



SM No. CBWO9021250101

PROPOSAL AND CONTRACT DOCUMENTS

FOR THE CONSTRUCTION OF

14

Upgrade of Administration Building HVAC Control System & 3rd Floor Space
Reallocation, known as State Project No. BWO-9021-25(010) / 503251301 in Hinds
County.

Project Completion: 01/11/2022

(STATE DELEGATED)

NOTICE

**BIDDERS MUST COMPLETE AN ONLINE REQUEST
FOR PERMISSION TO BID THIS PROJECT.**

Electronic addendum updates will be posted on www.gomdot.com

SECTION 900

OF THE CURRENT 2017 STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION JACKSON, MISSISSIPPI

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

SECTION 901 - ADVERTISEMENT

Electronic bids will be received by the Mississippi Transportation Commission at 10:00 o'clock A.M., Tuesday, February 23, 2021, from the Bid Express Service and shortly thereafter publicly read on the Sixth Floor for:

Upgrade of Administration Building HVAC Control System & 3rd Floor Space Reallocation, known as State Project No. BWO-9021-25(010) / 503251301 in Hinds County.

The attention of bidders is directed to the predetermined minimum wage rate set by the U. S. Department of Labor under the Fair Labor Standards Act.

The Mississippi Department of Transportation hereby notifies all bidders that it will affirmatively insure that in any contract entered into pursuant to this advertisement, disadvantaged business enterprises will be afforded full opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, sex, age, disability, religion or national origin in consideration for an award.

Plans and specifications are on file in the offices of the Mississippi Department of Transportation.

Contractors may request permission to bid online at <http://shopmdot.ms.gov> at no cost. Upon approval, Contractors shall be eligible to submit a bid using Bid Express at <http://bidx.com>. Specimen proposals may be viewed and downloaded online at no cost at <http://mdot.ms.gov> or purchased online at <http://shopmdot.ms.gov> at a cost of Ten Dollars (\$10.00) per proposal plus a small convenience fee. Cash or checks will not be accepted as payment.

Plans must be purchased online at <https://shopmdot.ms.gov>. Costs of plans will be on a per sheet basis plus a small convenience fee. If you have any questions, you can contact the MDOT Plans Print Shop at (601) 359-7460, or e-mail at plans@mdot.state.ms.us. Plans will be shipped upon receipt of payment. Cash or checks will not be accepted as payment.

Bid bond, signed or countersigned by a Mississippi Agent or Qualified Nonresident Agent, with Power of Attorney attached, a Cashier's check or Certified Check for five (5%) percent of bid, payable to STATE OF MISSISSIPPI, must accompany each proposal.

The attention of bidders is directed to the provisions of Subsection 102.07 pertaining to irregular proposals and rejection of bids.

MELINDA L. MCGRATH
EXECUTIVE DIRECTOR

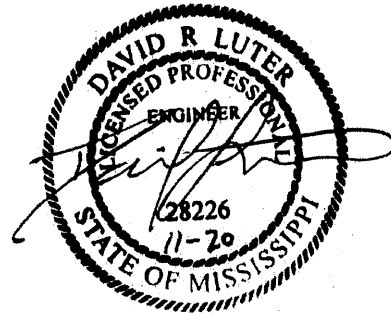
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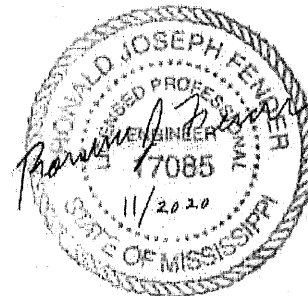
Architectural
Cooke Douglass Farr Lemons
3100 North State Street
Jackson, MS 39216
(601) 366-3110



Plumbing / Mechanical
Cooke Douglass Farr Lemons
3100 North State Street
Jackson, MS 39216
(601) 366-3110



Electrical
Cooke Douglass Farr Lemons
3100 North State Street
Jackson, MS 39216
(601) 366-3110



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ADMINISTRATION BUILDING – 3rd FLOOR
 RENOVATIONS
 JACKSON, HINDS COUNTY, MISSISSIPPI

PROJECT NUMBER:

BWO-9021-25(010) 503251

DATE:

11-18-20

DESCRIPTION A: This Work shall consist of all construction work necessary in constructing the Administration Building - 3rd Floor Renovations in Jackson, Hinds County, Mississippi, in accordance with these Specifications and conforming with the Drawings.

It is the intention of these Specifications to provide the necessary items and instruction for a building renovation including all code compliance. Omission of items or instruction necessary or considered standard good practice for the proper installation and construction of the building renovation shall not relieve the Contractor of furnishing and installing such items and conforming to the building codes having jurisdiction.

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1.01 LIST OF DRAWINGS

- A. List of Drawings: Drawings consist of the following Contract Drawings and other drawings of type indicated:

WORKING NUMBER	SHEET NUMBER	DESCRIPTION
G-001	1	COVER SHEET
G-002	2	PROJECT DATA
G-103	3	SITE PLAN
AD-001	4	SCHEDULE - DEMOLITION
AD-110	5	FLOOR PLAN - EXISTING
AD-111	6	DEMO PLAN - 3RD FLOOR, OVERALL
AD-111A	7	DEMO PLAN - 3RD FLOOR, PART A
AD-111B	8	DEMO PLAN - 3RD FLOOR, PART B
AD-121	9	DEMO RCP - 3RD FLOOR, OVERALL
AD-121A	10	DEMO RCP - 3RD FLOOR, PART A
AD-121B	11	DEMO RCP - 3RD FLOOR, PART B
A-101	12	LIFE SAFETY PLAN - 3RD FLOOR
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A-111	14	FLOOR PLAN - 3RD FLOOR, OVERALL
A-111A	15	FLOOR PLAN - 3RD FLOOR, PART A
A-111B	16	FLOOR PLAN - 3RD FLOOR, PART B
A-121	17	RCP - 3RD FLOOR, OVERALL
A-121A	18	RCP - 3RD FLOOR, PART A
A-121B	19	RCP - 3RD FLOOR, PART B
A-410	20	INTERIOR ELEVATIONS
A-500	21	DIAGRAMS - WALL FRAMING
A-501	22	DIAGRAMS - WALL CONSTRUCTION
A-502	23	PARTITION TYPES/MICS. DETAILS
A-550	24	MILLWORK DETAILS
A-600	25	DOOR, WINDOW, LOUVER SCHEDULE
I-101	26	FIRST FLOOR FINISH PLAN
FP-001	27	FIRE PROT. LEGENDS & GEN. NOTES
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P-002	30	PLUMBING LEGENDS
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M-101B	37	HVAC PLAN - 3RD FLOOR, PART B - DUCTWORK
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INSTRUCTIONS TO BIDDERS

PART 1 - GENERAL

1.01 QUESTIONS

- A. Questions Regarding Bidding: Bidders are advised that all questions that arise regarding the contract documents (proposal) or plans on this project shall be directed to the www.gomdot.com current letting webpage. Click on the call number for this project to open an email form to submit your question. Questions must be submitted by 8:00 a.m. on the Thursday prior to the letting. Answers to questions will be posted by 5:00 p.m. on the Thursday prior to the letting. Answers can be viewed by clicking on Q&A link under the Proposal Addenda column.
- B. It shall be the Bidders responsibility to familiarize themselves with the questions and answers that have been submitted on this project. Bidders are advised that by signing the contract documents for this project, they agree that the on-line Questions and Answers submitted on this project shall be added to and made part of the official contract.

1.02 BIDDER'S QUALIFICATIONS

- A. Prequalification of Bidders: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 102 – Bidding Requirements and Conditions, Subsection 102.01 – Prequalification of Bidders.

1.03 NON-RESIDENT BIDDER

- A. Consideration of Proposals: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 103 – Award and Execution of Contract, Subsection 103.01 – Consideration of Proposal.

1.04 CONDITIONS OF WORK

- A. Each Bidder must fully inform themselves of all conditions relating to the construction of the Project and employment of labor thereon. Failure to do so will not relieve a successful Bidder of obligations to furnish all material and labor necessary to carry out the provisions of the Contract. Insofar as possible, the Bidder must employ methods, or means, which will not cause interruption of, or interference with, the work of any other Bidder or Contractor.

1.05 EXAMINATION OF PROPOSAL AND SITE

- A. Examination of proposal and Site: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 102 – Bidding Requirements and Conditions, Subsection 102.05 – Examination of Plans, Specifications, Special Provisions, Notice to Bidders and Site Work.
- B. There will be no Pre-Bid Meeting, but failure to visit the site prior to submitting a bid will in no way relieve the successful Bidder from furnishing materials or performing work required to complete Work in accordance with Drawings and Project Manual (Proposal).
- C. Schedule a Site Visit: Contact Mr. Jim Jordan - Central Service Director, Tel. Office: 601-359-9776, Cell: 601-946-7276, no later than 2-10-2021.

1.06 LAWS AND REGULATIONS

- A. Laws and Regulations: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 107 – Legal Relations and Responsibility to Public, Subsection 107.01 – Laws to be Observed.

1.07 BID DOCUMENT

- A. The amount for Bid Document (Proposal) is indicated in the advertisement for Bids. Selected plan rooms will be issued one set of documents without charge.

1.08 METHOD OF BIDDING

- A. Lump sum, single bids received on a general contract will include general, mechanical and electrical construction (including Pay Items) and work shown on Drawings or specified in the Project Manual (Proposal).

1.09 PROPOSAL FORMS

- A. Preparation of Proposal: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 102 – Bidding Requirements and Conditions, Subsection 102.06 – Preparation of Proposal.

1.10 TIME OF COMPLETION

- A. The Bidder shall agree to commence work on a date specified in a written *NOTICE TO PROCEED* and fully complete the Project within the Contract Time indicated on the Proposal.

1.11 SUBSTITUTIONS

- A. No substitutions, qualifications or redefining of the Specification requirements are allowed to be marked on the Proposal Form, unless specifically required by the Bid Documents. Refer to Section 01 25 00 entitled Substitution Procedures which covers procedures after the award of Contract. .

1.12 ADDENDA

- A. Addenda to the Drawings or Project Manual issued before or during the time of bidding shall be included in the proposal and become a part of the Contract.
- B. If the Proposal, Section 905, does not contain acknowledgement of receipt and addition to the Proposal and Contract Documents of all addenda issued prior to opening of bids will be considered irregular and may be rejected.

1.13 BIDDER IDENTIFICATION

- A. Signature: The Proposal Form shall be signed, by any individual authorized to enter into a binding agreement for the Business making the bid proposal.
- B. Legal Address: The address appearing on the Proposal Form should be the same address exact as recorded at the Secretary of State <https://corp.sos.ms.gov/corp/portal/c/page/corpBusinessIdSearch/portal.aspx?#clear=1> which should be the same as you applied for at the Mississippi Board of Contractors <http://www.msdoc.us/>

- C. Certificate of Responsibility Number(s): The Certificate of Responsibility Number(s) appearing on the Proposal Form should be the same number appearing in the current Mississippi State Board of Contractors Roster.

1.14 BID SECURITY

- A. Proposal Guaranty: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 102 – Bidding Requirements and Conditions, Subsection 102.08 – Proposal Guaranty with the exception that the first and second paragraphs in Subsection 102.08 on page 20 should be deleted and substitute:
 1. No proposal will be considered unless accompanied by certified check, cashier's check or bid bond, made payable to the State of Mississippi, in an amount of not less than five percent (5%) of the total amount of the proposal offered. The guaranty shall be evidence of good faith that, if awarded the contract, the bidder will execute the contract and give performance and payment contract bond(s) as stipulated in Subsection 103.05.1, 103.05.2, and as required by law.
 2. If a bid bond is offered as guaranty, the bond must be made by a Surety acceptable to the Executive Director and signed or countersigned by a Mississippi Agent or Qualified Nonresident Agent and the Bidder. Such bid bond shall also conform to the requirements and conditions stipulated in Subsection 103.05.2, applicable.

1.15 POWER OF ATTORNEY

- A. Power of Attorney: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 103 – Award and Execution of Contract, Subsection 103.05 – Requirement of Contract Bond.

1.16 SUBMITTAL

- A. Delivery of Proposals: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 102 – Bidding Requirements and Conditions, Article 102.09 – Delivery of Proposal.

1.17 MODIFICATION TO BID

- A. A Bidder may NOT MODIFY the bid prior to the scheduled closing time indicated in the Advertisement for Bids in the following manner:
 1. Notification on Envelope: A modification may NOT be written on the outside of the sealed envelope containing the bid.
 2. Facsimile: A facsimile (fax) will NOT be acceptable.

1.18 OPENING OF BIDS

- A. Public Opening of Proposal: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 102 – Bidding Requirements and Conditions, Subsection 102.12 – Public Opening of Proposal.

1.19 IRREGULARITIES

- A. Irregular Proposals: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 102 – Bidding Requirements and Conditions, Subsection 102.07 – Irregular Proposal. Proposals will be considered irregular and may be rejected for any of the following reasons:
 1. If the proposal is on a form other than that furnished by the Department, or if the form is altered or any part thereof is detached except that is allowed.
 2. If there are unauthorized additions, conditions or alternate bids, or irregularities of any kind that may tend to make the proposal incomplete, indefinite, or ambiguous as to its meaning.
 3. If the bidder adds any provisions reserving the right to accept or reject an award, or to enter into a Contract pursuant to an award.
 4. If the proposal, Section 905, does not contain acknowledgement of receipt and addition to the proposal and contract documents of all addenda.
 5. Failure to execute required affidavits, certificates, etc., and furnish proposal guaranty.
 6. The Commission reserves the right, for any reason, to reject any or all proposals, to waive technicalities or irregularities, or to advertise for new proposals, and the decision of the Commission to reject any bid or proposal shall not be cause for any liability or damage against the Commission, the Department, or any of its officers or employees.

1.20 PROTEST

- A. Any protest must be delivered in writing to the Owner prior to the Award Date.

1.21 ERRORS

- A. Any claim of error and request for release from bid must be delivered in writing to the Owner within twenty-four (24) hours after the bid opening. The Bidder shall provide sufficient documentation with the written request clearly proving an error was made.

1.22 AWARD OF CONTRACT

- A. Award of Contract: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 103 – Award and Execution of Contract, Subsection 103.02 – Award of Contract.
- B. Consideration of Proposal: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 103 – Award and Execution of Contract, Subsection 103.01 – Consideration of Proposal.

