximum 6 foot length.

B. Sleeves for Conduits: Sleeves shall be adjustable type, of 26 gage galvanized iron, Adjust-to Crete Co. Adjust-to-Crete, or Jet Line Products Inc. Jet-Line, or equal.

C. Where conduit enters a building through a concrete foundation below grade, or ground water level, or where it is necessary to seal around a conduit where it passes through a concrete floor or wall, provide O-Z/Gedney Type FSK Thru Wall and Floor Seal, or equal.

D. Wireways shall be 16 gage galvanized steel enclosed hinge/screw wiring troughs, surface metal raceway, wireway, and auxiliary gutter designed to enclose electrical wiring. Wireway fittings shall be furnished with removable covers and sides to permit complete installation of conductors throughout the entire wireway run. Cover shall be furnished with keyhole slots to accept captive screws locking the cover securely closed. Wireways shall be UL or another NRTL listed, and shall be Square D Type LDG NEMA-1 enclosure for interior applications, or Type RD NEMA-3R enclosure for exterior applications, or equal by Cooper B-line, Hoffman, Wire Guard, or Circle AW.

E. Penetration in Fire-Rated Structures: Provide 3M, or equal, caulk and fire barriers for installing fire-rated seals around penetrations through floors, walls, and elevator shafts. Fire stop system must be UL, or another NRTL listed, and classified for through-penetration applications of metallic conduits and busways.

F. Pull Wires: Install 1/8 inch polypropylene cords in empty or spare conduits.

PART 3 - EXECUTION

3.01 CONDUIT INSTALLATION

A. General Requirements:

1. Provide complete and continuous systems of rigid metallic conduit, outlet boxes, junction boxes, fittings and cabinets for systems of electrical wiring including lighting, power, and signal systems, except as otherwise specified.

2. EMT may be installed in interior concealed or exposed applications where not subject to damage. EMT shall not be installed in concrete, directly buried underground, outdoors, in boiler rooms, elevator pits, or where subject to damage.

3. Within buildings, flexible metallic conduit may be installed instead of rigid steel conduit where permitted by code. Flexible metallic conduit shall not be installed for conduit installations longer than 6 feet (inclusive of fittings and boxes), in concealed ceilings or walls, and where conduit size is 1-1/2 inches or greater.

4. Flexible metallic conduit shall be installed for final connection of motor terminal boxes, shop equipment, mechanical equipment, HVAC equipment and other equipment, or for frequent interchange, and shall be of sufficient length, not exceeding 36 inches, to permit full travel or adjustment of motor on its base. Flexible metallic conduit shall not be used for equipment not requiring adjustment or frequent interchange.

5. Liquid-tight flexible metallic conduit shall be installed at exterior locations or where subject to liquid or oil exposure, except where otherwise specified, for final connection of equipment and as listed above.

6. Liquid-tight flexible metallic conduit shall be installed at interior locations where subject to liquid exposure or where connecting to water heaters, water coolers, drinking fountains, instantaneous water heaters, etc.

7. Connectors for flexible metal conduit and liquid-tight flexible metallic conduit shall be compatible with the conduit, and of the types which threads into convolutions of conduit. Connectors for watertight flexible metal conduit shall be as required for installation and shall be installed to provide a watertight connection.

8. Exposed conduit shall be installed vertically and horizontally following the general configuration of the equipment, using cast threaded hub conduit fittings where required and shall be clamped to equipment with suitable iron brackets and one hole pipe strap.

9. If connection is from a flush wall-mounted junction box, install an approved extension box.

10. Underground feeder distribution conduits for systems may be non-metallic conduit instead of rigid conduit except where otherwise specified or indicated.

11. Conduit shall be concealed unless otherwise indicated. Conduits exposed to view, except those in attic spaces and under buildings, shall be installed parallel or at right angles to structural members, walls, or lines of building. Conduits shall be installed to clear access openings.

12. Bends or offsets will not be permitted unless absolutely necessary. Radius of each conduit bend or offset shall be as required by ordinance. Bends and offsets shall be performed with standard industry tools and equipment or may be factory fabricated bends or elbows complying with requirements for radius of bend specified. Heating of metallic conduit to facilitate bending is not permitted. Public telephone conduit bends and offsets shall be provided with a radius which is not less than 10 times trade size of conduit unless otherwise permitted. Refer to underground installation, specified in this section, for radius of bends and offsets required for underground installations.

13. Running threads are not permitted. Provide conduit unions where union joints are necessary. Conduit shall be maintained at least 6 inches from covering of hot water and steam pipes and 18 inches from flues and breechings. Open ends of conduits shall be sealed with permitted conduit seals during construction of buildings and during installation of underground systems.

14. Expansion Joints/Seismic Separations/Separations between buildings/Locations Indicated: Provide Thomas & Betts XJG-TB, O-Z Electrical Mfg. Co. Inc. Type AX with bonding strap and clamps. At exterior locations, provide Thomas & Betts XJG-TB, O-Z Electrical Mfg. Co. Inc. Type EX, or equal. Provide O-Z Electrical Mfg. Co. Type AXDX, or equal Combination Deflection/Expansion Fittings at all seismic separations. Provide manufactures internal and external Bonding Jumpers at all locations. Liquid-tight flexible conduit shall not be approved at expansion joints or seismic separations.

15. Where conduits are terminated in groups at panelboards, switchboards, and signal cabinets, etc., provide templates or spacers to fasten conduits in proper position and to preserve alignment.

16. Conduits shall be supported as required by code, but not to exceed 10 feet. Where applicable, conduit needs to be rigidly supported every 5 feet and supported within 3 feet of every junction box. Conduits installed in ceiling space are to be fastened or strapped to trusses with factory fabricated straps or clamps and held securely in place.

17. Where auxiliary supports, saddles, brackets, etc., are required to meet special conditions, they shall be fastened rigid and secure before conduit is attached.

18. Conduit in ceiling spaces, stud walls, and under floors, shall be supported with factory fabricated pipe straps or shall be suspended with pipe hangers or pipe racks. Pipe straps shall be attached to and shall fasten conduit tight at point of support against ceiling and floor joists, rafters, and wall studs, or 2-inch x 4-inch headers fitted between joists or wall studs.

19. Conduits installed on exposed steel trusses and rafters shall be fastened with factory fabricated conduit straps or clamps, which shall fasten conduit tight against supporting member at point of support.

20. Pipe hangers for individual conduits shall be factory fabricated. Steel rods shall be 3/8 inch for 2-inch conduit hangers and smaller and shall be 1/2 inch for 2-1/2 inch conduit hangers and larger.

21. Pipe racks for groups of parallel conduits and for supporting total weights not exceeding 500 pounds shall be trapeze type and shall consist of a cross channel, Steel City Kindorf B-900, Unistrut P-1000, or equal, suspended with a 3/8 inch minimum diameter steel rod at each end. Rods shall be fastened with nuts, top and bottom to cross-channel and with square washers on top of channel. Conduits shall be clamped to top for cross-channel with conduit clamps, Steel City Kindorf C-105 or Unistrut P-1111 through P-1124. Conduits shall not be stacked one on top of another, but a maximum of 2 tiers may be on same rack providing an additional cross-channel is installed. Where a pipe rack is to be longer than 24 inches, or if the supported weight exceeds 500 pounds, submit Shop Drawings of installation to the Architect for review.

22. Conduits suspended on rods more than 2 feet long shall be rigidly braced to prevent horizontal motion or swaying.

23. Factory fabricated pipe straps shall be one or 2-hole formed galvanized clamps, heavy-duty type, except where otherwise specified.

24. Hangers, straps, rods, or pipe supports under concrete shall be attached to inserts set at time concrete is placed, or with approved concrete anchors. Under wood, install bolts, lag bolts, or lag screws; under steel joists or trusses, install beam clamps. Contractor shall submit size of anchors, bolts, screws, and installation method to Architect for approval prior to start of any work.

25. One inch and smaller exposed conduits shall be fastened with one-hole malleable iron straps. Perforated straps and plumber's tape is not permitted for the support of conduits. Do not fasten or support conduits with "tie-wire".

26. Conduits stubbed up through a roof or facade shall be flashed with a waterproof flashing. Refer to roofing specification for additional requirements.

27. Bushings and locknuts for rigid steel conduit shall be steel threaded insulating type. Setscrew bushings are not permitted.

28. Flex conduits shall be cut square and not at an angle.

29. Routing of conduits may be changed providing length of any conduit run is not increased more than 10 percent of the length indicated on Drawings.

B. Underground Requirements:

1. Underground conduits and raceways shall be buried to a depth of not less than 24 inches below finished grade to top of the conduit envelope, unless otherwise specified.

2. Assemble sections of conduit with required fittings. Cut ends of conduit shall be reamed to remove rough edges. Joints in conduits shall be provided liquid-tight. Bends at risers shall be completely below surface where possible.

3. The architect or engineer will observe underground installations before and during conduit placement. A mandrel shall be drawn through each run of conduit in presence of the architect or engineer before and after placement. Mandrel shall be 6 inches in length minimum, and have a diameter that is within 1/4 inches of diameter of conduit to be tested.