1.23 FAILURE TO ENTER INTO A CONTRACT

- A. Failure to Execute Contract: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 103 – Award and Execution of Contract, Subsection 103.08 – Failure to Execute Contract.

1.24 SECURITY FOR FAITHFUL PERFORMANCE

- A. Requirements of Contract Bonds: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 103 – Award and Execution of Contract, Subsection 103.05 – Requirement of Contract Bond.

1.25 BIDDER'S CHECKLIST

A. Proposal Form:

1. Base Bid:
☐ Fill-in the amount of the base bid in numbers.
2. Alternates:
☐ Fill-in each alternates amount in numbers.
3. Certification Form (State Non-Collusion Certificate)
☐ Certification (regarding Non-Collusion, Debarment and Suspension, etc). Form has been executed in duplicate.
4. Acceptance:
☐ Proposal is signed by authorized person.
☐ Name of Business. - complete spelling of bidder's name and address – exact as recorded at the Secretary of State
<https://corp.sos.ms.gov/corp/portal/c/page/corpBusinessIdSearch/portal.aspx?#clear=1> which should be the same as you applied for at the Mississippi Board of Contractors <http://www.msdoc.us/>
☐ Legal address of the business listed above (at SOS and Contractor's Board).
☐ Correct Certificate of Responsibility Number(s) as it appears in the current Mississippi State Board of Contractors Roster.
5. Certificate of Responsibility Number(s):
☐ Base Bid is under \$50,000 and no number is required.
☐ Base Bid is under \$50,000 and the statement "bid does not exceed \$50,000" is on the outside of the sealed envelope.
☐ Base Bid is equal to or over \$50,000 and number is required.
☐ Joint Venture and *joint venture* number is required.
 Or
☐ Joint Venture participants' numbers are required.

B. Bid Security

1. Bid Bond:
☐ Included Bid Bond payable to the STATE OF MISSISSIPPI with Project number identified thereon,
 Or
☐ Included Certified Check payable to the STATE OF MISSISSIPPI with Project number identified thereon.
2. Power of Attorney:
☐ Included Power of Attorney.

C. Non-Resident Bidder

1. Preference Law:
☐ Attached a Copy of Non-Resident Bidder's Preference Law.
 Or
☐ Attached a Statement.

D. Subcontractors' Name

1. Subcontractor:
 () List Mechanical, Plumbing, and/or Electrical Subcontractor regardless of cost.
 * List name even for under \$50,000.
 * Fire Protection Sprinkler Contractors do not have to be listed.
 * If there is a separate HVAC/Plumbing Sub-Contractor, so notate as mentioned herein.
 * If Mechanical, Plumbing, and/or Electrical Subcontractor is performed by the General Contractor, be sure the General has COR for said discipline.
 * If there is no Mechanical, Plumbing, and/or Electrical Sub-Contractor listed, then use of Sub-Contractor to perform such scope will not be permitted.

E. Subcontractors' COR Number

1. Certificate of Responsibility
 () List certificate of responsibility Number for all listed Sub-Contractors over \$50,000.
 * If under \$50,000 – so notate on the COR line “under \$50,000” (or can still show COR Number)

1.26 BIDDER'S CONTACT LIST

- A. Proposal and Contract Documents: If the Bidder has any questions pertaining to the following specific areas of the Documents, please direct them to the following individuals:

1. Additional Proposals: Kerry Harris – Contract Administration (601) 359-7700
3. Bid Forms: Neal Dougherty – Contract Admin. Director (601) 359-7730
4. Specifications: Shane Martin – Assist. Construction Engr. (601) 359-7301
5. Drawings: Shane Martin – Assist. Construction Engr. (601) 359-7301
6. Bidder's List & Specimen Proposals are available online at:
<http://www.gomdot.com/Applications/BidSystem/Home.aspx>

END OF DOCUMENT

DOCUMENT 00 22 13

SUPPLEMENTARY INSTRUCTIONS TO BIDDERS

1.01 INSTRUCTIONS TO BIDDERS

- A. Instructions to Bidders for Project consist of the following:

1.02 WORK IN PROXIMITY OF HIGH VOLTAGE POWER LINES

- A. Contractor's Responsibility for Utility Property and Services: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 107 – Legal Relations and Responsibility to Public, Subsection 107.18 – Contractor's Responsibility for Utility Property and services.

1.03 PLANT PEST QUARANTINES INFORMATION

- A. Quarantine Information: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 107 – Legal Relations and Responsibility to Public, Subsection 107.22.7 – Quarantine Information.

1.04 PROMPT PAYMENT

- A. General: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 108 – Prosecution and Progress, Subsection 108.01.1 – General.

1.05 ALTERATIONS IN BIDDING PROCESS

- A. Preparation of Proposal: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 102 – Bidding Requirements and Conditions, Subsection 102.06 – Preparation of Proposal.

1.06 CONTRACT TIME

- A. It is anticipated that the Notice of Award will be issued by not later than March 09, 2021, and the date for Notice to Proceed and Beginning of Contract Time will be April 8, 2021.
- B. The calendar date for completion of this Contract shall be February 11, 2022 which date or extended date as provided in Article 8 - TIME shall be the end of contract time
- C. Construction Schedule: Refer to Mississippi Standard Specifications for Road and Bridge Construction 2017 Edition Section 108 – Prosecution and Progress (as amended).
- D. A Construction Schedule as described in Section 01 32 00-Construction Progress Documentation of these Specifications will be required for building construction.

1.07 SUBCONTRACTING

- A. The Bidder is specifically advised that any person, firm or other party to whom it proposes to award a subcontract must be acceptable to the Owner. The total allowable subcontract amount shall not exceed **sixty percent (60%) of the Contract Sum**, excluding the value of any "Specialty Items" listed below:
1. Building related Items, Materials, or Systems:
 - a. Plumbing Items
 - b. Heating, Ventilating and Air Conditioning Items
 - c. Security and Surveillance Items
 - d. Electrical Items
 2. These items are not to be confused with Division 10 – Specialties of the Specifications.

END OF DOCUMENT

DOCUMENT 00 72 00

GENERAL CONDITIONS

1.01 DESCRIPTION.

- A. The American Institute of Architects AIA DOCUMENT A201-2007, "General Conditions of the Contract for Construction", 2007, Sixteenth Edition, Articles 1 through 15 inclusive, except as may be added to or modified herein, is hereby made a part of the Contract Documents. For brevity, AIA DOCUMENT A201-2007 is also referred to in the Contract documents as the "General Conditions".
- B. All persons intending to provide goods or services in connection with this Work are required to read and understand the referenced document prior to proceeding.

END OF DOCUMENT



AIA® Document A201™ – 2007

General Conditions of the Contract for Construction

for the following PROJECT:

(Name and location or address)

ADMINISTRATION BUILDING – 3RD FLOOR RENOVATION
401 NORTH WEST STREET
JACKSON, MS 39201

BWO-9021-25(010) 503251

THE OWNER:

(Name, legal status and address)

MISSISSIPPI TRANSPORTATION COMMISSION
P O BOX 1850
JACKSON, MISSISSIPPI 39215-1850

THE ARCHITECT:

(Name, legal status and address)

TABLE OF ARTICLES

- 1 GENERAL PROVISIONS
- 2 OWNER
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- 4 ARCHITECT
- 5 SUBCONTRACTORS
- 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS
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- 12 UNCOVERING AND CORRECTION OF WORK
- 13 MISCELLANEOUS PROVISIONS
- 14 TERMINATION OR SUSPENSION OF THE CONTRACT

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.

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User Notes:

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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. .

The Contract Documents include the Advertisement for Bids, Instructions to Bidders, Notice to Bidders, Proposal Form, sample forms and all portions of addenda issued prior to execution of the Contract.

§ 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. The Project Manual is a volume assembled for the Work which may include the bidding requirements, sample forms, Conditions of the Contract and Specifications

§ 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 and certify termination of the Agreement under Section 14.2.2.

§ 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

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indicated results. In the event of a conflict between or among the Contract Documents, Contractor shall perform Work and obligations of the higher quality, larger quantity, greater expense, tighter schedule and more stringent requirements, unless otherwise directed in writing by the Owner.

§ 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 will retain all common law, statutory and other reserved rights, including copyrights. The Contractor, Subcontractors, Sub-subcontractors, and material or equipment 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 this Project is not to be construed as publication in derogation of the Architect's or Architect's consultants' reserved rights. This Paragraph in no way supersedes the Owner's document rights set forth in the "Engineering Services Contract" Agreement Between the Owner and the Professional.

§ 1.5.2 The Contractor, Subcontractors, Sub-subcontractors and material or equipment suppliers are authorized to use and reproduce the Instruments of Service provided to them 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 material or equipment suppliers may not use the Instruments of Service on other projects or for additions to this Project outside the scope of the Work without the specific written consent of the Owner, Architect and the Architect's consultants.

§ 1.6 TRANSMISSION OF DATA IN DIGITAL FORM

If the parties intend to transmit Instruments of Service or any other information or documentation in digital form, they shall endeavor to establish necessary protocols governing such transmissions, unless otherwise already provided in the Agreement or the Contract Documents.

§ 1.7 EXECUTION OF THE WORK

Sections of Division 01 General Requirements govern the execution of the Work of all Sections in Divisions 02-49 of the Specifications.

ARTICLE 2 OWNER

§ 2.1 GENERAL

§ 2.1.1 The Owner, as used in these Documents, refers to the Mississippi Transportation Commission, a body Corporate of the State of Mississippi, acting by and through the duly authorized Executive Director of the Mississippi Department of Transportation for the benefit of the Department for which the Work under this Contract is being performed. The Owner is the entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Owner's representative, who shall have express authority to bind the Owner with respect to all matters requiring the Owner's approval or authorization, is the individual who signed the Construction Contract for the Owner. 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 INFORMATION AND SERVICES REQUIRED OF THE OWNER

§ 2.2.1 Prior to commencement of the Work, the Contractor may request in writing that the Owner provide reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract. Thereafter, the Contractor may only request such evidence if (1) the Owner fails to make payments to the Contractor as the Contract Documents require; (2) a change in the Work materially changes the Contract Sum; or (3) the Contractor identifies in writing a reasonable concern regarding the Owner's ability to make payment when due. The Owner shall furnish such evidence as a condition precedent to commencement or continuation of the Work or the portion of the Work affected by a material change. After the Owner furnishes the evidence, the Owner shall not materially vary such financial arrangements without prior notice to the Contractor.

§ 2.2.2 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.

§ 2.2.3 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.

§ 2.2.4 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 the Contractor's written request for such information or services.

§ 2.2.5 After the Contract is executed by the Executive Director, the Contractor will receive free of charge two bound copies of the Project Manual (Proposal and Contract Documents) (one executed and one blank), and five full-scale copies of the Drawings and two half-scale copies. The Contractor shall have available on the Project Site at all times one copy each of the Contract Drawings and the Project Manual (Proposal).

§ 2.3 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.

§ 2.4 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 written 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 deficiencies. In such case an appropriate Change Order shall be issued deducting from payments then or thereafter due the Contractor 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. Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Architect. If payments then or thereafter due the Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner.

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 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 and any Work or material called for by either shall be provided as if called for by both, 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 2.2.3, 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 and 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 make 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 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, unless the Contract Documents give other specific instructions concerning these matters. If the Contract Documents give specific instructions concerning construction means, methods, techniques, sequences or procedures, the Contractor shall evaluate the jobsite safety thereof and, except as stated below, shall be fully and 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 written notice to the Owner and Architect and shall not proceed with that portion of the Work without further written instructions from the Architect. If the Contractor is then instructed to proceed with the required means, methods, techniques,

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sequences or procedures without acceptance of changes proposed by the Contractor, the Owner and Professional shall be responsible for any resulting loss or damage.

§ 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. The Owner will furnish utilities for construction (electricity and water). Contractor must use "as-is" or pay for any necessary modifications.

§ 3.4.2 Except in the case of minor changes in the Work authorized by the Architect in accordance with Sections 3.12.8 or 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.

§ 3.4.4 All Work as described or required shall be executed in a neat, skillful manner, in accordance with the best-recognized trade practice. Only competent workmen (including the superintendent), who work and perform their duties satisfactorily shall be employed on the Project. When requested by the Project Engineer, the Contractor shall discharge and shall not re-employ on the Project, any person who commits trespass or who is, in the opinion of the Project Engineer, dangerous, disorderly, insubordinate, incompetent, or otherwise objectionable.

§ 3.4.5 All materials and each part or detail of the Work are subject to inspection by the Project Engineer. Work performed or materials used by the Contractor without supervision, inspection, or written approval by an authorized Department representative may be ordered removed and replaced, at Contractor's expense, if found to be defective or noncompliant with the Contract Documents. No Work shall be performed on Legal Holidays, Sundays or after 5:00 P.M. on week days without prior written approval from the Project Engineer.

§ 3.5 WARRANTY

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.

§ 3.6 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 effective 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 21 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 an equitable adjustment 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 in writing, stating the reasons. If either party disputes the Architect's determination or recommendation, that party may proceed 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 Supplemental Agreement (Change Order). The amount of the Supplemental Agreement (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.

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§ 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 furnish in writing to the Owner through the Architect the name and qualifications of a proposed superintendent. The Architect may reply within 14 days to the Contractor in writing stating (1) whether the Owner or the Architect has reasonable objection to the proposed superintendent or (2) that the Architect requires additional time to review. Failure of the Architect to reply 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 SCHEDULES

§ 3.10.1 The Contractor, promptly after being awarded the Contract, shall prepare and submit for the Owner's and Architect's information a Contractor's construction schedule for the Work. The schedule shall not exceed time limits current under the Contract Documents, shall be revised at appropriate intervals as required by the conditions of the Work and Project, shall be related to the entire Project to the extent required by the Contract Documents, and shall provide for expeditious and practicable execution of the Work.

§ 3.10.2 The Contractor shall prepare a submittal schedule, promptly after being awarded the Contract and thereafter as necessary to maintain a current submittal schedule, and shall submit the schedule(s) for the Architect's approval. The Architect's approval shall not unreasonably be 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, 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 maintain at the site for the Owner one copy of the Drawings, Specifications, Addenda, Change Orders and other Modifications, in good order and marked currently to indicate field changes and selections made during construction, and one copy of approved Shop Drawings, Product Data, Samples and similar required submittals. These shall be available to the Architect and shall be 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 the way by which 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 with the submittal schedule approved by the Architect or, in the 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 approved submittals except that the Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Architect's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Architect in writing 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 written 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 architecture or 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. 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 cause such services or certifications to be provided by a properly 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, accuracy and completeness of the services, certifications and approvals performed or provided by such design professionals, provided the Owner and Architect have specified to the Contractor all performance and design criteria that such services must satisfy. Pursuant to this Section 3.12.10, the Architect will review, 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. The Contractor shall not be responsible for the adequacy of the performance and design criteria specified in the Contract Documents.

§ 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, and lawful orders of public authorities and the Contract Documents and shall not unreasonably encumber the site with materials or equipment. The Contractor shall not allow tradesman, technicians and laborers to enter other portions of existing facilities except as predetermined and approved by the Project Engineer. Existing utilities shall not be interrupted unless pre-approved by the Project Engineer. Parking for construction vehicles shall be in areas designated by the Owner at the Pre-construction Conference.

§ 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 and patching shall be restored to the condition existing prior to the cutting, fitting and 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 such construction by the Owner or a separate contractor except with written consent of the Owner and of such separate contractor; such consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold from the Owner or a separate contractor the Contractor's consent to cutting or otherwise altering the Work.

§ 3.15 CLEANING UP

§ 3.15.1 The Contractor shall keep the premises and surrounding area free from accumulation of waste materials or 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 Owner shall be entitled to reimbursement from the Contractor.

§ 3.16 ACCESS TO WORK

The Contractor shall provide the Owner and Architect 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 such 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 the Contractor has reason to believe that the required design, process or product is an infringement of a copyright or a patent, the Contractor shall be responsible for such loss unless such information is promptly furnished to the Architect.

§ 3.18 INDEMNIFICATION

§ 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. The Contractor agrees to defend, hold harmless and indemnify the Owner against all claims or demands caused by the Contractor's acts or omissions.

§ 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 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.

§ 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.

§ 4.1.3 If the employment of the Architect is terminated, the Owner shall employ a successor architect as to whom the Contractor has no reasonable objection and whose status under the Contract Documents shall be that of the Architect.

§ 4.1.4 The term "Architect," "Engineer," "Professional", or "Consultant" as used in these Documents refers to the Professional firm who has been directed by the Owner to design, provide Construction Documents and Construction Administration for this Project. These Consultants are advisors to the Project Engineer and MDOT Architect.

§ 4.1.5 The term "Project Engineer" as used in these Documents refers to the Mississippi Department of Transportation Executive Director's authorized representative. The Project Engineer shall be the Initial Decision Maker referenced in Article 15. The term "MDOT Architect" is the representative for the MDOT Architectural Services Unit and is an advisor to the Project Engineer.

§ 4.2 ADMINISTRATION OF THE CONTRACT

§ 4.2.1 The Architect will provide assistance to the Project Engineer and MDOT Architect for administration of the Contract as described in the Contract Documents and will be the Project Engineer's representative during construction until the date the Project Engineer issues the final Certificate for Payment. The Architect will have authority to act on behalf of the Project Engineer 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 Project Engineer, 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, except as provided in Section 3.3.1.

§ 4.2.3 On the basis of the site visits, the Architect will keep the Project Engineer reasonably informed about the progress and quality of the portion of the Work completed, and report to the Project Engineer (1) known deviations from the Contract Documents and from the most recent construction schedule submitted by the Contractor, and (2) 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 FACILITATING CONTRACT ADMINISTRATION

Except as otherwise provided in the Contract Documents or when direct communications have been specially authorized, the Architect and Contractor shall endeavor to communicate with each other through the Project Engineer about matters arising out of or relating to the Contract. Communications by and with the Architect's consultants shall be through the Architect to the MDOT Architect and Project Engineer. Communications by and with Subcontractors and material suppliers shall be through the Contractor. Communications by and with separate contractors shall be through the Project Engineer.

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§ 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 the Project Engineer will prepare State Estimates for Payment in such amounts.

§ 4.2.6 The Architect shall advise the Project Engineer to reject Work that does not conform to the Contract Documents. Whenever the Architect considers it necessary or advisable, the Architect will advise the Project Engineer to require inspection or testing of the Work in accordance with Sections 13.5.2 and 13.5.3, whether or not such Work is fabricated, installed or completed. However, neither this recommendation 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, material and equipment 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, unless otherwise specifically stated by the Architect, 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 Project Engineer, with recommendations from the Architect, will prepare Supplemental Agreements (Change Orders) and Advanced Authority (Construction Change Directives), and may authorize 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 Project Engineer, MDOT Architect, and Architect will conduct inspections to determine the date or dates of Completion; determine Final Acceptance; receive and forward to the Project Engineer, for 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 Project Engineer 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 duties, responsibilities and limitations of authority of such project representatives shall be as set forth in an exhibit to be incorporated in the Contract Documents.

§ 4.2.11 The Architect will interpret and recommend 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 or 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 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 AWARD OF SUBCONTRACTS AND OTHER CONTRACTS FOR PORTIONS OF THE WORK

§ 5.2.1 Unless otherwise stated in the Contract Documents or the bidding requirements, the Contractor, as soon as practicable after award of the Contract, shall furnish in writing to the Owner through the Architect the names of persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for each principal portion of the Work. The Architect may reply within 14 days to the Contractor in writing stating (1) whether the Owner or the Architect has reasonable objection to any such proposed person or entity or (2) that the Architect requires additional time for review. Failure of the Owner or Architect to reply 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 previously selected if the Owner or Architect makes reasonable objection to such substitution.

§ 5.3 SUBCONTRACTUAL RELATIONS

By appropriate agreement, written where legally required for validity, 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, which the Contractor, by these 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 that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The Contractor shall make available to each proposed Subcontractor, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor will be bound, and, upon written request of the Subcontractor, identify to the Subcontractor terms and conditions of the proposed subcontract agreement that may be at variance with the Contract Documents. Subcontractors will similarly make copies of applicable portions of such documents available to their respective proposed Sub-subcontractors.

§ 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

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- .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 in writing; 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 such 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 BY OWNER OR BY SEPARATE CONTRACTORS

§ 6.1 OWNER'S RIGHT TO PERFORM CONSTRUCTION AND TO AWARD SEPARATE CONTRACTS

§ 6.1.1 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 either in connection with other portions of the Project or other construction or operation on the site. In such event, the Contractor shall coordinate its activities with those of the Owner and of other Contractors so as to facilitate the general progress of all work being performed by all parties. Cooperation will be required in the arrangement for the storage of materials, and in the detailed execution of the work.

(Paragraph Deleted)

§ 6.1.3 The Owner shall provide for coordination of the activities of the separate contractors with the Work of the Contractor, who shall cooperate with them. The Contractor shall participate with other separate contractors and the Owner in reviewing their construction schedules. The Contractor shall make any revisions to the 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.

(Paragraph Deleted)

§ 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 report to the Architect apparent discrepancies or defects in such other construction that would render it unsuitable for such proper execution and results. Failure of the Contractor so to report 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, except as to defects not then reasonably discoverable.

§ 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.

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§ 6.2.4 The Contractor shall promptly remedy damage the Contractor wrongfully causes to completed or partially completed construction or to property of the Owner or separate contractors 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 Supplemental Agreement (Change Order), Advance Authority (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 Supplemental Agreement (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 Project Engineer.

§ 7.1.3 Changes in the Work shall be performed under applicable provisions of the Contract Documents, and the Contractor shall proceed promptly, unless otherwise provided in the Supplemental Agreement (Change Order), Advance Authority (Construction Change Directive) or order for a minor change in the Work.

§ 7.2 SUPPLEMENTAL AGREEMENT (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:

- .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.

§ 7.2.2 The maximum cost included in a Supplemental Agreement (Change Order) for profit and overhead is limited to twenty percent (20%) 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 Subcontractors shall comply passively without protest to the same requirements when participating in a Supplemental Agreement (Change Order).

§ 7.3 ADVANCE AUTHORITY (CONSTRUCTION CHANGE DIRECTIVES)

§ 7.3.1 Advance Authority (Construction Change Directive) is a written order prepared and signed by the Project Engineer, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Project Engineer may by Advance Authority (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 as Advanced Authority on changes to the Work where agreement has been reached prior to preparation of Supplemental Agreement (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;

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- .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 7.3.7.

§ 7.3.4 If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are materially changed in a proposed Change Order or Construction Change Directive so that application of such unit prices to quantities of Work proposed will cause substantial inequity to the Owner or Contractor, the applicable unit prices shall be equitably adjusted.

§ 7.3.5 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.

§ 7.3.6 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.

§ 7.3.7 If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Architect shall determine the method and 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 provided in the Contract Documents, costs for the purposes of this Section 7.3.7 shall be limited to the following:

- .1 Costs of labor, including social security, old age and unemployment insurance, fringe benefits required by agreement or custom, and workers' compensation insurance;
- .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 related to the Work; and
- .5 Additional costs of supervision and field office personnel directly attributable to the change.

§ 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 Project Engineer will prepare a Supplemental Agreement (Change Order). Supplemental Agreements (Change Orders) shall be issued for all or any part of an Advance Authority (Construction Change Directive).

§ 7.4 MINOR CHANGES IN THE WORK

The Architect has authority to order minor changes in the Work not involving adjustment in the Contract Sum or extension of the Contract Time and not inconsistent with the intent of the Contract Documents. Such changes will be effected by written order signed by the Architect and shall be binding on the Owner and Contractor.

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ARTICLE 8 TIME

§ 8.1 DEFINITIONS

§ 8.1.1 Unless otherwise provided, Contract Time is the period of time, including authorized adjustments, allotted in the Contract Documents for 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 Completion is the date certified by the Project Engineer and approved by the Owner 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, prematurely commence operations on the site or elsewhere prior to the effective date of insurance required by Article 11 to be furnished by the Contractor and Owner. The date of commencement of the Work shall not be changed by the effective date of such insurance.

§ 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 any act of neglect of the Owner or Project Engineer, or by any employee or either, or by changes ordered in the Work, or by labor disputes, fire, unusual delay in deliveries, unavoidable casualties or any causes beyond the Contractor's control, or by any other causes which the Project Engineer determines may justify the delay, then the Contract time may be extended by Change Order for such reasonable time as the Project Engineer may determine, subject to the Owner's approval. The Contractor's sole and exclusive right and remedy for delay by any cause whatsoever is an extension of the Contract Time but no increase in the Contract Sum. Any claim for loss or any delay occasioned by any separate Contractor, or Subcontractor, shall be settled between the Contractor and such other separate Contractor, or Subcontractors.

§ 8.3.2 No delay, interference, hindrance or disruption, from whatever source or cause, in the progress of the Contractor's Work shall be a basis for an extension of time unless the delay, interference hindrance or disruption is (1) without the fault and not the responsibility of the Contractor, its subcontractors and suppliers and (2) directly affects the overall completion of the Work as reflected on the critical path of the updated Construction Schedule. The contractor expressly agrees that the Owner shall have the benefit of any float in the construction schedule and delay in construction activities which do not affect the overall completion of the work does not entitle the Contractor to any extension in the Contract Time.

§ 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.

1. The weather experienced at the project site during the contract period must be found to be unusually severe, that is, more severe than the adverse weather anticipated for the project location during any given month.
2. The unusually severe weather must actually cause a delay in the completion of the project. The delay must be beyond the control and without the fault or negligence of the Contractor.

§ 8.3.5 The following schedule of monthly anticipated adverse weather delays is based on National Oceanic and Atmospheric Administration (NOAA) or similar data for the project location and will constitute the base line for monthly weather time evaluations. The Contractor's activity durations for inclusion in the progress schedule must reflect these anticipated adverse weather delays in all weather dependent activities.

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1. Adverse Weather Evaluation: The table below defines the monthly anticipated adverse weather in days for the project:

Adverse Weather Table

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10	9	9	8	9	8	10	9	7	6	8	9

§ 8.3.6 Monthly anticipated adverse weather delay work days based on five (5) day work week.

§ 8.3.7 Upon acknowledgement of the Notice to Proceed (NTP) and continuing throughout the Contract, the Contractor shall record on the daily report, the occurrence of adverse weather and resultant impact to normally scheduled work. Actual adverse weather delay days must prevent work on the overall projects' critical activities for 50 percent or more of the Contractor's scheduled workday. The number of actual adverse weather days shall include days impacted by actually adverse weather (even if adverse weather occurred in previous month), be calculated chronologically from the first to the last day of each month and be recorded as full days. If the number of actual adverse weather delay days exceeds the number of days anticipated in paragraph 8.3.5 above, the Owner and the Architect will convert any qualifying delays to calendar days giving full consideration for equivalent fair weather work days, and issue a modification in accordance with the Contract.

ARTICLE 9 PAYMENTS AND COMPLETION

§ 9.1 CONTRACT SUM

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.

§ 9.2 SCHEDULE OF VALUES

Where the Contract is based on a stipulated sum, the Contractor shall submit to the Architect, before the first Application for Payment, a schedule of values allocating the entire Contract Sum to the various portions of the Work and prepared in such form and supported by such data to substantiate its accuracy as the Architect may require. This schedule, unless objected to by the Architect, MDOT Architect, or Project Engineer, shall be used as a basis for reviewing the Contractor's 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. Such application shall be notarized, if required, and supported by such data substantiating the Contractor's right to payment as the Owner or Architect may require, such as copies of requisitions from Subcontractors and material suppliers, and shall reflect retainage if provided for in the Contract Documents. 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 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 in 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 material supplier, unless such Work has been performed by others whom the Contractor intends to pay.

§ 9.3.1.3 The Owner will retain five percent (5%) until the Work is at least fifty percent (50%) complete, on schedule, and satisfactory in the Project Engineer's opinion, at which time fifty percent (50%) of the retainage held to date shall be returned to the Contractor for distribution to the appropriate Sub-Contractors and Suppliers. Future retainage shall be withheld at the rate of two and one half percent (2-1/2%) of the amount due the Contractor on account of progress payments.

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§ 9.3.1.4 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 made 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 Owner approval in any way.

§ 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.

§ 9.3.2.1 Payment on materials stored at some location other than the building site, may be approved by the Project Engineer 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 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 Project Engineer of the materials stored off-site prior to release of payment.
- .7 Guarantee no storage costs, additional delivery fees, or subsequent costs to the Owner.
- .8 List of stored items shall be sent to the Chief Engineer for his approval prior to payment of stored materials.

§ 9.3.2.2 Payment for materials stored at the building site, may be approved by the Project Engineer and the Owner after the Contractor has submitted the following items:

- .1 A Bill of Sale from the Manufacturer to the General Contractor for the stored materials.
- .2 List of stored items shall be sent to the Chief Engineer for his approval prior to payment of stored materials.