4. Non-metallic conduit installations shall comply with following additional requirements. Joints in PVC conduit shall be sealed by means of required solvent-weld cement supplied by conduit manufacturer. Non-metallic conduit bends and deflections shall comply with requirements of applicable electrical code, except that minimum radius of any bend or offset for conduits sized from 1/2 inch to 1-1/2 inches inclusive shall not be less than 24 inches. Bends at risers and risers shall be galvanized, rigid steel conduit. Conduits below slab shall be painted with epoxy, resin paint.

5. All below grade non-metallic conduits shall have galvanized, rigid steel 90's painted epoxy, resin paint.

6. Furnish and install a 6-inch wide, polyethylene, red underground barrier tape 12 inches above full length of conduits reading, "CAUTION ELECTRIC LINE BURIED BELOW".

7. Underground conduit systems provided for utility companies shall be furnished to meet the requirements of the utility companies requiring service.

8. Protect inside of conduit and raceway from dirt and rubbish during construction by capping openings.

9. Add bell-end bushings for conduit stub-up including underground entries to pull boxes, and manholes. Under floor standing switchboards and motor control centers provide a 4" galvanized nipple with ground bushing.

10. Underground conduit for systems operating above 600 volts shall be a minimum size of 4 inches.

11. All underground conduits and raceways shall be swabbed prior to wire pull.

3.02 PROTECTION

A. Protect the Work of this section until Substantial Completion.

3.03 CLEANUP

A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Provisions of Division 01 apply to this section

B. Section Includes:

1. Receptacles
2. Switches
3. Dimmer switches
4. Coverplates
5. Occupancy sensor switches

C. Related Sections:

1. Section 16010: Basic Electrical Requirements.
2. Section 16050: Basic Electrical Materials and Methods

1.02 SUBMITTALS

A. Provide in accordance with Division 01.

B. Shop Drawings:

a. Include manufacturer's cut sheets for each type device being installed listing description, manufacturer, and part number.

b. Include manufacturer's cut sheets for each device coverplate being installed listing description, manufacturer, and part number.

C. Installation Instructions: Submit manufacturer's written installation instructions including any warning labels and instruction manuals.

1.03 QUALITY ASSURANCE

A. Receptacles shall comply with NEMA WD 1, NEMA WD 6, and UL 498.

B. Switches shall comply with NEMA WD 1 and UL 20.

PART 2 - PRODUCTS

2.01 RECEPTACLES AND SWITCHES

A. Receptacles:

1. Color: Coordinate with architect
2. Duplex receptacles shall be heavy-duty specification grade, grounding type. Terminal screws shall be back and side wired with internal screw pressure plates. Mounting strap shall feature heavy-duty brass construction. Receptacle back body shall be PVC.

Receptacle face shall be impact resistant nylon. Receptacles shall have triple wipe brass power contacts.

NEMA #	Pass & Seymour	Hubbell	Leviton
NEMA 5-20	PS5362	HBL5362	5362

3. Provide specification grade ground-fault circuit interrupter (GFCI) type receptacles in accordance with UL standards. GFCI receptacles shall have a trip indication light. Receptacle terminal screws shall be back and side wire with internal screw pressure plates. Test and reset buttons shall match device body in color. GFCI receptacles shall be manufactured in standard configuration for installation with stainless steel smooth plates. Exterior mounted receptacles shall be mounted inside weatherproof enclosure.

NEMA #	Pass & Seymour	Hubbell	Leviton
(20 amps) NEMA 5-20R	2094	GFR5352	8898

4. Provide weatherproof receptacles, except where otherwise indicated or specified, consisting of GFCI receptacles, as specified herein, and metal plates with die-cast hinged, "in-use" covers and weatherproof mats.

5. Receptacles within 6 feet of water fountains, counter tops, or any sources of water shall be GFCI type.

6. Single receptacles shall be heavy-duty specification grade, grounding type. Terminal screws shall be back and side wire with internal screw pressure plates. Mounting strap shall feature heavy-duty brass construction. Receptacle back body shall be thermoplastic. Receptacle face shall be impact resistant nylon. Receptacles shall have triple wipe brass power contacts. For circuits consisting of one single receptacle only, ampere rating of receptacle shall be same as circuit breaker or fuse.

NEMA #	Pass & Seymour	Hubbell	Leviton
(20 amps) NEMA 5-20R	5361	HBL5361	5361

7. For equipment receptacles, provide 2-wire or 3-wire, grounding type, rated 30 or 50 amps at 125/250 volts, NEMA rating as noted on drawings or as required for equipment, with 2-gang stainless steel plates.

8. Provide tamper-resistant receptacles with thermoplastic dual mechanism shutter system to help prevent insertion of foreign objects. Receptacles shall have extra heavy-duty brass, one-piece mounting strap with integral ground. Receptacles shall have impact resistant nylon face and back body. For tamper-resistant receptacles rated 20 amps/125 volts, provide NEMA 5-20R. For tamper-resistant receptacles rated 15 amps/125 volts, provide NEMA 5-15R.

NEMA #	Pass & Seymour	Hubbell	Leviton
(20 amps) NEMA 5-20R	TR63	HBL8300SH	8300SG

B. Switches:

1. Color: Coordinate with architect

2. Local Switches:

a. Provide local switches, high strength thermoplastic toggle, specification grade, rated 20 amps at 120-277 volts AC only, with plaster ears, external screw pressure plate back and side wired, and standard size composition cups which fully enclose mechanism. Switches shall be approved for installation at currents up to full rating on resistive, inductive, tungsten filament lamp and fluorescent lamp loads, and for up to 80 percent of rating for motor loads. Switches shall have oversized silver alloy contacts for long life and better heat dissipation. Provide switches as single pole, double pole, 3-way, 4-way, non-lock type.

	Pass & Seymour	Hubbell	Leviton
Single pole	PS20AC1	HBL1221	1221-2
Double pole	PS20AC2	HBL1222	1222-2
Three way	PS20AC3	HBL1223	1223-2
Four way	PS20AC4	HBL1224	1224-2

C. Dimmers:

1. Color: Coordinate with architect.
2. Slide type dimmer as manufactured by Lutron, Nova T series, or equal.
3. Dimmers provide full range, continuously variable control of light intensity.
4. Ten-year operational life while operating continually at any temperature in an ambient temperature range of 0 degrees C (32 degrees F) to 40 degrees C (104 degrees F) and 90 percent non-condensing relative humidity.
5. Operate at the rated capacity across the full ambient temperature range including modified capacities for ganging configurations which require the removal of fins.
6. Provide Radio Frequency Interference Suppression on dimming controls and fully variable fan speed controls.
7. Utilize air gap off, activated when user selects “off” at any control to disconnect the load from line supply eliminating any leakage current.
8. Possess power failure memory such that if power is interrupted and subsequently returned, lights will automatically return to same levels (dimmed setting, full on, or off) prior to power interruption for a minimum period of [2] years.
9. Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment per IEC 801-2.
10. Design and test dimmers to withstand line-side surges without impairment to performance when subjected to surges of 6,000 volts, 200 amps per ANSI/IEEE C62.41C.
11. Capable of operating at the rated capacity; this includes modified capacities for ganging configurations which require the removal of fins. Operation at rated capacity shall be possible across the full ambient temperature range, without shortening design lifetime.
12. Load Specific Requirements
    a. LED compatible with fixture being controlled.

D. Occupancy sensor switches (CEILING OR WALL MOUNT):

1. Control Specifications
    a. Adjustment: Self-Adjusting
    b. Manual Time Adjustment: 30 sec to 30 min
    c. Timer Factory Preset: 10 Minutes
    d. Sensitivity Adjustment: 0 to 100 Pct
    e. Sensitivity Factory Preset: Ultrasonic 50 Pct Infrared 75 Pct
    f. Photo Cell Adjustment: 20 to 3000 Lux
    g. Single/Multi-Tech Mode: Switchable ON/OFF PIR/ULTRA
2. Electrical Specifications
    a. Input Voltage: 120/277 volt
    b. Current Consumption: 30-50mA
    c. Output Voltage: 120/277 volt
3. Material Specifications
    a. Color: match other devices
    b. Housing Material: High-Impact, Injection Moulded Plastic

c. LED Indicator: Red Infrared Motion & Green Ultrasonic Motion
d. PIR Lens Type: Extended Range
e. Wire Leads: Color Coded 6 Inch

4. Mechanical Specifications
   a. Sensor Technology: PIR/Ultrasonic 32kHz
   b. Pattern Degrees: 360
   c. Coverage (Sq.Ft.): 1000 or 2000 Sq. Ft. or linear coverage for corridors
5. Wall mount switches shall have a manual off override function.

PART 3 - EXECUTION

3.01 INSTALLATION OF DEVICES

A. Installation shall be in accordance with the NEC and as shown as on the drawings.

B. Ground terminal of each receptacle shall be bonded to the outlet box with an approved green bonding jumper and also connected to the green equipment grounding conductor.

C. Ensure that devices and their boxes are protected until completion of project.

D. Do not install junction boxes back-to-back in walls. Maintain a minimum of 4" separation measured edge-to-edge between boxes. Where separation is not possible, install sound proofing material in boxes to minimize noise transfer between rooms. In fire rated walls, boxes may be no larger than 4" x 4" and are to be separated 24" minimum, measured edge-to-edge.

E. Do not cut holes for boxes with routers that are designed to ride along the inside of device back box. Replace any damaged wiring from router cut outs.

F. Keep outlet boxes free of plaster, drywall compounds, mortar, cement, paint, dust, or other materials that may contaminate the devices, conduits, wiring, cables, etc.

G. Install device boxes in brick or block walls so the cover plate does not cross a joint unless the joint is toweled flush with the face of the wall.

H. Cut outs around device boxes shall be completed such that a standard faceplate completely covers the cut out. Walls shall be patched accordingly where oversize cut outs occur.

I. Install proper size and depth tile extension rings at outlet back boxes based on wall types and thickness.

J. Do not install wiring devices until all wall preparation, painting, finishing, is complete.

K. Do not strip insulation from wiring until devices are being installed.

L. Replace any devices that have been damaged or show signs of use during construction phase of project before finishes were complete.

M. Keep devices in their package or protected until time of installation.

N. Connect devices using pigtail connections of not less than 6". Where conductors larger than #12 AWG have been installed, use #12 AWG for pigtail connections to devices.

O. Remove fiber or plastic washers prior to installation to ensure metal-to-metal contact.

P. Outlet boxes for light and dimmer switches shall be mounted on the strike side of doors, unless shown otherwise.

Q. Provide barriers in multi-gang outlet boxes to separate systems of different voltages, Normal Power and Emergency Power systems, and in compliance with the NEC.

R. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with

box openings aligned with the face of the surrounding finish material. Pay special attention to installations in cabinet work, and in connection with laboratory equipment.

S. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for roughing-in of conduit and equipment, the Contractor shall coordinate exact field location of the above items with other trades. In addition, check for exact direction of door swings so that local switches are properly located on the strike side.

T. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, defective devices, or similar problems using a portable receptacle tester. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

U. Test GFCI devices for tripping values specified in UL 1436 and UL 943.

V. Heights of outlets and equipment indicated on Drawings shall govern. In absence of such indications and if applicable to the project, the following heights shall be maintained with heights measured to centerline unless otherwise noted:

1. Install wall-mounted telephones, light switches, other switches, and fire alarm pull stations, 48 inches above finished floor. Refer to other Division 16 Sections.
2. Install power receptacle outlets, telephone outlets, and data outlets 18 inches above finished floor.
3. Install television outlets at a height corresponding to location of television monitor, or a minimum of 18 inches above finished floor. Refer to other Division 16 sections.
4. Install fire alarm horn/strobe or strobe lights 96 inches to top of light above finished floor.

3.02 COVER PLATES

A. Provide a plate on each outlet device as indicated or required. Plates shall be of stainless steel unless otherwise specified.

B. Flush wiring device and signal system outlets indicated to be blank covered, shall be covered with blank stainless-steel plates. Flush lighting outlets to be blanked shall be covered with decorative, blank cover plates, painted to match surrounding finish. Provide stainless steel covers to blank indicated or required surface-mounted outlets. All flush wiring device and outlets that are not utilized, shall have a blank cover plate.

C. In the following cases, and at required locations. Switch and receptacle plates shall be engraved with the device(s), or fixtures being controlled, or as indicated:

1. Three-gang and larger gang switches.
2. Switches so located that operator cannot see fixtures, or items of equipment controlled while his hand is on the switch.
3. Switches not in same room with fixtures or items of unit heaters, air curtains, fly fans, etc.
4. Receptacles operating at other than 120 V shall be labeled with the operating voltage.
5. Where indicated designations shall be as indicated on Drawings or as specified by Architect.

3.03 PROTECTION

A. Protect Work of this section until Substantial Completion.

3.04 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off Project site.

END OF SECTION

SECTION 16280
ELEC SYSTEMS DEVICE COORDINATION STUDY/ARC FLASH

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies the overcurrent protective device coordination study, related calculations and analysis, indicated as the study in this section.

B. A short-circuit and selective coordination study, and arc flash calculations and analysis shall be prepared for the electrical overcurrent devices to be installed under this project.

C. The study shall present a well-coordinated time-current analysis of each overcurrent protective device from the individual device.

1.02 RELATED WORK

A. Section 16010: Basic Electrical Requirements.

B. Section 16050: Basic Electrical Materials and Methods.

3. Section 16445: Panelboards, Safety Switches, Cabinets.

1.03 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Section 16010.

B. The study shall be prepared by a 3rd party, the equipment manufacturer, and/or performed by the equipment manufacturer's licensed electrical engineer.

1.04 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 16010, and the following requirements:

1. Product data on the software program to be used for the study. Software shall be in mainstream use in the industry, shall provide device settings and ratings, and shall show selective coordination by time-current drawings.

2. Complete study as described in paragraph 1.06. Submittal of the study shall be well-coordinated with submittals of the shop drawings for equipment in related specification sections.

3. Certifications: Two weeks prior to final inspection, submit the following.

a. Certification by the Contractor that the overcurrent protective devices have been set in accordance with the approved study.

1.05 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. Institute of Electrical and Electronics Engineers (IEEE):

241-90 ..... Recommended Practice Electrical Systems in Commercial Buildings

242-03 ..... Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

399-97 ..... Recommended Practice for Industrial and Commercial Power Systems Analysis

1584-02 ..... Performing Arc-Flash Hazards Calculations

1584A-04 ..... Performing Arc-Flash Hazards Calculations – Amendment 1

1584B-11 ..... Performing Arc-Flash Hazards Calculations – Amendment 2

C. National Fire Protection Association (NFPA):

70-17 ..... National Electrical Code (NEC)

70E-18 ..... Standard for Electrical Safety in the Workplace

99-18 ..... Health Care Facilities Code

1.06 STUDY REQUIREMENTS

A. The study shall be in accordance with IEEE and NFPA standards.

B. The study shall include one line diagram, short-circuit and ground fault analysis, protective coordination plots for all overcurrent protective devices, and arc flash calculations and analysis.

C. One Line Diagram:

1. Show all electrical equipment and wiring to be protected by the overcurrent devices.

2. Show the following specific information:

a. Calculated fault impedance, X/R ratios, and short-circuit values at each feeder and branch circuit bus.

b. Relay, circuit breaker, and fuse ratings.

c. Voltage at each bus.

d. Identification of each bus, matching the identification on the drawings.

e. Conduit, conductor, and busway material, size, length, and X/R ratios.

D. Short-Circuit Study:

1. The study shall be performed using computer software designed for this purpose. Pertinent data and the rationale employed in developing the calculations shall be described in the introductory remarks of the study.

2. Calculate the fault impedance to determine the available short-circuit and ground fault currents at each bus. Incorporate applicable motor and/or generator contribution in determining the momentary and interrupting ratings of the overcurrent protective devices.

3. Present the results of the short-circuit study in a table. Include the following:

a. Device identification.

b. Operating voltage.

c. Overcurrent protective device type and rating.

d. Calculated short-circuit current.

E. Coordination Study:

1. Prepare the coordination curves to determine the required settings of overcurrent protective devices to demonstrate selective coordination. Graphically illustrate on log-log paper that adequate time separation exists between devices, including the

utility company upstream device if applicable. Plot the specific time-current characteristics of each overcurrent protective device in such a manner that all devices are clearly depicted.

2. The following specific information shall also be shown on the coordination curves:

   a. Device identification.

   b. Potential transformer and current transformer ratios.

   c. Three-phase and single-phase ANSI damage points or curves for each cable.

   d. Applicable circuit breaker or protective relay characteristic curves.

   e. No-damage, melting, and clearing curves for fuses.

   f. Transformer in-rush points.

3. Develop a table to summarize the settings selected for the overcurrent protective devices. Include the following in the table:

   a. Device identification.

   b. Protective relay or circuit breaker potential and current transformer ratios, sensor rating, and available and suggested pickup and delay settings for each available trip characteristic.

   c. Fuse rating and type.

F. Arc Flash Calculations and Analysis:

1. Arc flash warning labels shall comply with Section 16010 and this specification.

2. Arc flash calculations shall be based on actual over-current protective device clearing time. Maximum clearing time shall be in accordance with IEEE 1584.

3. Arc flash analysis shall be based on the lowest clearing time setting of the over-current protective device to minimize the incident energy level without compromising selective coordination.

4. Arc flash boundary and available arc flash incident energy at the corresponding working distance shall be calculated for all electrical power distribution equipment specified in the project, and as shown on the drawings.

5. Required arc-rated clothing and other PPE shall be selected and specified in accordance with NFPA 70E.

1.07 ANALYSIS

A. Analyze the short-circuit calculations, and highlight any equipment determined to be underrated as specified. Propose solutions to effectively protect the underrated equipment.

1.08 ADJUSTMENTS, SETTINGS, AND MODIFICATIONS

A. Final field settings and minor modifications of the overcurrent protective devices shall be made to conform with the study, without additional cost to the Government.

PART 2 - PRODUCTS

2.01 POWER SYSTEM ANALYSIS SOFTWARE

A. Comply with IEEE 399 and IEEE 551.

1. Analytical features of power systems analysis software program shall have capability as listed in IEEE 399.

2.02 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Detailed list of all electrical equipment found to be underrated for the available short-circuit current.

C. Recommendations for resolving any issues found with underrated equipment.

D. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

E. One-line diagram of modeled power system, indicating the following:

1. Protective device designations and ampere ratings.

2. Conductor types, sizes, and lengths.

3. Transformer size and impedance.

4. Motor and generator designations and ratings.

5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.

6. Any revisions to electrical equipment required by the study.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment short-circuit ratings exceed available short-circuit current based on the applicable standards.