§ 9.3.3 The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously 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, material suppliers, or other persons or entities making a claim by reason of having 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 recommend acceptance or state what portions should be modified to the Project Engineer for such amount as the Architect determines is properly due, or notify the Contractor and Project Engineer in writing of the Architect's reasons for modifications in whole or in part as provided in Section 9.5.1.

§ 9.4.2 The recommendations for Payment will constitute a representation by the Architect to the Project Engineer, based on the Architect's evaluation of the Work and the data comprising the Application for Payment, that, to the best of the Architect's knowledge, information and belief, the Work has progressed to the point indicated and that the quality of the Work is in accordance with the Contract Documents. The foregoing representations are subject to an evaluation of the Work for conformance with the Contract Documents upon Date of Completion, to results of

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subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion and to specific qualifications expressed by the Architect. The recommendations for Payment will further constitute a representation that the Contractor is entitled to payment in the amount recommended. However, the recommendations 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 material 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 recommend to withhold 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 recommend 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 make recommendation for Payment for the amount for which the Architect is able to make such representations to the Owner. The Architect may also make recommendations to withhold Payment or, because of subsequently discovered evidence, may make recommendations to nullify the whole or a part of a Payment previously made, 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 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 the above reasons for recommendations to withhold Payment are removed, recommendations will be made for amounts previously withheld.

(Paragraph Deleted)

§ 9.6 PROGRESS PAYMENTS

§ 9.6.1 After the Architect has reviewed the Application for Payment and made recommendations to the Project Engineer, the Project Engineer shall make payment in the manner and within the time provided in the Contract Documents.

§ 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 material and equipment 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 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, except as may otherwise be required by law.

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§ 9.6.5 Contractor payments to material and equipment 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 and 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, shall create any fiduciary liability or tort liability on the part of the Contractor for breach of trust or shall entitle any person or entity to an award of punitive damages against the Contractor for breach of the requirements of this provision.

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9.6.8 The amount retained by the Contractor from each payment to each Subcontractor and material supplier will not exceed the percentage retained by the Owner from the Contractor

§ 9.7 FAILURE OF PAYMENT

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 Substantial Completion shall not be recognized under this Contract. The Project Engineer shall determine when the building or designated portion is complete to the point it can be used for its intended purpose. This date shall be the Date of Completion. All Warranties and Extended Warranties shall use this date as the starting date of Warranty Period.

§ 9.8.2 When the Contractor considers that the Work, or a 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, 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 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 such Certificate. Upon such acceptance and consent of surety, if any, the Owner shall make payment of retainage applying to such 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.

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§ 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 as required under Section 11.3.1.5 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 written 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 and, 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 terms and conditions of 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 and will not be canceled or allowed to expire until at least 30 days' prior written notice has been given to the Owner, (3) a written statement that the Contractor knows of no substantial 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 and (5), if required by the Owner, other data establishing payment or satisfaction of obligations, such as receipts, 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. If such lien 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 such lien, including all costs and reasonable attorneys' fees.

§ 9.10.3 If, after Date of 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 agreement by the Architect, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed 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 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 agreement 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

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- .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; or
- .3 terms of special warranties required by the Contract Documents.

§ 9.10.5 Acceptance of final payment by the Contractor, a Subcontractor or material 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 of final Application for Payment.

§ 9.11 LIQUIDATED DAMAGES

§ 9.11.1 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 pay the Owner liquidated damages for each calendar day of delay until the work is substantially complete as follows:

For More Than	To and Including	Per Calendar D
\$0	\$100,000	\$150
100,000	500,000	360
500,000	1,000,000	540
1,000,000	5,000,000	830
5,000,000	10,000,000	1,200
10,000,000	20,000,000	1,800
20,000,000	-----	3,500

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 or the Contractor's Subcontractors or Sub-subcontractors; and
- .3 other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of construction.

§ 10.2.2 The Contractor shall 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 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 owners and users of adjacent sites and utilities.

§ 10.2.4 When use or storage of explosives or other hazardous materials or equipment or unusual methods are necessary for execution of the Work, the Contractor shall exercise 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, except damage or loss attributable to acts or omissions of the Owner or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, or the Project Engineer 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 act or omission of the other party, or of others for whose acts such party is legally responsible, written notice of such 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

§ 10.3.1 The Contractor is responsible for compliance with any requirements included in the Contract Documents regarding hazardous materials. 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 report the condition to the Owner and Architect in writing.

(Paragraphs Deleted)

§ 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 LIABILITY INSURANCE

§ 11.1.1 The Contractor shall purchase from and maintain in a company or companies lawfully authorized to do business in the jurisdiction in which the Project is located such insurance as will protect the Contractor from claims set forth below 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 Subcontractor or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable:

- .1 Claims under workers' compensation, disability benefit and other similar employee benefit acts that are applicable to the Work to be performed;
- .2 Claims for damages because of bodily injury, occupational sickness or disease, or death of the Contractor's employees;
- .3 Claims for damages because of bodily injury, sickness or disease, or death of any person other than the Contractor's employees;
- .4 Claims for damages insured by usual personal injury liability coverage;
- .5 Claims for damages, other than to the Work itself, because of injury to or destruction of tangible property, including loss of use resulting therefrom;
- .6 Claims for damages because of bodily injury, death of a person or property damage arising out of ownership, maintenance or use of a motor vehicle;

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- .7 Claims for bodily injury or property damage arising out of completed operations; and
- .8 Claims involving contractual liability insurance applicable to the Contractor's obligations under Section 3.18.

§ 11.1.2 The insurance required by Section 11.1.1 shall be written for not less than limits of liability specified in the Contract Documents or required by law, whichever coverage is greater. Coverages, whether written on an occurrence or claims-made basis, shall be maintained without interruption from the date of commencement of the Work until the date of final payment and termination of any coverage required to be maintained after final payment, and, with respect to the Contractor's completed operations coverage, until the expiration of the period for correction of Work or for such other period for maintenance of completed operations coverage as specified in the Contract Documents.

§ 11.1.3 Certificates of insurance acceptable to the Owner shall be filed with the Owner prior to commencement of the Work and thereafter upon renewal or replacement of each required policy of insurance. These certificates and the insurance policies required by this Section 11.1 shall contain a provision that coverages afforded under the policies will not be canceled or allowed to expire until at least 30 days' prior written notice has been given to the Owner. An additional certificate evidencing continuation of liability coverage, including coverage for completed operations, shall be submitted with the final Application for Payment as required by Section 9.10.2 and thereafter upon renewal or replacement of such coverage until the expiration of the time required by Section 11.1.2. Information concerning reduction of coverage on account of revised limits or claims paid under the General Aggregate, or both, shall be furnished by the Contractor with reasonable promptness.

§ 11.1.4 The Contractor shall cause the commercial liability coverage required by the Contract Documents to include (1) the Owner, the Architect and the Architect's consultants as additional insureds for claims caused in whole or in part by the Contractor's negligent acts or omissions during the Contractor's operations; and (2) the Owner as an additional insured for claims caused in whole or in part by the Contractor's negligent acts or omissions during the Contractor's completed operations.

§ 11.1.5 The Contractor's limits of liability shall be written for not less than the following:

.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 Fire
Medical Expense	5,000.00	Per Person

.2 OWNERS & CONTRACTORS PROTECTIVE LIABILITY:

Bodily Injury & Property Damage	\$1,000,000.00	Aggregate
Bodily Injury & Property Damage	500,000.00	Per Occurrence

.3 AUTOMOBILE LIABILITY

Owned, Non-owned & Hired Vehicle	\$500,000.00	Per Occurrence
Contractor Insurance Option Number 1: Bodily Injury & Property Damage (Combined Single Limit)		
Contractor Insurance Option Number 2:	250,000.00	Per Person
Bodily Injury		
Bodily Injury	500,000.00	Per Accident
Property Damage	100,000.00	Per Occurrence

.4 EXCESS LIABILITY:

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User Notes:

(Umbrella on projects over \$500,000) Bodily Injury & Property Damage (Combined Single Limit)	\$1,000,000.00	Aggregate
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.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 Or	Equal to Value of Work
Installation Floater	Equal to Value of Work

§ 11.1.6 Furnish one (1) copy of the Standard Construction Contract Certificate of Insurance Form for each copy of the Standard Form of Agreement Between Owner and Contractor specifically setting forth evidence of all coverage required by Subparagraphs 11.1.1, 11.1.2 and 11.1.3. Furnish to the Owner copies of any endorsements that are subsequently issued amending limits of coverage.

§ 11.1.7 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.

§ 11.2 OWNER'S LIABILITY INSURANCE

The Contractor shall purchase and maintain such insurance as will protect the Owner from his 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.

§ 11.3 PROPERTY INSURANCE

§ 11.3.1 The Contractor shall purchase and maintain, in a company or companies lawfully authorized to do business in the jurisdiction in which the Project is located, property insurance written on a builder's risk "all-risk" or equivalent policy form in the amount of the initial Contract Sum, plus value of subsequent Contract Modifications and cost of materials supplied or installed by others, comprising total value for the entire Project at the site on a replacement cost basis without optional deductibles. Such property insurance shall be maintained, unless otherwise provided in the Contract Documents or otherwise agreed in writing by all persons and entities who are beneficiaries of such insurance, until final payment has been made as provided in Section 9.10 or until no person or entity other than the Owner has an insurable interest in the property required by this Section 11.3 to be covered, whichever is later. This insurance shall include interests of the Owner, the Contractor, Subcontractors and Sub-subcontractors in the Project.

§ 11.3.1.1 Property insurance shall be on an "all-risk" or equivalent policy form and shall include, without limitation, insurance against the perils of fire (with extended coverage) and physical loss or damage including, without duplication of coverage, theft, vandalism, malicious mischief, collapse, earthquake, flood, windstorm, falsework, testing and startup, temporary buildings and debris removal including demolition occasioned by enforcement of any applicable legal requirements, and shall cover reasonable compensation for Architect's and Contractor's services and expenses required as a result of such insured loss.

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(Paragraph Deleted)

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

§ 11.3.1.4 This property insurance shall cover portions of the Work stored off the site, and also portions of the Work in transit.

§ 11.3.1.5 Partial occupancy or use in accordance with Section 9.9 shall not commence until the insurance company or companies providing property insurance have consented to such partial occupancy or use by endorsement or otherwise. The Owner and the Contractor shall take reasonable steps to obtain consent of the insurance company or companies and shall, without mutual written consent, take no action with respect to partial occupancy or use that would cause cancellation, lapse or reduction of insurance.

(Paragraphs Deleted)

§ 11.3.7 WAIVERS OF SUBROGATION

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, and (2) the Architect, Architect's consultants, separate contractors described in Article 6, 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 covered by property insurance obtained pursuant to this Section 11.3 or other property insurance applicable to the Work, except such rights as they have to proceeds of such insurance held by the Owner as fiduciary. The Owner or Contractor, as appropriate, shall require of the Architect, Architect's consultants, separate contractors described in Article 6, if any, and the subcontractors, sub-subcontractors, agents and employees of any of them, by appropriate agreements, written where legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, and whether or not the person or entity had an insurable interest in the property damaged.

§ 11.3.8 A loss insured under the Owner's property insurance 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 11.3.10. The Contractor shall pay Subcontractors their just shares of insurance proceeds received by the Contractor, and by appropriate agreements, written where legally required for validity, shall require Subcontractors to make payments to their Sub-subcontractors in similar manner.

§ 11.3.9 If required in writing by a party in interest, the Owner as fiduciary shall, upon occurrence of an insured loss, give bond for proper performance of the Owner's duties. The cost of required bonds shall be charged against proceeds received as fiduciary. The Owner shall deposit in a separate account proceeds so received, which the Owner shall distribute in accordance with such agreement as the parties in interest may reach, or as determined in accordance with the method of binding dispute resolution selected in the Agreement between the Owner and Contractor. If after such loss no other special agreement is made and unless the Owner terminates the Contract for convenience, replacement of damaged property shall be performed by the Contractor after notification of a Change in the Work in accordance with Article 7.

§ 11.3.10 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

§ 11.4 PERFORMANCE BOND AND PAYMENT BOND

§ 11.4.1 The Owner shall have the right to require the Contractor to furnish bonds covering faithful performance of the Contract and payment of obligations arising thereunder as stipulated in bidding requirements or specifically required in the Contract Documents on the date of execution of the Contract.

§ 11.4.2 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.

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 it shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, costs of uncovering and replacement shall, by appropriate Change Order, be at the Owner's expense. If such Work is not in accordance with the Contract Documents, such costs and the cost of correction shall be at the Contractor's expense unless the condition was caused by the Owner or a separate contractor in which event the Owner shall be responsible for payment of such costs.

§ 12.2 CORRECTION OF WORK

§ 12.2.1 BEFORE OR AFTER DATE OF COMPLETION

The Contractor shall promptly correct Work rejected by the Architect or failing to conform to the requirements of the Contract Documents, whether discovered before or after 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 DATE OF COMPLETION

§ 12.2.2.1 In addition to the Contractor's obligations under Section 3.5, if, within one year after the date of 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 an 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 written 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 that period after receipt of notice from the Owner or Architect, the Owner may correct it in accordance with Section 2.4.

§ 12.2.2.2 The one-year period for correction of Work shall be extended with respect to portions of Work first performed after Date of Completion by the period of time between Date of 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 not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

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

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§ 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 has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations 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 laws of the State of Mississippi except that, 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 such 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 such assignment.

§ 13.3 WRITTEN NOTICE

Written notice shall be deemed to have been duly served if delivered in person to the individual, to a member of the firm or entity, or to an officer of the corporation for which it was intended; or if delivered at, or sent by registered or certified mail or by courier service providing proof of delivery to, the last business address known to the party giving notice.

§ 13.4 RIGHTS AND REMEDIES

§ 13.4.1 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.

§ 13.4.2 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 there under, except as may be specifically agreed in writing.

§ 13.5 TESTS AND INSPECTIONS

§ 13.5.1 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 be present for such procedures. The Owner shall bear costs of (1) tests, inspections or approvals that do not become requirements until after bids are received or negotiations concluded, and (2) tests, inspections or approvals where building codes or applicable laws or regulations prohibit the Owner from delegating their cost to the Contractor.

§ 13.5.2 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 13.5.1, 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 13.5.3, shall be at the Owner's expense.

§ 13.5.3 If such procedures for testing, inspection or approval under Sections 13.5.1 and 13.5.2 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.

§ 13.5.4 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.

§ 13.5.5 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.