2. Tabulations of circuit breaker, fuse, and other protective device short-circuit ratings versus calculated short-circuit duties.

3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

G. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.

2. Utility or incoming power short-circuit data.

3. Manufacturer, model, and short-circuit rating of protective devices.

4. Conductors.

5. Transformer data.

H. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and single line to ground fault calculations, indicating the following for each overcurrent device location:

a. Voltage.

b. Calculated fault-current magnitude and angle.

c. Fault-point X/R ratio.

d. Multiplying factor.

2. High-Voltage Momentary Short-Circuit Report: Three-phase and single line to ground fault calculations, indicating the following for each equipment location:

a. Voltage.

b. Calculated symmetrical fault-current magnitude and angle.

c. Fault-point X/R ratio.

d. Calculated asymmetrical fault currents:

1) Based on fault-point X/R ratio.

2) Based on calculated symmetrical value multiplied by 2.6.

3. High-Voltage Interrupting Short-Circuit Report: Three-phase and single line to ground fault calculations, indicating the following for each equipment location:

a. Voltage.

b. Calculated symmetrical fault-current magnitude and angle.

c. Fault-point X/R ratio.

d. No AC Decrement (NACD) ratio.

4. Equipment Duty Report: For each protective device, indicate short-circuit ratings and calculated equipment duty for both ½ cycle and interrupting ratings as applicable. Calculated duty must automatically take into account any necessary derating factor due to the system X/R ratio and based on the actual maximum fault current through each device rather than the total bus fault current. All calculations to be based on the specific applicable test standards for each device such that no further interpretation of the results is necessary.

2.03 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram, indicating the following:

1. Protective device designations, locations, and ampere ratings.

2. Conductor types, sizes, and lengths.

3. Transformer kilovolt ampere (kVA) and voltage ratings.

4. Motor and generator ratings.

5. Switchgear, switchboard, motor-control center, and panelboard designations.

6. Utility sources.

D. Study Input Data: As described in "Power System Data" Article.

E. Data on all protective devices; manufacturers, types, sizes and adjustable settings that were used for the arc-flash calculations.

F. List of protective devices found to be inoperable or with signs of impending failure. These devices must be clearly listed and excluded from use in determination of the arc time.

G. Equipment Duty Study: Report to verify that all protective devices have adequate short-circuit ratings to interrupt the calculated maximum short-circuit current.

H. Arc-Flash Study Calculations and Output Reports:

1. Arcing fault magnitude.

2. Protective device clearing time.

3. Duration of arc.

4. Arc-flash boundary.

5. Restricted approach boundary.

6. Limited approach boundary.

7. Working distance.

8. Incident energy.

I. Arc-Flash Study input data, scenario descriptions, and arc-flash calculations including a definition of terms and guide for interpretation of the arc-flash hazard report.

2.04 ARC-FLASH WARNING LABELS

A. Provide a weatherproof, self-adhesive equipment label for each location requiring arc-flash hazard identification.

1. Minimum Size: 6 inches (150 mm) wide by 4 inches (100 mm) high.

2. Sample label submitted for review prior to printing of actual labels.

B. Content: Orange header with the wording, "WARNING, ARC-FLASH HAZARD, Arc-Flash and Shock Risk Assessment, Appropriate PPE Required." and the following information taken directly from the arc-flash hazard analysis:

1. Equipment ID.

2. Nominal voltage.

3. Protection boundaries.

a. Arc-flash boundary.

b. Restricted approach boundary.

c. Limited approach boundary.

4. Available incident energy.

5. Working distance.

6. Engineering report number, revision number, and issue date.

C. Completely machine printed, no field-applied markings.

D. Compliance: NFPA 70E.

PART 3 - EXECUTION

3.01 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the study.

1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Engineer’s attention.

2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.

B. Gather and tabulate the required input data to support the short-circuit study. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data

gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or their representative. Data must include, but not be limited to, the following:

1. Product Data for Project's overcurrent protective devices. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at each service from the serving utility.
3. For transformers, include kVA ratings, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
4. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
5. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
6. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
7. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
8. Motor horsepower and NEMA MG 1 code letter designation.
9. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.02 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents in accordance with IEEE 551.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin the scope of the short-circuit current and equipment duty analysis at the service, extending down to system overcurrent protective devices, down to and including all three-phase panelboards at voltages 208 V ac or higher.

F. For systems with multiple sources or multiple operating conditions, evaluate short-circuit and equipment duty for multiple scenarios as necessary to determine the maximum short-circuit current at each location.

G. Analysis software must factor in ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply this to the short-circuit and equipment duty calculations as recommended by applicable standards. Also account for the fault-current dc decrement to address asymmetrical current ratings of applicable electrical equipment and components.

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

I. Equipment duty report must clearly indicate any protective device that is being applied outside its short-circuit rating.

J. For any equipment found to be underrated, the report shall include recommendations for resolving this deficiency.

3.03 ARC-FLASH HAZARD ANALYSIS

A. Comply with the latest versions of NFPA 70E for the arc-flash hazard analysis study.

B. Study all operating scenarios to determine the maximum incident energy at each location.

C. Submit proposed arc-flash analysis scenarios for review prior to performing arc-flash calculations. Arc-flash hazard analysis report shall indicate which scenario created the maximum arc-flash energy for each location. All arc-flash calculations must be performed in accordance with the procedures and recommendations contained in the latest version of IEEE 1584. Calculate the arc-flash hazard boundary and incident energy at all locations in electrical distribution system where personnel could service or examine equipment while energized.

D. Include all three-phase equipment locations.

E. Calculate the limited and restricted approach boundaries for each location.

F. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources or fault current that changes with time during the fault. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented based on the recommendations in IEEE 399 and ANSI C37 where applicable.

G. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.

2. When the line terminals of the circuit breaker are separate from the work location.

H. Base arc-flash calculations on the time-current curve or operating time of the fastest upstream device using the predicted arcing current through that device. Based on the recommendations in IEEE 1584 and sound engineering judgment, a maximum arc time of two seconds can be applied for situations where the protective device operating time is found to exceed two seconds.

3.04 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on one-line diagram on Drawings. Call any discrepancies or missing information to Owner's attention.

2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.

3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer. Data shall include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams,

overcurrent protective device submittals, input and output data, and recommended device settings.

2. Obtain electrical power utility impedance or available short-circuit current at each service.

3. Short-circuit current at each system bus (three phase and line to ground).

4. Voltage level at each bus.

5. Motor horsepower where necessary.

6. Low-voltage conductor sizes, lengths, number, conductor material, and conduit material.

3.05 LABELING

A. Apply arc-flash label on the front cover of each section of the equipment and where applicable, on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.

B. Each piece of equipment listed below shall have an arc-flash label applied to it:

1. Panelboards.

3.06 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.07 DEMONSTRATION

A. Engage Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the interpretation of arc-flash warning labels.

END OF SECTION

SECTION 16445
PANELBOARDS, SAFETY SWITCHES, CABINETS

PART 1 - GENERAL

1.01 SUMMARY

A. Provisions of Division 01 apply to this section

B. Section Includes: Lighting and power distribution facilities, including panelboards.

C. Related Sections:

1. Section 16010: Basic Electrical Requirements.

2. Section 16050: Basic Electrical Materials and Methods.

3. Section 16500: Lighting.

1.02 SUBMITTALS

A. Provide in accordance with Division 01.

B. Shop Drawings: Include a front elevation indicating cabinet dimensions, make, location and capacity of equipment, size of gutters, type of mounting, finish, and catalog number. General layout of internal devices, wiring drawings with wire numbers and device connections, vendor cut sheets of devices in enclosure and bill of materials listing description, manufacturer, part number, and quantity of items shall be included.

C. Installation Instructions: Submit manufacturer's written installation instructions.

1.03 DESIGN REQUIREMENTS

A. Panelboards:

1. Panelboards shall be wall-mounted, enclosed safety type with 277/480 volt, 4-wire or 120/208 volt, 4-wire solid neutral mains as indicated on Drawings or specified. First panelboard of each building shall be provided with main or sub-feeder circuit breakers where indicated.

2. Single pole branches shall be molded case, thermal magnetic circuit breakers with inverse time delay, trip free, quick-make, quick-break mechanism and silver alloy contacts. Circuit breakers shall be fully rated, with ampere rating marked on handle and shall indicate on/off and tripped positions. Ground fault interrupters shall be incorporated into circuit breakers where indicated. They shall be listed by UL, or other NRTL as ground fault devices. Provide appropriate lug kit of sufficient size to accommodate the feeders.

3. Two- and 3-pole branches shall be enclosed, and shall be thermal magnetic circuit breakers with inverse time delay, tamper-proof, ambient compensated, single handle, internal common trip, and quick-make, quick-break mechanism with silver alloy contacts. Circuit breakers shall be fully rated or as otherwise indicated on the Drawings.

4. Main and subfeeder circuit breakers shall be enclosed, thermal magnetic type with inverse time delay, single handle common trip, quick-make, quick-break mechanism, corrosion-resistant bearings and silver alloy contacts. Ampere frame size and trip rating shall be as indicated on Drawings. Voltage rating shall be as indicated on Drawings. Branch mounted mains are not acceptable.

5. Circuit breakers shall be fully rated and of one-piece, bolt-on type and shall meet short-circuit interrupting capacity requirements indicated on Drawings.

6. Internal connections shall be fabricated with plated copper bus bars and the busses shall extend for full length of space available for branch circuit breakers. Feeder cable connectors shall be installed at point of feeder entrance. Terminals shall be furnished with copper conductors. Panelboards fed by conductors having over-current protection greater than 200 amperes shall be protected on supply side by over-current devices having a rating not greater than that of panelboards. Copper bussing shall be fully rated. Heat rated bussing is not acceptable

7. Except where otherwise indicated, circuit breakers shall be in 2 vertical rows connected to bus bars in a distributed phase arrangement. Two-pole branches shall be balanced on busses. Single pole branches shall be numbered adjacent to its circuit breaker, with odd numbers on left and even numbers on right.

8. Specified circuit breaker spaces shall be furnished with hardware required for future installation of circuit breakers.

B. Surge Suppressors: Where indicated on Drawings, provide transient voltage surge suppressors as separately installed of panelboards. Panelboards shall be complete with 200 percent rated copper neutral bus, ground bus and isolated ground bus in addition to requirements of this section. Surge suppressors shall be as follows:

1. Surge Capacity:
   a. Service Entrance SPDs shall be ANSI/UL listed type 1 SPD with a 160 KA surge rating per mode, with field replaceable surge modules.
   b. Distribution or Branch panels shall be UL listed type 1 SPD with a 80 KA surge rating per mode.

2. UL 1449 3rd Edition Suppressed Voltage Rating:

Voltage Configuration	L-N	N-G	L-G	L-L
120/240V	800V	700V	900V	1200V
120/208V	800V	700V	900V	1200V
240V			1200V	1200V
277/480V	1200V	1200V	1200V	2000V
480V			2000V	2000V

3. EMI/RFI High-Frequency Noise Power Filter (Characteristics):
   a. 100 KHz at 444 dB.
   b. 100 MHz at 44 dB.
   c. 10 MHz at 44 dB.
   d. 100 MHz at 444 dB.

4. MOVs shall be thermally protected for low current faults and shall be fused with surge-rated fuses. The surge-rated surge current passes and clears the circuit safely if the surge capacity is exceeded. Enhanced diagnostics shall continuously monitor the unit's status and shall include LEDs to signal a reduction in surge capacity or the loss of a suppression circuit. An audible alarm, with test and silence features, shall be furnished in diagnostic package.

5. Each phase or the entire unit shall be replaceable and have bolted-on, tin-plated copper connections. Unit to have UL witnessed fault current rating of 65,000 symmetrical amperes.

6. Surge suppression units shall comply with the following:

a. UL certified.

b. UL 1283 5th Edition.

c. UL 1449 3rd Edition.

d. IEEE C 62.45.

e. IEEE C 62.41.

f. Nationally Recognized Testing Laboratory (NRTL) or equal

C. Panelboard Cabinets:

1. Panelboard cabinets shall be code gage galvanized steel or blue steel; fronts, doors, and trims shall be code gage furniture steel. Cabinets shall be furnished with at least 6-inch high gutters at top and bottom where feeder cable size exceeds 4 gage or where feeder cable passes through cabinet vertically. Cabinets shall be furnished with top and bottom gutters sized as required by inspection department having jurisdiction, but never less than 6 inches where more than one feeder enters top or bottom of cabinets. Side gutters shall not be less than 4 inches wide. Width of cabinets shall be 20 inches, unless otherwise indicated on Drawings.

2. Doors shall be cut true, shall accurately fit opening and finish smooth across joints. Hinges shall be entirely concealed except for barrels and pins. Hinge flanges shall be welded to door and trim.

3. Outdoor cabinets shall be NEMA Type 3R. Construction shall be formed from code gage galvanized steel with ANSI No. 61 gray enamel finish. Provide heavy-duty, 3-point latching, vault type door handles with padlocking provisions. Provide stainless steel or galvanized butt hinges on doors.

4. Self-tapping screws and bolts not permitted.

D. Panelboard Schedule: Provide a neatly typewritten schedule with number or name of room or area, or load served by each panelboard circuit. Room numbers or names shall be determined at the Project site and shall not necessarily be those indicated on the Drawings. Schedule shall also indicate panel designation, voltage and phase, building and distribution panel or switchboard from which it is fed. Schedule shall be installed in a frame under transparent plastic on inside of each panelboard door.

E. Panelboard Standards: Panelboards shall be UL, or other NRTL listed and labeled. Panelboards shall meet latest revisions of following standards:

1. National Electric Code, Article 408.

2. UL 67, Panelboards.

3. UL 50, Cabinets and Boxes.

4. UL 943, GFCI.

5. UL 489, Molded Case Circuit Breakers.

6. NEMA PB1.

7. Federal Specifications W-P- 115C and WC-375B.

F. Safety Switches:

1. In accordance with UL 98, NEMA KS1, and NEC.

2. Shall be HP rated.

3. Fusible Switch, 600 amp and smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses or recommended fuses, lockable handle; interlocked with cover in closed position.

4. Non-Fusible Switch, 600 amp and smaller: NEMA KS 1, Type HD, lockable handle; interlocked with cover in closed position.

5. Shall have the following features:

   a. Switch mechanism shall be the quick-make, quick-break type.
   b. Copper blades, visible in the OFF position.
   c. An arc chute for each pole.
   d. External operating handle shall indicate ON and OFF position and have lock-open padlocking provisions.
   e. Mechanical interlock shall permit opening of the door only when the switch is in the OFF position, defeatable to permit inspection.
   f. Fuse holders for the sizes and types of fuses specified.
   g. Electrically operated switches shall only be installed where shown on the drawings.
   h. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.
   i. Ground lugs for each ground conductor.
   j. Enclosures:
      i. Shall be the NEMA types shown on the drawings for the switches.
      ii. Where the types of switch enclosures are not shown, they shall be the NEMA types most suitable for the ambient environmental conditions. Unless otherwise indicated on the plans, all outdoor switches shall be NEMA 3R.
      iii. Shall be finished with manufacturer's standard gray baked enamel paint over pretreated steel (for the type of enclosure required).

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Equipment shall be manufactured by General Electric, Cutler Hammer, Square D, Siemens, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment shall be located so it is readily accessible and not exposed to physical damage.

B. Equipment installed outdoors shall be specifically listed for wet locations and shall be weatherproof in NEMA Type 3R cabinets.

C. Equipment locations shall provide sufficient working space around panels to comply with the National Electrical Code.

D. Panelboards shall be securely fastened to structure and mounted on surface by at least 4 points.

E. Disconnects/Safety switches shall be installed in the vertical position with "ON" at the up position and top of the switch.

F. Disconnects/Safety Switches shall be securely fastened to wall or structural member by at least 4 points. Where structural support is not present, uni-strut shall be installed for additional support and points-of-contact.

G. Unused openings in cabinets and disconnects shall be effectively closed as required by the manufacturer.

H. Cabinets shall be grounded as specified in Article 250 of the National Electrical Code.

I. Conduits shall be installed so as to prevent moisture or water from entering and accumulating within the enclosure.

J. Lugs shall be suitable and listed for installation with the conductor being connected.

K. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.

L. Maintain the required bending radius of conductors inside the cabinet.

M. Clean the cabinet of foreign material such as cement, plaster, and paint. Repaint to manufacturers original finish any blemishes that occur during construction.

N. Distribute and arrange conductors neatly in the wiring gutters.

O. Use the manufacturer's torque values to tighten lugs.

P. Before energizing panelboards, the following steps shall be taken:

1. Retighten connections to the manufacturer's torque specifications. Verify that required connections have been provided.
2. Remove shipping blocks from component devices and panelboard interiors.
3. Manually exercise circuit breakers to verify they operate freely.
4. Remove debris from panelboard interior.

Q. Follow manufacturer's instructions for installation.

R. Do not install in highly corrosive environments, unless rated for the application.

3.02 PROTECTION

A. Protect the Work of this section until Substantial Completion.

3.03 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Provisions of the General and Supplementary Conditions and Division 01 apply to this section.

B. Section Includes: Furnishing and installing lighting fixtures, including lamps, ballasts/drivers, wiring, and lighting controls.

C. Light fixtures model numbers were determined at the time this specification was written; model numbers may need to be modified, or may require the addition or deletion of options to fully meet specification requirements.

D. Related Sections:

1. Section 16010: Basic Electrical Requirements

2. Section 16050: Basic Electrical Materials and Methods.

1.02 SUBMITTALS

A. Provide in accordance with Division 01.

B. List of Materials: Submit a complete list of materials proposed for this section.

C. Shop Drawings: Provide detailed and dimensioned Shop Drawings or manufacturer's data sheet with specific model and part numbers indicating kind, weight and thickness of materials, method of fitting and fastening parts together, location and number of sockets, size of lamps, and complete details of method of fitting suspension and fastening fixtures in place.

D. Submittals must comply with contract general provisions.

1.03 MOUNTING REQUIREMENTS

A. Design of lighting fixtures, accessories, supports, and method of fixture installation shall comply with requirements of ceiling type which fixture is installed.

B. Provide suspension points at no more than 2 feet from fixture ends. Spacing between supports shall not exceed 8 feet.

C. For fixtures mounted in grid ceiling, provide fixture supports at all (4) corners of the fixture independent of ceiling grid system, or manufacturer's approved ceiling support system.

1.04 QUALITY ASSURANCE

A. Components and fixtures shall be listed and approved for the intended application by Underwriter's Laboratories (UL), or other Nationally Recognized Testing Laboratory (NRTL).