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

§ 13.6 INTEREST

Payments due and unpaid under the Contract Documents shall bear interest from the date payment is due at such rate as the parties may 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.

§ 13.7 TIME LIMITS ON CLAIMS

The Owner and Contractor shall commence all claims and causes of action, whether in contract, tort, breach of warranty or otherwise, against the other arising out of or related to the Contract in accordance with the requirements of the final dispute resolution method selected in the Agreement within the time 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 13.7.

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 or a Subcontractor, Sub-subcontractor or their agents or employees or any other persons or entities performing portions of the Work under direct or indirect contract with the Contractor, 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 promptly, upon the Contractor's request, reasonable evidence as required by Section 2.2.1.

§ 14.1.2 The Contractor may terminate the Contract if, through no act or fault of the Contractor or a Subcontractor, Sub-subcontractor or their agents or employees or any other persons or entities performing portions of the Work under direct or indirect contract with the Contractor, 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' written notice to the Owner and Architect, terminate the Contract and recover from the Owner payment for Work executed, including reasonable overhead and profit, costs incurred by reason of such termination, and damages.

§ 14.1.4 If the Work is stopped for a period of 60 consecutive days through no act or fault of the Contractor or a Subcontractor or their agents or employees or any other persons performing portions of the Work under contract with the Contractor 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' written 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 enough properly skilled workers or proper materials;
- .2 fails to make payment to Subcontractors for materials or labor in accordance with the respective agreements between the Contractor and the Subcontractors;
- .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 above reasons exist, the Owner, upon certification by the Initial Decision Maker that sufficient cause exists to justify such action, 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' written 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 Time shall be adjusted for increases in the time caused by suspension, delay or interruption as described in Section 14.3.1. 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 Contract.

§ 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 written notice from the Owner of such termination for the Owner's convenience, the Contractor shall

- .1 cease operations as directed by the Owner in the notice;
 - .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 Contractor shall be entitled to receive payment for Work executed, and costs incurred by reason of such termination, along with reasonable overhead and profit on the Work not executed.

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, 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.

§ 15.1.2 NOTICE OF CLAIMS

Claims by either the Owner or Contractor must be initiated by written 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 must 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 CONTINUING CONTRACT PERFORMANCE

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. The Architect will prepare Change Orders and issue Certificates for Payment in accordance with the decisions of the Initial Decision Maker.

§ 15.1.4 CLAIMS FOR ADDITIONAL COST

If the Contractor wishes to make a Claim for an increase in the Contract Sum, written notice as provided herein shall be given before proceeding to execute the Work. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Section 10.4.

§ 15.1.5 CLAIMS FOR ADDITIONAL TIME

§ 15.1.5.1 If the Contractor wishes to make a Claim for an increase in the Contract Time, written notice as provided herein 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.

.1 The Contractor shall anticipate delays in the progress of the Work, due to adverse weather, during the stipulated Contract Time in the amount of days published in recognized official data. If documented evidence (from recognized official data) indicates weather delays in excess of this amount, then the Contractor may be granted an Extension of Time for each Work Day, in excess of the normal days, in which the weather prevented work on the Project Site for fifty (50) percent or more of the Contractor's "Normal Work Day", but only if such prevented work was critical to the timely completion of the project.

- .2 Contractor's "Normal Work Day" shall be defined on the basis of a five (5) Day Work Week. Example: If the "normal" (regular) schedule is a five (5) Day Work Week, meaning Monday through Friday, then a rain on Sunday (since not a scheduled Work Day) will not necessarily delay the Work of the Project. However, site conditions, as a result of the rain, could partially or fully prevent scheduled outside work on Monday (and thereafter) thereby making the Contractor eligible to apply for a Weather Delay Extension of Time on the basis of the conditions stated in the paragraph above.

§ 15.1.5.4 The Contractor shall not be entitled to a separate increase in the Contract Time for each one of the causes of delay which may have concurrent or interrelated affects on the progress of the Work, or for concurrent delays due to the fault of the Contractor

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§ 15.1.6 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 15.1.6 shall be deemed to preclude an award of liquidated damages, when applicable, in accordance with the requirements of the Contract Documents.

§ 15.2 INITIAL DECISION

§ 15.2.1 Claims, excluding those arising under Sections 10.3, 10.4, 11.3.9, and 11.3.10, shall be referred to the Initial Decision Maker for initial decision. The Project Engineer will serve as the Initial Decision Maker. 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 arising prior to the date final payment is due, unless 30 days have passed after the Claim has been referred to the Initial Decision Maker with no 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 may, but shall not be obligated to, consult with or seek information from either party 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 furnish additional supporting data, such party shall respond, within ten days after receipt of such 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 to the terms of Section 15.2.6.1.

§ 15.2.6.1 Either party may, within 30 days from the date of an initial decision, demand in writing that the other party file for mediation within 60 days of the initial decision. If such a demand is made and the party receiving the demand fails to file for mediation within the time required, then both parties waive their rights to mediate or pursue binding dispute resolution proceedings with respect to the initial decision.

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§ 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.

§ 15.5 ARBITRATION PROCEDURES FOR THE MISSISSIPPI TRANSPORTATION COMMISSION

All matters of dispute arising out of any agreement with the Mississippi Transportation Commission for planning, design, engineering, construction, erection, repair, or alteration of any building, structure, fixture, road, highway, utility or any part thereof, or any agreement with the Mississippi Transportation Commission for architectural, engineering, surveying, planning, and related professional services which provides for mediation or arbitration, shall comply with the following course for resolution. No arbitration hearing shall be granted on any claim in excess of One Hundred Thousand Dollars (\$100,000.00).

§ 15.5.1 **CONDITIONS PRECEDENT TO ARBITRATION** The aggrieved party must first notify opposing party in writing in detail of the matter(s) in dispute, the amount involved and the remedy sought. Such writing shall include copies of any documents, writings, plans, or other matter pertinent to the resolution of the dispute. The Chief Engineer of the Mississippi Department of Transportation, or his authorized representative, and a principal of the opposing party shall be the proper parties for

such notice and shall be active parties in any subsequent dispute resolution.

(Paragraph Deleted)

§ 15.5.2 **REQUESTS FOR ARBITRATION:** Within thirty (30) days of a claim being rejected in writing by the Project Engineer, either party may request arbitration. Notices for requests for arbitration shall be made in writing to the Chief Engineer of the Mississippi Department of Transportation, P. O. Box 1850, Jackson, Mississippi 39215-1850. Such notice shall set forth in detail the matter(s) in dispute, the amount involved, and the remedy sought. A copy of the request shall be mailed to the opposite party. The party requesting arbitration must deposit the sum of two hundred dollars (\$200.00) with its request as a deposit against costs incurred by the arbitrators. Each party will be notified in writing in any manner provided by law of certified mail not less than twenty (20) days before the hearing of the date, time and place for the hearing. Appearance at the hearing waives a party's right to notice.

§ 15.5.3 **SELECTION OF ARBITRATORS:** Upon request for arbitration, a panel of three (3) arbitrators shall be chosen. The Chief Engineer of the Mississippi Department of Transportation shall appoint one (1) member. One (1) member shall be appointed by the Executive Director of a professional or trade association that represents interests similar to that of the non-state party. The first two shall appoint the third member.

§ 15.5.4 **HEARINGS:** All hearings shall be open to the public. All hearings will be held in Jackson, Mississippi, unless the parties mutually agree to another location. The hearings shall be conducted as prescribed by **Mississippi Code 1972, Annotated**, Sections 11-15-113, 11-15-115, and 11-15-117. A full and complete record of all proceedings shall be taken by a certified court reporter. The scheduling and cost of retaining the court reporter shall be the responsibility of the party requesting arbitration. The costs of transcription of the record shall be the responsibility of the party requesting such transcript. No arbitration hearing shall be held without a certified court reporter. Deliberations of the arbitrators shall not be part of the record.

§ 15.5.5 **AWARDS:** Awards shall be made in

writing and signed by the arbitrators joining in the award. A copy of the award shall be delivered to the parties by certified mail.

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15.5.6 FEES AND EXPENSES: Reasonable fees and expenses, excluding counsel fees, incurred in the conduct of the arbitration shall be at the discretion of the Arbitrator except each party shall bear its own attorney's fees and costs of expert witnesses.

§ 15.5.7 MODIFICATIONS, CONFIRMATIONS, AND APPEALS: All modifications, confirmations and appeals shall be as prescribed by **Mississippi Code 1972, Annotated**, Section 11-15-123 et seq. All awards shall be reduced to judgment and satisfied in the same manner other judgments against the State are satisfied.

§ 15.5.8 SECRETARY FOR THE ARBITRATORS: All notices, requests, or other correspondence intended for the arbitrators shall be sent to the Chief Engineer, Mississippi Department of Transportation, P. O. Box 1850, Jackson, Mississippi 39215-1850.

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ADDENDA

1.01 NOTICE TO BIDDERS

- A. Addenda issued on this Project will become part of the Standard Form of the Agreement Between the Owner and the Contractor.
- B. Addenda will be indicated on the second sheet of Section 905 (end of the Proposal/Project Manual) as addenda.

END OF DOCUMENT

SECTION 01 10 00

SUMMARY

PART 1 - GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS

- A. Work covered by the Contract Documents shall be provided by one (1) General Contractor as one (1) Contract to improve the Mississippi Department of Transportation site in constructing the Administration Building - 3rd Floor Renovations in Jackson, Hinds County, Mississippi.
- B. Time of Completion: The completion of this Work is to be on or before the time indicated on the Owner and Contractor Agreement.
- C. Contractor's Duties:
 - 1. Except as specifically noted, provide and pay for:
 - a. Labor, materials, equipment.
 - b. Tools, construction equipment, and machinery.
 - c. Other facilities and services necessary for proper execution and completion of the Work.
 - 2. Pay legally required sales, consumer, use, payroll, privilege and other taxes.
 - 3. Secure and pay for, as necessary for proper execution and completion of Work, and as applicable at time of receipt of bids:
 - a. Permits.
 - b. Government Fees.
 - c. Licenses.
 - 4. Give required notices
 - 5. Comply with codes, ordinances, rules, regulations, orders and other legal requirements of public authorities that bear on performance of Work.
 - 6. Promptly submit written notice to Project Engineer of observed variance of Contract Documents from legal requirements. Appropriate modifications to Contract Documents will adjust necessary changes. Assume responsibility for Work known to be contrary to such requirements, without notice.
 - 7. Enforce strict discipline and good order among employees. Do not employ on Work, unfit persons or persons not skilled in assigned task.
 - 8. Schedule of Values: Submit 8 copies to the MDOT Architectural Services Unit a Schedule of Values as described in Section 01 29 73 of these Specifications. This submittal will be recorded as submittal number one for this Project. When this submittal is approved, a copy will be transmitted to Construction Administration to be used to review and compare to amounts submitted on the CAD-720 form. Other copies will be kept by Architectural Services Unit and distributed to Project Engineer, MDOT Consultants, and Contractor.
 - 9. Sub-Contractor List: Submit 8 copies of a list, acceptable to the MDOT, of all subcontractors to be used on the Project within seven (7) days after written notice of Contract award by the MDOT. The list shall include the Firm's name, contact person, street address, e-mail address, telephone and fax numbers. Submit original to Contract Administration Division and one copy to the Project Engineer and to the MDOT Architect CAD-720 form - REQUEST FOR PERMISSION TO SUBCONTRACT for each subcontractor before they are allowed to perform any Work.

10. Coordination: The Contractor is responsible for the coordination of the total Project. All subcontractors will cooperate with the Contractor so as to facilitate the general progress of the Work. Each trade shall afford all other trades every reasonable opportunity for the installation of their Work. Refer to Section 01 31 00– Project Management & Coordination.

1.02 CONTRACTOR'S USE OF PREMISES

- A. Confine operations at the site to areas permitted by:
 1. Law
 2. Ordinances
 3. Permits
 4. Contract Documents
 5. Owner
- B. Do not unreasonably encumber site with materials or equipment.
- C. Do not load structure with weight that will endanger structure.
- D. Assume full responsibility for protection and safekeeping of products stored on premises.
- E. Move stored products which interfere with operations of MDOT or other Contractors.
- F. Obtain and pay for use of additional storage of work areas needed for operations.
- G. Limit use of site for work and storage to the area indicated on the Drawings.

1.03 PHASED CONSTRUCTION (Not applicable)

1.04 OWNER FURNISHED PRODUCTS (Not applicable)

1.05 ACCESS TO SITE

- A. General: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
- B. Use of Site: Limit use of Project site to work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
 1. Limits: Confine construction operations to 3rd floor and as indicated on Drawings.
 2. Driveways, Walkways and Entrances: Keep driveways parking garage, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

1.06 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Owner will occupy site and existing building during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated. Owner will vacate the 3rd floor prior to start of construction.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
 - 2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.
- B. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
 - 1. Architect will prepare a Certificate of Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.
 - 2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
 - 3. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
 - 4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.07 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7:00 a.m. to 5:00 p.m., Monday through Friday, unless otherwise indicated.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
 - 1. Notify Project Engineer not less than two days in advance of proposed utility interruptions.
 - 2. Obtain Project Engineer's written permission before proceeding with utility interruptions.
- D. Retain "Noise, Vibration, and Odors" Paragraph below for work in or near occupied facilities.

- E. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.

1. Notify Project Engineer not less than two days in advance of proposed disruptive operations.
2. Obtain Project Engineer's written permission before proceeding with disruptive operations.

- F. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet of entrances, operable windows, or outdoor-air intakes.

1.08 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Format: The Specifications are organized into Groups, Subgroups, Divisions and Sections using CSI/CSC's "MasterFormat" 2004 Edition numbering system.
- B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
 2. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 3. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- D. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 25 00

SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Section 01 33 00 "Submittal Procedures" for submittal requirements.
 - 2. Section 01 60 00 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.02 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1.03 ACTION SUBMITTALS

- A. The MDOT Architect and his Consultants WILL NOT consider requests for substitutions during bidding. ONLY ONE REQUEST per product will be allowed.
- B. Substitution Requests: Within 30 days after Notice to proceed, submit four copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use facsimile of form provided in Project Manual.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.

- j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. MDOT Architect's Action: If necessary, MDOT Architect will request additional information or documentation for evaluation within ten days of receipt of a request for substitution. MDOT Architect will notify Contractor through Project Engineer of acceptance or rejection of proposed substitution within 15 days of receipt of request, or ten days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if MDOT Architect does not issue a decision on use of a proposed substitution within time allocated.