B. Owners approval shall be obtained for any equipment or materials substitutions.

1.05 GUARANTEE

A. Provide a 1 year labor warranty.

B. Provide material warranty as specified:

1. Lamps: 1 years

2. Ballasts/Drivers: 5 years

4. Controls: 3 years

C. Warranty period begins at substantial completion or project acceptance for beneficial occupancy.

PART 2 - PRODUCTS

2.01 MATERIAL AND FABRICATION

A. Lighting fixtures shall be the type indicated on Drawings and as specified. Fixtures of same type shall be of one manufacturer.

B. Fixtures shall be of the types and manufacturers described in the Luminaire Schedule of the Drawings, with lamps, wattage and voltage as indicated. Alternate fixtures must be submitted for approval minimum 2 weeks prior to project bid date.

C. All fixtures shall be baked-on enamel or powder-coated, unless otherwise specified in subsections below.

2.02 LAMPS AND BALLASTS/DRIVERS

A. LED Fixtures, Driver, and Characteristics

1. LED Fixture

a. Cast aluminum heat sink integrated directly with housing.

b. Replaceable PC board with quick connects.

c. High lumen output LED's with 50,000 hours life expectancy.

d. No lead or mercury.

2. Optics System

a. Computer-optimized internal reflector with specular finish with diffusing lens to conceal the LED's for uniform luminance.

b. Low glare, lumens as noted on drawings.

3. LED Driver

a. Non-dimming and/or optical 0-10V dimming driver accommodating 120 or 277 volts AC at 60 Hz.

b. Power factor 0.9 minimum.

c. Driver to accept 120 or 277 volts AC.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Remove, salvage, and reinstall all light fixtures where noted.

B. Install a lighting fixture for each lighting outlet indicated and mark new ballasts/drivers with day of installation.

C. Fixture voltage shall be as indicated on Drawings.

D. Install recessed and surface-mounted fixtures, with plaster frames compatible with ceiling and wall systems employed; secure fixtures mechanically to frames.

E. Align rows of suspended and surface-mounted fluorescent fixtures to form straight lines at uniform elevations.

F. Recessed fixtures shall fit snugly against ceilings to prevent light leakage.

G. Support suspended recessed fixtures in T-bar ceilings. Fixture installation shall be coordinated with acoustical ceiling installation.

H. Continuous suspended fixtures:

1. Fixture suspension device shall allow vertical adjustment of fixture without the use of tools. Cable shall be minimum 7 strand twisted stainless steel capable of supporting minimum four times the fixture weight. For continuous linear suspended fixtures longer than eight feet, provide not less than three suspension points.

2. Top of fixture shall be suspended as shown on the Drawings, typically 24 inches below the ceiling and a minimum of 18 inches from the ceiling.

3. Fixture shall utilize factory furnished or approved hardware and canopy for either hard or T-bar ceilings.

I. Where emergency battery packs are installed, provide constant hot for emergency fixtures. Unless noted otherwise, when powering unit inverter power packs, use the same circuit that powers the switched ballast/driver to power the inverter.

J. Where emergency ballast(s)/driver(s) are specified within the fixture, provide constant hot for the ballast(s)/driver(s). Nonemergency ballasts/drivers within the same fixture shall be switched as indicated, unless noted otherwise.

K. Surface mount fixtures shall be attached to structure. Toggle bolts are NOT permitted. Provide backing where required.

3.02 TESTING

A. Check and adjust fixtures for required illumination.

B. Replace defective lamps and ballasts/drivers.

C. Test and adjust lighting control equipment for proper operation.

3.03 PROTECTION

A. Protect the Work of this section until Substantial Completion.

3.04 CLEANUP

A. Remove rubbish, debris, and waste materials from all areas of work each day.

B. Clean fixture surfaces of dirt, cement, plaster and debris. Furnish cleansers compatible with material surfaces being cleaned.

3.05 HAZARDOUS WASTE DISPOSAL

A. All hazardous waste disposal shall be handled and disposed of by an approved, licensed contractor.

B. Any and all ballasts are assumed to contain PCB unless clearly marked “NO PCB.”

C. Place ballasts and lamps in appropriate containers provided by hazardous waste contractor labeled clearly with:

1. Project Name

2. Quantity of lamps

3. Date lamps became waste

D. Store, remove, transport and dispose of hazardous materials in all accordance with state and federal regulations.

E. Provide Owner with copy of manifest and certificate of destruction.

END OF SECTION

SECTION 16715

FIRE ALARM SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Provisions of Division 01 apply to this section

B. Section Includes:

1. Fire alarm system shall consist of one fire alarm control panel or networked nodes, of the same make and listed for the application as indicated in drawings.

2. All labor, equipment, materials, connections, testing, and performance of operations in the installation of fire alarm system as indicated on Drawings or as specified herein.

C. Related Sections:

1. Hydraulic Elevators.

2. Heating, Ventilating, and Air Conditioning Equipment.

3. HVAC Instrumentation and Controls.

4. Section 16010: Basic Electrical Requirements.

5. Section 16050: Basic Electrical Materials and Methods.

6. Section 16060: Grounding and Bonding.

7. Section 16120: Low-Voltage Wire 600 Volts AC

8. Section 16130: Raceways, Fittings and Supports.

1.02 SYSTEM REQUIREMENTS

A. Fire detection system shall continually supervise and monitor the following initiating, signaling, and monitoring circuits:

1. Manual fire-pull stations.

2. Smoke and heat detectors, duct detectors, including those installed under other sections.

3. Alarm signaling circuits including, horns and visual alarm units.

4. Annunciators.

5. Power supplies and batteries.

6. Where applicable, interconnection with Central and Autonomous Public Address systems, telephone network system, Clock System-Classroom/Program schedule change, HVAC system/Building Automation control unit, and elevator equipment for control of recall function and elevator circuit breaker shunt trip.

B. System controls shall be UL listed for power limited applications in accordance with National Electrical Code.

C. The fire alarm devices and equipment shall be listed for installation for the fire alarm control panel to which they are being connected.

D. Complete installation shall conform to the current version of NFPA 72, Local Fire Codes and Building Code, and National Electrical Code (NEC).

E. System labels and devices programming addresses shall be based on final signage and building labeling submittals. For existing facilities contractor shall obtain from Owner Authorized Representative a copy of the current site layout and building labeling designations.

1.03 CERTIFICATION

A. Certification: Installation of fire alarm system shall not begin until Shop Drawings are submitted and reviewed by the Architect. Written certification by fire alarm equipment distributor or manufacturer shall be submitted to the Architect stating that system and its component parts are as approved and listed by the authority having jurisdiction, and that the design conforms to requirements set forth by the construction documents.

1.04 PERFORMANCE

A. System shall be fully programmable, configurable, and expandable in the field without special tools or PROM programmers and shall not require replacement of memory components. Installer shall provide a CD of all system installed software, site specific system programming and all information and tools required to re-program or modify the system.

1.05 SYSTEM FUNCTIONAL OPERATION

A. When a fire alarm condition is detected by one of the system alarm initiating devices, the following functions shall occur:

1. System alarm LED shall flash.
2. Local sounding device in panel shall be activated.
3. The LCD display shall indicate type of device, custom label location label and point status alarm condition.
4. Appropriate change of status message shall be transmitted to remote annunciator(s).
5. Automatic programs assigned to alarm point shall be executed and associated indicating devices and relays activated.
6. In response to a fire alarm condition, the system will process all control programming and activate all system outputs (alarm notification appliances and/or relays) associated with the point(s) in alarm. Additionally, the system shall send events to a central alarm supervising station via either dial-up over public switched telephone network (PSTN) or internet via public switched data network (PSDN) or virtual private network.
7. In the event of a fire alarm control panel activation, the fire alarm panel shall signal the elevator(s) control panel(s) to shunt the power for the elevator(s) and elevator(s) shall be recalled to the designated floor of discharge.

B. Trouble and Supervisory Conditions.

1. When any trouble condition is detected the following functions shall occur:
    a. System trouble LED shall flash.
    b. Local sounding device in panel shall be activated.
    c. The LCD display shall indicate the type of trouble and custom label location associated with the trouble condition and its location. Unacknowledged alarm messages shall have priority over trouble messages. If such an alarm is displayed, then trouble messages shall not be displayed.
    d. Appropriate message shall be transmitted to remote annunciators.

C. When any supervisory condition occurs, the following function shall occur:

1. System supervisory LED shall flash.
2. Local sounding device in panel shall be activated.
3. Appropriate message shall be transmitted to remote annunciators.

D. Activation of control panel ACKNOWLEDGE switch in response to a single new alarm, trouble or supervisory condition shall silence panel sounding device and change system alarm, trouble, or supervisory LED from flashing to steady-ON. If additional new alarm, trouble, or

supervisory conditions exist in the system; activation of this switch shall advance display to next alarm, trouble, or supervisory condition that exists, and shall not silence local audible device or change LED to steady until new conditions have been so acknowledged. New alarm conditions shall always be displayed before new trouble conditions. Occurrence of a new alarm, trouble, or supervisory condition shall cause panel to resound, and sequences as described above, shall repeat.

E. Activation of the signal SILENCE switch shall cause appropriate notification (indicating) appliances and relays to return to normal condition. Selection of notification appliance circuits and relays silenced by this switch shall be fully programmable.