1.04 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

PART 2 - PRODUCTS

2.01 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals. ONLY ONE REQUEST per product will be allowed.
1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied:
- a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Contractor has personally investigated proposed product or method, compared the product specified with the proposed substitution, and determined that it is equal or superior in all respects to that specified.
 - c. Cost data is complete and includes all related costs under his Contract.
 - d. Contractor waives all claims for additional costs related to substitution that consequently becomes apparent.
 - e. Requested substitution will not adversely affect Contractor's construction schedule.
 - f. Requested substitution has received necessary approvals of authorities having jurisdiction.

- g. Requested substitution is compatible with other portions of the Work.
 - h. Requested substitution has been coordinated with other portions of the Work.
 - i. Requested substitution provides specified warranty.
- B. Substitutions for Convenience: Architect will consider requests for substitution if received within 30 days after the Notice to Proceed. ONLY ONE REQUEST per product will be allowed.
- 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied:
 - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to MDOT Architect's Consultants for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 - b. Contractor has personally investigated proposed product or method, compared the product specified with the proposed substitution, and determined that it is equal or superior in all respects to that specified.
 - c. Cost data is complete and includes all related costs under his Contract.
 - d. Contractor waives all claims for additional costs related to substitution that consequently becomes apparent.
 - e. Requested substitution does not require extensive revisions to the Contract Documents.
 - f. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - g. Requested substitution will not adversely affect Contractor's construction schedule.
 - h. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - i. Requested substitution is compatible with other portions of the Work.
 - j. Requested substitution has been coordinated with other portions of the Work.
 - k. Requested substitution provides specified warranty.

PART 3 - EXECUTION

PRODUCT SUBSTITUTION REQUEST FORM

PROJECT: _____ PROJECT NO. _____

OWNER: _____

CONTRACTOR: _____

ARCHITECT: _____

CONTRACTOR'S REQUEST, WITH SUPPORTING DATA

1. Section of the Specifications to which this request applies:

☐ Product data for specified item and proposed substitution is attached (description of product, reference standards, performance and test data).

☐ Sample is attached

2. Itemized comparison of proposed substitution with product specified.

ORIGINAL PRODUCT	SUBSTITUTION
Name, brand _____	_____
Catalog No. _____	_____
Manufacturer _____	_____
Significant variations: _____	_____

Reason for Substitution:

3. Proposed change in Contract Sum:

Credit to Owner: \$ _____

Additional Cost to Owner: \$ _____

4. Effect of the proposed substitution on the Work:

Contract Time: _____

CONTRACTORS STATEMENT OF CONFORMANCE OF PROPOSED
SUBSTITUTION TO CONTRACT REQUIREMENTS

I / We have investigated the proposed substitution. I / We

1. Believe that it is equal or superior in all respects to originally specified product, except as stated in 2. above;
2. Will provide same warranty as required in Contract Documents;
3. Have included all cost data and cost implications of proposed substitution; including, if required, costs to other contractors, and redesign and special inspection costs caused by use of proposed substitution;
4. Will coordinate incorporation of proposed substitution in the Work;
5. Will modify other parts of the Work as may be needed, to make all parts of the Work complete and functioning;
6. Have verified that use of this substitution conforms to all applicable codes.
7. Waive future claims for added cost to Owner caused by proposed substitution.

CONTRACTOR _____ DATE: _____
Signature

MDOT ARCHITECT'S REVIEW AND ACTION

- ___ Accepted
- ___ Not Accepted
- ___ Provide more information in the following categories and resubmit _____
- ___ Sign Contractor's Statement of Conformance and resubmit
- ___ Proposed substitution is accepted, with the following conditions:

Change Order (Supplemental Agreements) will make the following changes:

(Add to) (Deduct from) Contract Sum: \$ _____

(Add to) (Deduct from) Contract Time: _____ days

ARCHITECT: _____ DATE _____

OWNER: _____ DATE _____

___ Accepted ___ Not accepted

END OF SECTION

SECTION 01 26 00

CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications (Supplemental Agreements) by the Project Engineer and the Contractor.

1.02 CHANGE ORDER (SUPPLEMENTAL AGREEMENT) PROCEDURES

- A. Change Proposed by the Project Engineer: The Project Engineer may issue a Proposal Request to the Contractor which includes a detailed description of a proposed change with supplementary or revised Drawings and Specifications and a change in Contract Time for executing the change. The Contractor shall prepare and submit an estimate within 10 days.
- B. Change Proposed by the Contractor: The Contractor may propose a change by submitting a request for change to the Project Engineer, describing the proposed change and its full effect on the Work, with a statement describing the reason for the change, and the effect on the Contract Sum and Contract Time with full documentation and a statement describing the effect on Work by separate or other Contractors. Document requested substitutions in accordance with Section 01 25 00 Substitution Procedures and Section 01 60 00 Product Requirements.
- C. Contractor's Documentation:
 - 1. Maintain detailed records of Work completed on a time and material basis. Provide full information required for evaluation of proposed changes, and substantiate costs of changes in the Work.
 - 2. Document each quotation for a change in cost or time with sufficient data allowing evaluation of the quotation.
 - 3. On request, provide additional data to support computations:
 - a. Quantities of products, labor, and equipment.
 - b. Taxes, insurance and bonds.
 - c. Overhead and profit.
 - d. Justification for change in Contract Time.
 - e. Credit for deletions from Contract, similarly documented.
 - 4. Support each claim for additional costs, and for work completed on a time and material basis, with additional information:
 - a. Origin and date of claim.
 - b. Dates and time work was performed and by whom.
 - c. Time records and wage rates paid.
 - d. Invoices and receipts for products, equipment, and subcontracts, similarly documented.
- D. Construction Change Directive: The Project Engineer may issue a document, approved by the Owner, instructing the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order (Supplemental Agreement). The document will describe changes in the Work, and will designate method of determining any change in the Contract Sum or Contract Time. The change in Work will be promptly executed.

- E. Format: The Project Engineer will prepare 5 originals of the Change Order (Supplemental Agreement) using the Mississippi Department of Transportation's Change Order (Supplemental Agreement) Form.
- F. Types of Change Orders (Supplemental Agreements):
 - 1. Stipulated Sum Change Orders: Based on Proposal Request and Contractor's fixed price quotation, or Contractor's request for a Change Order (Supplemental Agreement) as approved by the Project Engineer and the MDOT Architect.
 - 2. Unit Price Change Order: For pre-determined unit prices and quantities, the Change Order (Supplemental Agreement) will be executed on a fixed unit price basis. For unit costs or quantities of units of work, which are not pre-determined, execute Work under a Construction Change Directive. Changes in Contract Sum or Contract Time will be computed as specified for Time and Material Change Order (Supplemental Agreement).
 - 3. Time and Material Change Order (Supplemental Agreement): Submit itemized account and supporting data after completion of change, within time limits indicated in the Standard Form of Agreement Between the Owner and the Contractor. The Project Engineer will determine the change allowable in Contract Sum and Contract Time as provided in the Contract Documents. The Contractor shall maintain detailed records of Work accomplished on Time and Material basis and shall provide full information required for evaluation of proposed changes, and to substantiate costs for changes in the Work.
- G. Execution of Change Order (Supplemental Agreement): The Project Engineer will issue Change Orders (Supplemental Agreements) for signatures of parties as provided in the Standard Form of Agreement Between the Owner and the Contractor. Final execution of all Change Orders (Supplemental Agreements) requires approval by the Owner.
- H. Correlation of Contractor Submittals: The Contractor shall promptly revise Schedule of Values and the Application for Payment forms to record each authorized Change Order (Supplemental Agreement) as a separate line item and adjust the Contract Sum. Promptly revise progress schedules to reflect any change in Contract Time, revise sub-schedules to adjust time for other items of Work affected by the change and resubmit. Promptly enter changes in Project Record Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 29 00

PAYMENT PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
 - 1. Section 01 26 00 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 2. Section 01 32 00 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.02 SCHEDULE OF VALUES

- A. Scope: Submit electronic pdf copy of the Schedule of Values to the MDOT Architect, with a copy to the Project Engineer, at least 10 days prior to submitting first Application for Payment. Upon Project Engineer's request, support the values given with data substantiating their correctness. Payment for materials stored on site will be limited to those listed in Schedule of Unit Material Values (refer to Article 9 of the Supplementary Conditions for requirements). Use Schedule of Values only as basis for contractor's Application for Payment
- B. This copy of the Schedule of Values will be reviewed as Submittal No.1. A copy of this submittal will be reviewed by the Architect and Mechanical / Electrical Consultants. One copy will be retained by MDOT Architectural Services, one by Architect, Mechanical / Electrical Consultants, one sent to Contract Administration for use in reviewing requests for Permission to Sub-Contract (CAD-720 Form), one sent to the Project Engineer, and one returned to the Contractor.
- C. Form of Submittal: Submit typewritten Schedule of Values on AIA Document G703-1992, using Table of Contents of this Specification as basis for format for listing costs of Work for Sections under Divisions 02 - 49. Identify each line item with number and title as listed in Table of Contents of this Specification.
- D. Preparing Schedule of Values:
 - 1. Itemize separate line item costs for each of the following general cost items: Performance and Payment Bonds, field supervision and layout, temporary facilities and controls, and closeout documents.
 - 2. Itemize separate line item cost for Work required by each Section of this specification. Breakdown installed cost with overhead and profit.
 - 3. Each line item, which has installed value of more than \$20,000, break down costs to list major products for operations under each item; rounding figures to nearest dollar. Make sum of total costs of all items listed in schedule equal to total Contract Sum.

E. Preparing Schedule of Unit Material Values:

1. Submit separate schedule of unit prices for materials to be stored on which progress payments will be made. Make form of submittal parallel to Schedule of Values with each line item identified same as line item in Schedule of Values. Include in unit prices only: Cost of material, delivery and unloading site, and sales tax.
2. Make sure unit prices (if required) multiplied by quantities equal material cost of that item in Schedule of Values.

F. Review and Re-submittal: After Project Engineer / MDOT Architect's review, if requested, revise and resubmit schedule in same manner

1.03 METHOD FOR PAYMENT

- A. The method of measurement and payment shall conform to the applicable provisions of Article 9 of the AIA Document A201-2007 General Conditions of the Contract for Construction.

1.04 APPLICATIONS FOR PAYMENT

A. Format:

1. Applications for Payments will be prepared on AIA forms G702-Application and Certificate for payment and G703-Continuation Sheet; or, a computer generated form containing similar data may be used.

B. Preparation of Application:

1. Present required information in type written form.
2. Execute certification by signature of authorized officer.
3. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of Work performed and for stored products.
4. List each authorized Change Order (Supplemental Agreement) as an extension on continuation sheet, listing Change Order (Supplemental Agreement) number and dollar amount as for an original Item of Work.
5. Prepare Application for Final Payment as specified in Section 01 77 00-Closeout Procedures.

C. Submittal Procedures:

1. Submit electronic pdf copy of each Application for Payment to the Project Engineer and to the MDOT Architect.
2. Submit an updated construction schedule with each Application for Payment as described in Section 01 32 00-Construction Progress Documentation.
3. Submit request for payment at intervals agreed upon by the Project Engineer, Owner, and Contractor.
4. Submit requests to the Project Engineer at agreed upon times, or as may be directed otherwise.

D. Substantiating Data:

1. Submit data justifying dollar amounts in question when such information is needed.
2. Provide copy of the data with a cover letter for each submittal.
3. Indicate the Application number, date and line item number and description.

1.05 STATEMENTS AND PAYROLLS

- A. The submission by the Contractor of the actual weekly payrolls showing all employees, hours worked, hourly rates, overtime hours, etc., or copies thereof, is not required to be turned in. However, each Contractor and Subcontractor shall preserve weekly payroll records for a period of three years from the date of Contract completion. All Contractor personnel working at the project site will be paid unconditionally and not less often than once a week without subsequent deduction or rebate on any account, except such payroll deductions as are permitted by regulations, the full amounts of wages and bona fide fringe benefits due at time of payment.
- B. The payroll records shall contain the name, with an individually identifying number for each employee, classification, rate of pay, daily and weekly number of hours worked, itemized deductions and actual wages paid to each employee.
- C. Upon request, the Contractor will make payroll records available at the project site for inspection by the Department Compliance Officer or authorized representative and will permit such officer or representative to interview employees on the job during working hours.
- D. The Contractor and Subcontractors shall submit Form CAD-880, "Weekly Summary of Wage Rates", each week to the Project Engineer. The forms may be obtained from the Contract Compliance Officer, Contract Administration Division, Mississippi Department of Transportation, Jackson, Mississippi. Custom forms, approved by Contract Administration Division, may be used in lieu of CAD forms.
- E. The Contractor shall make all efforts necessary to submit this information to the Project Engineer in a timely manner. The Engineer will have the authority to suspend the work wholly or in part and to withhold payments because of the Contractor's failure to submit the required information. Submission of forms and payrolls shall be current through the first week of the estimate period in order for the Project Engineer to process an estimate.

1.06 BASIS OF PAYMENT

- A. This Work will be paid for by Contract Sum for the construction in District Five. The Work includes Administration Building - 3rd Floor Renovations in Jackson, Hinds County, Mississippi. The Contract Sum shall be full compensation for furnishing all materials, and all other Work and effort of whatever nature in the construction of the buildings renovations, installation of equipment, and final clean-up of the area. It shall also be complete compensation for all equipment, tools, labor, and incidentals necessary to complete the Work.

B. Payment will be made under:

1. Description A:
BWO-9021-25(010) 503251
Administration Building - 3rd Floor Renovations in
Jackson, Hinds County, Mississippi.

TOTAL PROJECT CONTRACT SUM

LUMP SUM

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 31 00

PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Scope: Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. Project Management.
 - 2. Requests for Information (RFIs).
 - 3. Project meetings.
- B. Project Coordinator: The General Contractor shall designate one individual as Project Coordinator (Superintendent), as referred to in the General Conditions. Prior to beginning Work his name, qualifications and address shall be submitted, in writing, to the MDOT Executive Director with copies to the Construction Engineer, Contract Administration Engineer, District Engineer, Project Engineer and MDOT Architect. Upon approval, he will remain until the Project is completed and cannot be removed during construction without just cause and without the written consent of the Project Engineer.
- C. Related Requirements:
 - 1. Section 01 73 00 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

1.02 DEFINITIONS

- A. RFI: Request from Project Engineer, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.03 INFORMATIONAL SUBMITTALS

- A. Key Personnel List: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site.
 - 1. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers.
 - 2. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project
- B. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Use CSI Form 1.5A. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.