F. Activation of system RESET switch shall cause electronically latched initiating devices or zones, as well as associated output devices and circuits, to return to normal condition after sixty seconds of alarm. If alarm conditions exist in system after system reset switch activation, system shall then re-sound alarm conditions as indicated hereafter.

G. Activation of lamp test switch shall turn on LED indicators, LCD display, and local sounding device in panel, and then return to previous condition.

H. Fire alarm indicating appliances may be silenced or extinguished, after one minute, by operating signal silence switch at the FACP or by use of key supervised alarm silence switch at remote annunciators. A subsequent zone alarm shall reactivate signals. Audible indicating appliances shall be automatically silenced after no less than 5 nor more than 10 minutes of operation. Visual indicating appliances shall be extinguished at system reset, or automatically after no less than 5 nor more than 10 minutes of operation.

I. Where applicable, elevator lobby, machine room and hoistway smoke detectors shall, in addition to operations listed above, cause elevator cars to be recalled as follows:

1. Elevator cars shall be recalled to main level of egress through the use of a primary recall interface relay.

2. Elevator cars shall be recalled to predetermine alternate level if main lobby smoke detector is activated.

3. Fire Fighter's indicator light in elevators shall provide visual warning when elevator lobby, machine room, and hoistway smoke detectors are activated.

J. All system's circuits including but not limited to initiation, indicating, and equipment interfacing shall be monitored for open/short circuit and ground fault conditions, these conditions shall be indicated on the Fire Alarm Control Panel and Annunciator displays while remaining circuits continue to operate normally.

K. All notification appliance circuits shall be silenceable for testing purposes by authorized persons. Protected pass-codes, keys, or another secure method that does not require entering into the system programming shall be used.

1.06 POWER REQUIREMENTS

A. The fire alarm control panel and remote power supply shall receive 120 VAC power, 60 Hz, through a dedicated 20 amps circuit. Circuit breaker protection for the dedicated fire alarm power circuits shall be equipped with a handle lock-on device, the breaker handle shall be colored red and labeled "FIRE ALARM". Clearly label the Electrical panel name, location and circuit number on the inside of the fire alarm control panel and all remote power supplies using a p-touch style labeling system. Transient voltage surge suppression shall be provided at the 120VAC input terminal.

B. System shall be provided with sufficient battery capacity to operate entire system upon loss of normal 120 VAC power, in a normal quiescent mode, for a period of 24 hours with 5 minutes of alarm indication at end of this period. System shall automatically transfer to standby batteries upon power failure. Battery charging and recharging operations shall be automatic. Batteries, once discharged, shall recharge at a rate to provide a minimum of 70 percent capacity in 12 hours.

C. Circuits requiring system operating power shall be 24 VDC and shall be individually protected at control panel.

1.07 SUBMITTALS

A. Provide in accordance with Division 01.

B. Component Plan Submittal: Availability and listing for its application shall be verified for all system components before presentation of the submittal. Include the following information and details as applicable:

1. Installer name, address, telephone number.

2. List of system components, equipment and devices, including manufacturer model numbers, quantity, mounting heights, and symbols per symbol list.

3. Copies of manufacturer specification sheets for equipment and devices indicated. Highlight or identify the specific components on Catalog cut sheets.

4. Voltage Drop Calculations: Include the following information for the worst case:

a. Point-to-point or Ohms law calculations.

b. Zone used in calculations.

c. Voltage drop percent. Voltage drop shall not exceed manufacturer's requirements. If voltage drop exceeds 10 percent, indicate manufacturer listed operating voltage ranges for equipment and devices.

5. Battery types, amp hours, and load calculations including the following:

a. Normal operation: 100 percent of applicable devices for 24 hours to equal control panel amps plus list of amps per device that draw power form the panel during standby power condition including, but not limited to, zone modules, detectors and devices as identified.

b. Alarm condition: 100 percent of applicable devices for 5 minutes to equal control panel amps plus list of amps per device that draw power from panel during alarm condition including, but not limited to, the following:

(1) Zone modules.

(2) Signal modules.

(3) Detectors.

(4) Signal devices.

(5) Annunciator.

(6) Other devices as identified.

c. Normal operation plus alarm operation load calculation shall include total amp hours required and total amp hours provided.

6. Provide one copy of testing procedures.

C. Shop Drawings: Provide Shop Drawings, in the same size as the design Drawings, Shop Drawings shall include the following:

1. Provide drawing scale, elevations of all system enclosures, and actual layout of the Fire Alarm Control Panel, power supply, annunciator, and all main system components.

2. Complete battery calculations, and voltage drop calculation shall be included; these calculations shall be based on the devices maximum UL current rating.

3. One line drawing for the entire system network indicating all system components and wiring. The one line diagram shall show but not be limited to panel to panel interconnections, conductors gauge and quantity, conduit size and type (designation) and specific function.

4. System panel one-line drawings indicating the quantity and type (designation) of conductors entering and exiting the fire alarm terminal cabinet in each building

(enclosure) for initiating, notification, or other command control functions required for complete system operation:

a. Individual floor/building plan view drawings indicating all device locations including end of line resistors “EOLR” in accordance with the legend provided.

b. Individual point addresses for all initiation and notification devices.

c. Device “typical” wiring diagrams. These drawings shall indicate specific termination details for all peripheral equipment and/or interface devices.

5. Provide interfacing with equipment furnished by others including voltages, and other required coordination items.

6. Each of the pictorial diagrams included shall appear identical to the products they are intended to depict, in order to speed installation of the system, and to enhance the accuracy of the installation Work. Typical wiring diagrams or catalog sheets are not permitted.

7. Background Drawings with device locations are available in electronic format and may be obtained with permission from the Architect and Engineer. Contractor is solely responsible for the accuracy and completeness of shop drawings. Buildings that are not part of the contract shall be clearly identified “NOT IN CONTRACT”. Shop Drawings shall be prepared in the latest version of AutoCAD with 3 – CD ROM electronic copies submitted along with full sized Shop Drawings.

8. Other installation and coordination drawings specifically related to this section shall be included as follows:

a. Size A (8-1/2 inch x 11 inches) and size B (11 inch x 17 inch) shall be bound into the manual.

b. Larger drawings shall be folded and inserted into transparent envelopes and bound into the manual.

9. Installation and coordination drawings for items in other sections shall be included with submittal of Shop Drawings. Submit copies of installation and coordination drawings.

10. Samples: Provide Samples of material and equipment as required by the Architect. If Samples are requested, they shall be submitted within 10 days from date of request.

D. In addition to the above requirements, provide submittals to meet any additional requirements of Architect or Owner.

E. Submittal of Equivalent Systems:

1. In addition to the submittal requirements of this section, if an equivalent system listed in Section 2.01A is submitted in lieu of the designed system shown on approved drawings, the Contractor shall also submit a letter stating that the system is equivalent, and that device locations and quantities of devices are unchanged. Attached to this letter shall be a copy of the revised equipment schedule with corresponding part numbers and a cut sheet for each item.

1.08 QUALITY ASSURANCE

A. Installer shall have successfully completed at least 5 projects of equal scope in the past 5 years, and have been in business of furnishing and installing fire alarm systems of this type for at least 5 years.

B. Installer shall be a factory authorized distributor and service provider for the brand of equipment offered and shall provide documentation to the Architect upon request.

C. Installer shall maintain a fully equipped service organization capable of furnishing repair service to the equipment and shall maintain a spare set of major parts for the system at all times.

D. All materials and equipment installed shall be new.

E. All of the equipment in this specification shall be furnished and installed by the Authorized Factory Distributor of the equipment.

F. Installer shall certify that the installation has been made in accordance with UL requirements.

G. Contractor/Installer's electricians and fire/life safety technicians shall be certified in accordance with applicable codes local ordinances.

H. System startup and testing shall be performed under the direct observation of the Architect's authorized representative. The Contractor at this time shall provide a legible half size reproduction of the original completed fire alarm red-line drawings (this copy will be retained by the Owner), an accurate copy of the fire alarm system points list, and a copy of the construction drawings on CD in AutoCad and Adobe Reader .pdf format.

I. Provide and install the most current software package available at the time of installation. In addition, when the programming software is available in disk format, a backup copy of the most up to date revision, in disk format, shall be delivered to the architect at the completion of the project. A software license agreement shall be made available for the responsible Owner representative to sign at the time of training.

1.09 WARRANTY

A. The Fire Alarm Equipment Manufacturer shall provide a 3 year material warranty. Installer shall provide a 1 year labor warranty.

B. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer for a period of 5 years after expiration of the warranty.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Fire alarm equipment shall be standard products of Siemens Building Technologies, Inc., or Notifier by Honeywell, Fire Lite Alarms by Honeywell, or Edwards Systems Technology, or Simplex Grinnell, or Johnson Controls. Manufacturers listed are intended to establish type and quality of equipment and system design as well as operating features required. Deviations from intended functions of specified system are not permitted. Equipment shall not be ordered or installed until such equipment has been reviewed and approved by the Architect.