1.04 DUTIES OF PROJECT COORDINATOR (SUPERINTENDENT)

- A. General: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
 - 1. Coordination: Coordinate the work of all subcontractors and material suppliers.
 - 2. Supervision: Supervise the activities of every phase of Work taking place on the project.
 - 3. Contractor's Daily Job Diary: Submit copy of daily job diary to Project Engineer and MDOT Architect each Monday for previous week.
 - 4. Electrical: Take special care to coordinate and supervise the Work of electrical and other subcontractors.
 - 5. Communication: Establish lines of authority and communication at the job site.
 - 6. Location: The Project Coordinator (Superintendent) must be present on the job site at all times while work is in progress. Superintendent shall advise Project Engineer of an intended absence from the work and designate a person to be in charge of the Work during such absence.
 - 7. Permits: Assist in obtaining building and special permits required for construction.
- B. Interpretations of Contract Documents:
 - 1. Consultation: Consult with Project Engineer to obtain interpretations.
 - 2. Assistance: Assist in resolution of questions.
 - 3. Transmissions: Transmit written interpretations to concerned parties.
- C. Cessation of Work: Stop all Work not in accordance with the requirements of the Contract Documents.
- D. Division 01: Coordinate and assist in the preparation of all requirements of Division 01 and specifically as follows:
 - 1. Enforce safety requirements.
 - 2. Schedule of Value: Assist in preparation and be knowledgeable of each entry in the Schedule of Values.
 - 3. Cutting and Patching: Supervise and control all cutting and patching of other trades work.
 - 4. Project Meetings: Schedule with Project Engineer's approval and attend all project meetings.
 - 5. Construction Schedules: Prepare and submit all construction schedules. Supervise Work to monitor compliance with schedules.
 - 6. Shop Drawings, Product Data and Samples: Administer the processing of all submittals required by the Project Manual.
 - 7. Testing: Coordinate all required testing.
 - 8. Temporary Facilities and Controls: Allocate, maintain and monitor all temporary facilities.
 - 9. Substitutions: Administer the processing of all substitutions.
 - 10. Cleaning: Direct and execute a continuing (daily) cleaning program throughout construction, requiring each trade to dispose of their debris.
 - 11. Project Closeout: Collect and present all closeout documents to the Project Engineer.
 - 12. Project Record Documents: Maintain up-to-date Project Record Documents.
- E. Changes: Recommend and assist in the preparation of requests to the Project Engineer for any changes in the Contract.

- F. Application for Payment: Assist in the preparation and be knowledgeable of each entry in the Application and Certificate for Payment.

1.05 COORDINATION AND PROJECT CONDITIONS

- A. Coordinate scheduling, submittals, and Work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- C. Coordinate space requirements, supports, and installation of Mechanical and Electrical Work that are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion and for portions of Work designated for Owner's partial occupancy, if required.
- E. After Owner occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.06 SUBCONTRACTOR'S DUTIES

- A. The Subcontractor is responsible to coordinate and supervise his employees in the Work accomplished under his part of the Contract.
- B. Schedules: Conduct Work to assure compliance with construction schedules.
- C. Suppliers: Transmit all instructions to his material suppliers.
- D. Cooperation: Cooperate with the Project Coordinator and other subcontractors.

1.07 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 - 1. MDOT Architect will return RFIs submitted to MDOT Architect by other entities controlled by Contractor with no response.
 - 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
 - 1. Project name.
 - 2. Project number.
 - 3. Date.
 - 4. Name of Contractor.
 - 5. Name of Architect

6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 14. RFI Forms: CSI Form 13.2A. Identify each page of attachments with the RFI number and sequential page number.
- C. MDOT Architect's Action: MDOT Architect will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by MDOT Architect after 1:00 p.m. will be considered as received the following working day.
1. The following RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for coordination information already indicated in the Contract Documents.
 - d. Requests for adjustments in the Contract Time or the Contract Sum.
 - e. Requests for interpretation of Architect's actions on submittals.
 - f. Incomplete RFIs or inaccurately prepared RFIs.
 2. MDOT Architect's action may include a request for additional information, in which case MDOT Architect's time for response will date from time of receipt of additional information.
 3. MDOT Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 01 26 00 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify MDOT Architect in writing within 7 days of receipt of the RFI response.
- D. On receipt of MDOT Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Contractor disagrees with response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log the first week of each month. Use CSI Log Form 13.2B. Include the following:
1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Architect.
 4. RFI number including RFIs that were dropped and not submitted.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date MDOT Architect's response was received.

- F. On receipt of MDOT Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify MDOT Architect within seven days if Contractor disagrees with response.
 - 1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 - 2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.08 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated. Project Meetings shall be held for the following reasons:
 - 1. Establish an understanding of what is expected from everyone involved.
 - 2. Enable an orderly Project review during the progress of the Work.
 - 3. Provide for systematic discussion of problems and effect remedies and clarifications.
 - 4. Coordination of the Work.
 - 5. Review installation procedures and schedules.
- B. Scheduling and Administration: The Project Engineer shall schedule and preside over all meetings throughout the progress of the Work. Duties include the following:
 - 1. Review, modify / approve minutes of the previous meeting.
 - 2. Discuss items that have been done the previous month and anticipated work to be done within the next month.
 - 3. Review Contractor's Pay Request and resolve questions or conflicts with Construction Documents.
- C. Scheduling and Administration: The Contractor shall attend and administer all meetings throughout the progress of the Work. Duties include the following:
 - 1. Preparation of agenda for meetings.
 - 2. Distribution of agenda and written notice 7 days in advance of date for each regularly scheduled meeting.
 - 3. Make physical arrangements for meetings.
 - 4. Record the minutes which shall include list of all participants and all significant proceedings and, in particular, all decisions, agreements, clarifications, and other data related to Project cost, time, and modifications.
 - 5. Distribute copies of minutes within 7 calendar days to all parties affected by decisions made at the meeting.
 - 6. Follow-up unresolved matters discussed at meetings and promptly effect final resolution, especially for work in progress. Advise all affected parties of result and include report of activities in next scheduled meeting.
- D. Scheduling and Administration: Representatives of Contractor's, Subcontractor's, and Supplier's attending the meetings shall be qualified and authorized to act on behalf of the entity each represents.
- E. Scheduling and Administration: Consultants may attend meetings to ascertain work is expedited consistent with Contract Documents and construction schedules.

- F. Preconstruction Conference: The Project Engineer, with the assistance of the MDOT Architect, will preside over and administer this meeting.
1. Schedule: Schedule Pre-Construction Meeting within 10 days after Notice to Proceed.
 2. Location: A central site, convenient for all parties, designated by the Project Engineer and the MDOT Architect.
 3. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Distribute and discuss tentative construction schedule prepared by Contractor.
 - b. Phasing.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.
 - e. Procedures for processing field decisions and Change Orders.
 - f. Procedures for RFIs.
 - g. Procedures for testing and inspecting.
 - h. Procedures for processing Applications for Payment.
 - i. Distribution of the Contract Documents.
 - j. Submittal procedures.
 - k. Preparation of record documents.
 - l. Use of the premises
 - m. Work restrictions.
 - n. Working hours.
 - o. Owner's occupancy requirements.
 - p. Responsibility for temporary facilities and controls.
 - q. Procedures for moisture and mold control.
 - r. Procedures for disruptions and shutdowns.
 - s. Construction waste management and recycling.
 - t. Parking availability.
 - u. Office, work, and material storage areas.
 - v. Equipment deliveries and priorities.
 - w. First aid.
 - x. Security.
 - y. Progress cleaning.
 4. Minutes: Record and distribute meeting minutes.
- G. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Project Engineer and MDOT Architect, and Owner's Commissioning Authority of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.

- j. Compatibility problems.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written instructions.
 - n. Warranty requirements.
 - o. Compatibility of materials.
 - p. Acceptability of substrates.
 - q. Temporary facilities and controls.
 - r. Space and access limitations.
 - s. Regulations of authorities having jurisdiction.
 - t. Testing and inspecting requirements.
 - u. Installation procedures.
 - v. Coordination with other work.
 - w. Required performance results.
 - x. Protection of adjacent work.
 - y. Protection of construction and personnel.
- 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 - 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 - 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

H. Progress Meetings:

- 1. Schedule: Progress Meetings will be scheduled monthly. The Project Engineer will cancel the meeting with at least 48 hours notice if a meeting is not necessary for any particular month.
- 2. Place of Progress Meetings: Contractor's Field Office except as otherwise agreed.
- 3. Attendance: Attending shall be the Project Engineer or his representative and MDOT representatives associated with the Project, the MDOT Architect or his representative (if requested by the District) and his Consultants, the General Contractor, and all Subcontractors as pertinent to the agenda.
- 4. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Progress cleaning.

- 10) Quality and work standards.
 - 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) Status of RFIs.
 - 14) Status of proposal requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.
 - 17) Pending claims and disputes.
 - 18) Documentation of information for payment requests.
5. Minutes: Record and distribute the meeting minutes to each party present and to parties requiring information.
- a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 32 00

CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Contractor's construction schedule.
 - 2. Construction schedule updating reports.
 - 3. Site condition reports.

1.02 SUBMITTALS

- A. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 - 1. Submit initial schedules to the Project Engineer / MDOT Architect within 15 days after date of Notice to Proceed.
 - 2. Submit to the Project Engineer / MDOT Architect, periodically updated schedules accurately depicting progress to first day of each month.
 - 3. Submit 2 copies, one to be retained by the Project Engineer and the other forwarded to the MDOT Architect.
- B. Construction Schedule Updating Reports: Submit with Applications for Payment.
- C. Site Condition Reports: Submit at time of discovery of differing conditions.

1.03 COORDINATION

- A. Coordinate Contractor's construction schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from entities involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.01 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Form of Schedules: Prepare in form of horizontal bar chart. The following is a minimum requirement and other type schedules are acceptable with Project Engineer's approval.
 - 1. Provide separate horizontal bar column for each trade or operation.
 - 2. Order: Table of Contents of Specifications.
 - a. Identify each column by major Specification section number.
 - 3. Horizontal Time Scale: Identify first work day of each week.
 - 4. Scale and Spacing: To allow space for updating.

B. Content of Schedules:

1. Provide complete sequence of construction by activity.
2. Indicate dates for beginning and completion of each stage of construction.
3. Identify Work of logically grouped activities.
4. Show projected percentage of completion for each item of Work as of first day of each month.

C. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.

D. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

1. Identification of activities that have changed.
2. Changes in early and late start dates.
3. Changes in early and late finish dates.
4. Changes in activity durations in workdays.
5. Changes in the Contract Time.

E. If the Contractor is required to produce two revised construction schedules because of lack of progress in the Work, the Owner will notify the Contractor's surety.

2.02 REPORTS

- A. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

PART 3 - EXECUTION

3.01 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

- B. Distribution: Distribute copies of approved schedule to Project Engineer, MDOT Architect, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION

SECTION 01 32 33

PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for the following:

1. Periodic construction photographs.

1.02 INFORMATIONAL SUBMITTALS

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

- B. Digital Photographs: Submit (e-mail) image files on a weekly basis.

1. Digital Camera: Minimum sensor resolution of 8 megapixels.
2. Format: Minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
3. Identification: Provide the following information with each image description in file metadata tag:
 - a. Name of Project.
 - b. Name of photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date photograph was taken.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation of construction.
 - g. Unique sequential identifier keyed to accompanying key plan.

PART 2 - PRODUCTS

2.01 PHOTOGRAPHIC MEDIA

- A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 8 megapixels, and at an image resolution of not less than 3200 by 2400 pixels.

PART 3 - EXECUTION

3.01 CONSTRUCTION PHOTOGRAPHS

- A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.

1. Maintain key plan with each set of construction photographs that identifies each photographic location.

- B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
 - 1. Date and Time: Include date and time in file name for each image.
 - 2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Project Engineer / MDOT Architect.
- C. Periodic Construction Photographs: Take photographs for each day that any substantial construction activity occurs at the job site. The number of photographs to be taken shall vary, depending on the construction activity that day. The purpose of the photographs is to document the installation of the work and verify that the work is being installed properly.
- D. Project Engineer /MDOT Architect -Directed Construction Photographs: The Project Engineer / MDOT Architect may direct the Contractor to take certain photographs during his job site observation or at any time as directed.

END OF SECTION

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Scope: Submit to the MDOT Architectural Services Unit shop drawings, product data, and samples required by Specification Sections. Faxed submittals WILL NOT be accepted. DO NOT submit Material Safety Data Sheets for approval. Refer to Section 01 25 00 – Substitution Procedures and Section 01 60 00 – Product Requirements, for requirements concerning products that will be acceptable on this Project.
- C. Related Requirements:
 - 1. Section 01 32 00 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 2. Section 01 78 23 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 3. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
 - 4. Section 01 79 00 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.02 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require MDOT Architect's responsive action.
- B. Informational Submittals: Written and graphic information and physical samples that do not require MDOT Architect's responsive action. Submittals may be rejected for not complying with requirements.

1.03 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by MDOT Architect and additional time for handling and reviewing submittals required by those corrections.
 - 1. Acceptance of submittal items will not preclude rejection of these items upon discovery of defects in them prior to final acceptance of completed Work.

1.04 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect's Digital Data Files: Electronic copies of digital data files of the Contract Drawings will not be provided by Architect for Contractor's use in preparing submittals.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. MDOT Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on MDOT Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 - 1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. MDOT Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 - 2. Partial submittals are NOT ACCEPTABLE, will be considered non-responsive, and will be returned without review.
 - 3. Resubmittal Review: Allow 15 days for review of each resubmittal.
- D. Paper Submittals: Place a permanent label or title block on each submittal item for identification. Paper Submittals are required for sheets larger than 11 by 17 inches.
 - 1. Indicate name of firm or entity that prepared each submittal on label or title block.
 - 2. Provide a space approximately 3 by 4 inches on label or beside title block to record Contractor's review and approval markings and action taken by MDOT Architect.
 - 3. Include the following information for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Name of subcontractor.
 - f. Name of supplier.
 - g. Name of manufacturer.
 - h. Submittal number or other unique identifier, including revision identifier.
 - 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
 - i. Number and title of appropriate Specification Section.
 - j. Drawing number and detail references, as appropriate.
 - k. Location(s) where product is to be installed, as appropriate.
 - l. Other necessary identification.