2.02 FIRE ALARM CONTROL PANEL (FACP) OR NETWORK NODES

A. Furnish addressable control panel and all applicable components for fire alarm control as indicated on drawings.

B. The control panel shall contain the following:

1. Initiation device circuits.

2. Alarm indicating circuits.

3. Power supply operating at 120 volts, with overcurrent protection as required to operate the system. Over-current protection shall be provided on all power outputs. The power supply shall continuously monitor all field wires for earth ground conditions, and shall have the following LED indicators:

   a. Ground Fault LED

   b. AC Power Fail LED

4. The power supply shall provide an integral battery charger. Battery arrangement may be configured in the field.

5. Control, Interface, and Input/Output modules as required for system operation.

6. Remote station or Remote panel(s) connection(s).

7. The system shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color coded system status LEDs, and an alphanumeric keypad with easy touch keys for the field programming and control of the fire alarm system.

8. Transient voltage surge suppression.

9. Digital Alarm Communicator Transmitter (DACT) and Internet Protocol Digital Alarm Communicator Transmitter (IPDACT). The DACT is an interface for communicating digital information between a fire alarm control panel and a UL-Listed central station. When the optional IPDACT Ethernet module is connected to the on board DACT, the system shall be capable of transmitting contact ID formatted alarms to a central station equipped with a compatible IP receiver via Ethernet over a private or public WAN/LAN, Intranet or Ethernet.

    a. The IPDACT communicator shall be an integral module component of the fire alarm control panel enclosure.

    b. The IPDACT communicator shall include connections to the alarm panel's phone outputs and shall convert the contact ID protocol in DTMF form into UDP Ethernet Packets. It shall include the ability for simultaneous reporting of panel events up to three different IP addresses.

    c. The IPDACT communicator shall be completely field-programmable locally from a PC via a serial port or via Ethernet and Telnet.

    d. The IPDACT communicator shall be capable of transmitting events in contact ID format.

10. Fire Alarm panel shall include cellular communicator for connection to monitoring agent. Fire alarm panel shall be capable of cellular communications.

11. Fire Alarm vendor shall include (1) year monitoring service contract in their pricing. Documentation and contract will be coordinated at project closeout.

C. Enclosures:

1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer’s standard finish.

2. The back box and door shall be constructed of steel with provisions for electrical conduit connections into the sides and top.

3. The supplied door shall include a key lock and shall include glass or other transparent opening for viewing of all indicators. For convenience, the door may be site configured for either right or left hand hinging.

2.03 REMOTE ANNUNCIATORS

A. Furnish remote annunciator(s) and all applicable components for fire alarm remote annunciator as indicated on drawings.

B. The remote annunciator shall be flush mounted with protective cover and contain the following:

1. LCD display that shows the local status of the fire alarm system.

2. LED's that illuminate when ALARM, SUPERVISORY, TROUBLE, and SECURITY events occur on the system.

3. A (4) line, minimum, liquid-crystal display (LCD) that will give details of the event in alphanumeric form. The display shall be capable of being toggled to display additional events.

4. Three (3) additional control buttons to acknowledge events, silence audible circuits, and reset the system.

2.04 PERIPHERAL DEVICES AND EQUIPMENT

A. Manual Stations:

B. Smoke Detectors:

C. Heat Detectors:

D. Duct Smoke Detectors:

E. Monitor Modules:

F. Control Modules:

G. Relay Modules:

H. Isolator Modules:

I. Alarm Indicating Devices:

1. Horn/Strobe:

2. Strobe only:

J. Door Holder/Releases:

1. Door holder power supply:

K. Output Cables and Conductors:

1. Alarm Horn Circuit(s), one pair 16 gage solid copper, unshielded.

2. Alarm Strobe Circuit(s), one pair 16 gage solid copper, unshielded.

3. Initiating Device Circuit(s), 2-conductor 18 gage stranded copper, unshielded.

The above cable types are based on the recommendations and approval of the specified system. If the submitted and approved fire alarm system requires a different cable configuration with additional conductors, multi-conductor versus twisted pairs, etc. than is specified above, the contractor shall request a substitution to supply and install the approved configuration of cables as required by the make and model of the fire alarm system that is to be installed.

PART 3 - EXECUTION

3.01 GENERAL

A. Fire alarm system shall not be used for any purpose other than fire alarm functions.

B. Fire alarm shall be interconnected but not limited to the following systems:

1. All systems required by code to be connected to the fire alarm systems shall be connected.

2. Ventilation systems where required for the purpose of fan shutdown

3. Damper control or smoke management systems.

4. Elevator controls for the purpose of elevator cab recall and shunt trip control, circuit supervision and shunt trip power supervision.

3.02 SYSTEM INSTALLATION

A. Install required conductors to devices indicated on Drawings. Provide required conductor terminations to devices for a complete system to function as specified and indicated on Drawings.

B. Splices are not allowed in junction boxes. Terminations shall be in terminal cabinets or on equipment terminals.

C. Conductors shall be installed within conduits, boxes, and terminal cabinets in a totally enclosed installation. Furnish and install conductors required to connect incoming and outgoing circuits, including spare conductors, to terminal strips within terminal cabinets.

D. Wiring within equipment and terminal cabinets shall be installed to conform to contract documentation and NFPA 72 standards, and shall be terminated on terminal blocks having terminals for connections. Wiring shall be securely fastened in place so that no weight is imposed on equipment or terminals.

E. Install required terminal blocks within terminal cabinets.

F. Conductors shall be color-coded and tagged with code markers at terminal cabinets and equipment. A wire index shall be typed and installed on terminal cabinet doors. Index shall be covered with clear plastic adhesive covers. Wiring shall be identified as to building and location of devices in the index.

G. Wiring within equipment and terminal cabinets shall be carefully strapped, and shall be formed in rectangular configuration. Wires shall be properly numbered in numerical order and shall maintain same number throughout the Project site.

H. Complete installation shall comply with local building codes and applicable provisions of the National Electrical Code, and the NFPA 72 National Fire Alarm Code.

I. Location of outlet boxes and equipment on Drawings is approximate, unless dimensions are indicated. Do not scale Drawings to determine locations and routing of conduits and outlet boxes. Location of outlet boxes and equipment shall conform to architectural features of the building and other Work already in place, and must be ascertained in the field before the start of Work.

J. Devices shown at exterior locations shall be weatherproof devices, provided with weatherproof back boxes, and shall contain all provisions for weatherproof installations.

K. Drawings generally indicate Work to be provided, but do not indicate all bends, transitions or special fittings required to clear beams, girders or other Work already in place. Investigate conditions where conduits are to be installed, and furnish and install required fittings.

L. Provide adhesive, typed label of approximately 1 inch wide with red lettering for each initiating device that is hidden from view. Tags shall indicate the address of the device.

M. Provide smoke and heat detectors in elevator hoist-ways as required. Provisions shall be made for fire rated access to the detector without entering the elevator hoist-way.

N. Provide and install adjacent to the FACP a neatly typewritten copy of the Fire Alarm Operating Instructions. The instructions shall reflect the installed and programmed features of the system. The instructions shall be placed into a suitably sized frame with a face cover. The frame shall be attached to the wall with a minimum of two screws into the wall material with appropriate anchors.

O. Provide and install adjacent to the FACP a computer generated site map showing all rooms with designations and buildings with names as programmed into the system. This map shall be sized to allow (normal vision) reading of the designations, names etc. A map so reduced in size to the point of not being readable will not be acceptable. This map shall include symbols indicating the locations of all installed initiation devices and manual pull stations. Provide a symbol list on the map for the symbols used. The site map shall be placed into a suitably sized frame with a face cover. The frame shall be attached to the wall with a minimum of two screws into the wall material with the appropriate anchors.

3.03 TESTING

A. Testing of fire detection system shall be as required by the Fire Marshal and local authorities having jurisdiction. Installer is responsible for identifying required testing, coordinating, scheduling, and conducting tests before Substantial Completion; one week notice of scheduled fire marshal test shall be provided to the engineer before final testing.

B. Complete the inspection and testing form as required by NFPA 72, and submit one copy of the completed form to the Architect and Engineer.

C. Contractor shall pretest system and clear all defects prior to scheduling final testing with fire marshal and architect/engineer.

3.04 SERVICE MANUALS

A. Contractor shall deliver upon completion of project, 3 copies of the service manuals. Each manual shall include the following:

1. Installation manuals, programming manuals and user manuals for all fire alarm components. Catalog cut sheets are not acceptable.
2. A printed copy of the system configuration as programmed, including all system labeling codes, and passwords.
3. An electronic copy on compact disk of the system configuration program
4. Final test report.
5. Detailed explanation of the operation of the system.
6. Instructions for routine maintenance.
7. Detailed final wiring diagram for the system, and an electronic copy (CD) of the posted system in Auto-Cad and pdf formats.
8. Provide codes and passwords for fire alarm system at testing.

3.05 SPARE PARTS

A. The following new spare parts shall be furnished in unopened boxes:

1. 5% spare pull stations including the associated monitor module (minimum one spare pull station per type).
2. 5% spare smoke and heat detectors (minimum one spare smoke and heat detector per type).
3. 5% spare audible devices (minimum one spare audible device per type).
4. 5% spare strobe devices (minimum one spare strobe device per type).

3.06 SYSTEM USER AND MAINTENANCE PERSONNEL TRAINING

A. Before Substantial Completion, provide one instruction period for the Project site based Owner operators and system users. The instruction period shall be scheduled and coordinated with the owner's representative.

B. All training materials and required deliverables shall be submitted to the owner's representative.

3.07 PROTECTION

A. Protect the Work of this section until Substantial Completion.

3.08 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off Project site.

END OF SECTION