4. Transmittal for Paper Submittals: Accompany submittals with transmittal letter, containing data, project title and number; Contractor's name and address; the number of each Shop Drawings, product data and samples submitted; notification of deviations from Contract Documents; and other pertinent data. Submittals shall be sent to MDOT Architect for review or distribution to Consultants, with copy of Transmittal Letter sent to Project Engineer. MDOT Architect will return without review submittals received from sources other than Contractor.
 - a. Transmittal Form for Paper Submittals: Use AIA Document G810 or CSI Form 12.1A.
 - b. Transmittal Form for Paper Submittals: Provide locations on form for the following information:
 - 1) Project name.
 - 2) Date.
 - 3) Destination (To:).
 - 4) Source (From:).
 - 5) Name and address of Architect.
 - 6) Name of Contractor.
 - 7) Name of firm or entity that prepared submittal.
 - 8) Names of subcontractor, manufacturer, and supplier.
 - 9) Category and type of submittal.
 - 10) Submittal purpose and description.
 - 11) Specification Section number and title.
 - 12) Specification paragraph number or drawing designation and generic name for each of multiple items.
 - 13) Drawing number and detail references, as appropriate.
 - 14) Transmittal number, numbered consecutively.
 - 15) Submittal and transmittal distribution record.
 - 16) Remarks.
 - 17) Signature of transmitter.
 - 18) Contractor's stamp, initialed or signed, certifying the review of submittal, verification of field measurements, and compliance with Contract Documents PRIOR to submitting to the MDOT Architectural Services Unit.
- E. Electronic Submittals: Electronic pdf submittals are required for pages smaller than 11 by 17 inches. Identify and incorporate information in each electronic submittal file as follows:
 1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Re-submittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by MDOT Architect.
 4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Project Engineer and MDOT Architect, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name of Contractor.
 - e. Name of firm or entity that prepared submittal.

- f. Names of subcontractor, manufacturer, and supplier.
 - g. Category and type of submittal.
 - h. Submittal purpose and description.
 - i. Specification Section number and title.
 - j. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - k. Drawing number and detail references, as appropriate.
 - l. Location(s) where product is to be installed, as appropriate.
 - m. Related physical samples submitted directly.
 - n. Indication of full or partial submittal.
 - o. Transmittal number, numbered consecutively.
 - p. Submittal and transmittal distribution record.
 - q. Other necessary identification.
 - r. Remarks.
5. Metadata: Include the following information as keywords in the electronic submittal file metadata:
- a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- F. Options: Identify options requiring selection by MDOT Architect.
- G. Deviations: Identify deviations from the Contract Documents on submittals.
- H. Re-submittals: Make re-submittals in same form and number of copies as initial submittal.
- 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 - 3. Resubmit submittals until they are marked with approval notation from MDOT Architect's action stamp.
- I. Distribution of Submittals after Review:
- 1. Distribute copies of Shop Drawings and product data which carry MDOT Architect's / Consultant's stamp to: Project Engineer's File, Architectural Services Unit File, Architect's File (as required) / Electrical / Mechanical / Structural Engineer's File (as required), Materials' File (if concrete), Contractor's File, Job Site File, and Subcontractor, Supplier and/or Fabricator as necessary.
 - 2. Distribute samples / color charts as directed. The Project Engineer, MDOT Architect and Consultant (as required) shall retain one of each.
- J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from MDOT Architect's action stamp.
- K. After an item has been accepted, no change in brand, make, manufacturer's catalog number, or characteristics will be considered unless:
- 1. Satisfactory written evidence is presented to and approved by the Project Engineer, that manufacturer cannot make scheduled delivery of accepted item, or;
 - 2. Item delivered has been rejected and substitution of a suitable item is an urgent necessity, or;

3. Other conditions became apparent which indicates acceptance of such substitute item to be in the best interest of the Owner.

PART 2 - PRODUCTS

2.01 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements:

1. Submit electronic submittals for 8 1/2 by 11 inches and 11 by 17 inches submittals only) via email as pdf electronic files.
 - a. MDOT Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
2. Action Submittals: Submit eight paper (required for all submittals over 11 by 17 inches in size) copies of each submittal with additional number of copies, if required, by Contractor for distribution. MDOT Architect will return four copies, unless indicated otherwise.
3. Informational Submittals: Submit three paper copies or one electronic pdf copy of each submittal unless otherwise indicated. MDOT Architect will not return copies.
4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
 - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
5. Submit Product Data concurrent with Samples.
6. Submit Product Data in electronic pdf file.

- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions (required) established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 11 by 17 inches, but no larger than 24 by 36 inches.
 3. Submit Shop Drawings in the following format:
 - a. Submit eight paper copies of each submittal with additional number of copies, if required, by Contractor for distribution. MDOT Architect will return four copies, unless indicated otherwise
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Attach label on unexposed side of Samples.
 3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit two full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. MDOT Architect will return one sample with options selected.
 - b. If a specified product color is discontinued, Contractor shall notify Project Engineer promptly to determine if it affects other color selections.

5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit four sets of Samples. Project Engineer and MDOT Architect will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record sample.
- E. Field Samples and Mock-Ups: Erect on Project Site at location acceptable to Project Engineer.
1. Construct each sample or mock-up complete, including Work of all trades required in the finished Work. Field Samples are used to determine standards in materials, color, texture, workmanship, and overall appearance.
 2. Work shall not be allowed using these materials until the mock-up is approved.
 3. The mock-up shall not be destroyed, until after the Work it represents is finished, without permission of the Project Engineer. This mock-up shall be used as a standard to compare to the Work it represents for color, craftsmanship, overall appearance, and how the different materials make up the whole system.
- F. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
1. Submit product schedule in the following format:
 - a. PDF Electronic pdf file for sheets less than 11 by 17 inches.
 - b. Four paper copies (for sheets larger than 11 by 17 inches) of product schedule or list unless otherwise indicated. Architect will return two copies.
- G. Coordination Drawings Submittals: Comply with requirements specified in Section 01 31 00 "Project Management and Coordination."
- H. Contractor's Construction Schedule: Comply with requirements specified in Section 01 32 00 "Construction Progress Documentation."
- I. Application for Payment and Schedule of Values: Comply with requirements specified in Section 01 29 00 "Payment Procedures."
- J. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 01 40 00 "Quality Requirements."
- K. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 01 77 00 "Closeout Procedures."
- L. Maintenance Data: Comply with requirements specified in Section 01 78 23 "Operation and Maintenance Data."
- M. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

- N. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- O. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- P. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- Q. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- R. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- S. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- T. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- U. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.
- V. Schedule of Tests and Inspections: Comply with requirements specified in Section 01 40 00 "Quality Requirements."
- W. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- X. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- Y. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- Z. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.02 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to MDOT Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file (optional) and eight paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.01 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to MDOT Architectural Services Unit.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 01 77 00 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
- D. Notify the Project Engineer in writing at the time of submission, of deviations in submittals from requirements of Contract Documents.
- E. Contractor's responsibility for deviations in submittals from requirements of Contract Documents is not relieved by review of submittals unless written acceptance of specific deviations is given.
- F. Contractor's responsibility for errors and omissions in submittals is not relieved by MDOT Architect's / Consultant's review of submittals.
- G. Do not order materials or begin Work requiring submittals until the return of submittals bearing MDOT Architect / Consultant's stamp and initials indicating review.

3.02 MDOT ARCHITECT'S / CONSULTANTS' ACTION

- A. General: MDOT Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.

- B. Action Submittals: MDOT Architect / Consultants will review with reasonable promptness, each submittal for design concept of Project and information given in Contract Documents, make marks to indicate corrections or revisions required, and return submittals to the Architectural Services Unit, which will retain one copy and forward one copy to the Project Engineer, one copy to the Materials Engineer (if concrete), and one (or the remainder (if paper submittal) to the Contractor. MDOT Architect / Consultants will stamp each submittal with an action stamp and will mark appropriately to indicate action. Consultants will retain one copy of reviewed submittals.
- C. Informational Submittals: MDOT Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. MDOT Architect will forward each submittal to appropriate party.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION

SECTION 01 35 16

ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Project coordination and assignment of the work of all Parties and the scheduling of all elements of alterations and renovation work by procedures and methods to expedite completion of the Work for each Part.
- B. Work to be assigned, coordinated and scheduled includes, but is not limited to, the following:
 - 1. Work of each Division and Section of the Specifications as shown on the Drawings and in the Specifications
 - 2. Procedures and activities required under the provisions of this Section.

1.02 PROJECT COORDINATION

- A. Definition: Project Coordination is the process utilized to guide all participants in the Project's construction and includes assigning, scheduling, expediting, reviewing, and modifying, as appropriate, the activities required to produce the total Work to the designated quality and within the assigned time.
- B. Responsibility: Except otherwise provided by the Contract Documents, all Project Coordination shall be the entire responsibility of the Contractor. The Contractor shall set forth procedures and conditions for coordination of the Work and shall personally be responsible for the implementation of the required coordination which shall include the following:
 - 1. Communications: Establish lines of authority and communication at the Job Site.
 - 2. General Coordination: Closely coordinate all work of Project participants to effect quality construction and steady progress in all phases and aspects of the Work with a minimum of delays and interference.
 - 3. Special Coordination Give additional careful attention to the work of the following:
 - a. Mechanical / Electrical Subcontractors and be responsible for the following:
 - 1) Establishment of locations, clearances and precedence for all piping, conduit and ductwork (above ceilings).
 - 2) Submittal of Schematic Drawings giving location and clearance information for Architect / Engineer review.
 - 4. Supervision: Supervise the activities of every phase of the Work of the Project. Make frequent inspections of the Work to determine progress and quality; proceed immediately to remedy problems and to effect changes needed in the construction process and personnel.
 - 5. Interpretation of Contract Documents:
 - a. Consultation: Consult with MDOT Architect to obtain interpretations.
 - b. Assistance: Assist in resolution of questions.
 - c. Stop work not in accordance with the requirements of the Contract Documents.
 - 6. Division One: Coordinate requirements of Division One and specifically as follows:
 - a. Testing: Coordinate all required testing. Refer to Section 01 45 23.
 - b. Temporary Facilities and Controls: Allocate, maintain and monitor all temporary facilities. Refer to Section 01 50 00.

- c. Cutting and Patching: Supervise and control all cutting and patching. Refer to Section 01 73 00 - Execution.
- d. Cleaning: Direct and execute a continuing cleaning program throughout the construction, requiring each trade to dispose of their own debris, except as otherwise provided in the Contract Documents. Refer to Section 01 74 19.
- e. Project Record Documents: Maintain up-to-date project record documents. Refer to Section 01 78 39.
- 7. Enforce all safety requirements.
- 8. Maintain quality control of all work.

1.03 QUALITY CONTROL

- A. Assign all elements of the work to trades qualified to perform each type of work.
- B. Patch, repair and refinish existing work using skilled mechanics that are capable of matching existing quality of workmanship. Quality of patched or extended work shall be not less than that specified for new work.

1.04 PROJECT MEETINGS

- A. When required by Project Engineer / MDOT Architect or by individual Specification Sections, convene meetings to coordinate the Work and / or to review conditions at the Site and to outline procedures by which the Work will be performed. Refer to Section 01 31 00 – Project Management & Coordination.
- B. Require attendance by all affected Parties.

1.05 CONSTRUCTION ACCESS

- A. Access to construction area for construction materials and exit way for demolition debris shall be as directed by the Project Engineer.

1.06 PROTECTION OF WORK

- A. Protect from damage, existing finishes, equipment, adjacent work scheduled to remain, and all new work.
 - 1. Protect existing and new work from temperature extremes. Maintain interior work above 60 degrees F.
 - 2. Provide heat and humidity control as needed to prevent damage to existing work and new work.
 - 3. Provide dust partitions as needed to prevent damage to existing work and new work.

1.07 CUTTING AND PATCHING

- A. Scope: Provide the necessary cutting, fitting and patching required to complete all elements of the Work including, but not limited to, the following procedures:
 - 1. To integrate with other work, to fit properly together.
 - 2. To uncover work to provide for installation of ill-timed work.
 - 3. To remove and replace defective and / or non-conforming work.
 - 4. To remove installed material for testing.
 - 5. To provide openings for penetration of mechanical and electrical work.

- B. Preparation: Prior to commencing cutting and patching, examine existing conditions (including structure and elements subject to movement) and advise Project Engineer in writing of any condition that could be adversely affected by cutting and patching.
 - 1. Submit written request in advance of cutting or alteration that affects:
 - a. Structural integrity of any element of the Project.
 - b. Integrity of weather-exposed or moisture-resistant element.
 - c. Efficiency, maintenance, or safety of any operational element.
 - d. Visual qualities of sight exposed elements.
 - e. Work of User or separate contractor.
 - 2. Include in the request:
 - a. Identification of Project.
 - b. Location and description of affected work.
 - c. Necessity for cutting or alteration.
 - d. Description of proposed work, and products to be used.
 - e. Alternatives to cutting and patching.
 - f. Effect on work of User or separate contractor.
 - g. Written permission of affected separate contractor.
 - h. Date and time work will be executed.
- C. Procedures: Perform cutting and patching as required in Part 3-Execution of this Section.
 - 1. Proceed only when permitted and after temporary supports and other devices are in place to ensure structural integrity and to protect other portions of the Project from damage.
 - 2. Execute work by methods to avoid damage to other Work, and which will provide appropriate surfaces to receive patching and finishing.
 - 3. Cut rigid materials using masonry saw or core drill. Pneumatic tools are not allowed without prior approval from the Project Engineer.
 - 4. Restore work with new products in accordance with requirements of the Contract Documents.
 - 5. Fit work air tight to pipes, sleeves, ducts, conduits and other penetrations through surfaces.
 - 6. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material, to full thickness of the penetrated element.
 - 7. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

1.08 WORK RESTRICTIONS

- A. Project participants shall not perform any work on any Sunday or any Legal Holidays (as defined in Section 3-3-7, Mississippi Code of 1972, Annotated) except as required by emergency conditions and approved by the Project Engineer.
- B. "No Smoking" shall be observed in the work areas.

PART 2 - PRODUCTS

2.01 SALVAGED MATERIALS

- A. Coordinate with Project Engineer in identifying salvageable materials. The Owner has first right of refusal for all items.

- B. Contractor shall take proper care in removing and placement where directed in designated area on Site.
- C. Salvage sufficient quantities of cut or removed material to replace damaged work of existing construction, when material is not readily obtainable on current market.
 - 1. Items not required for use in repair of existing work to remain shall be discarded if of no value to the Owner.
 - 2. Do not incorporate salvaged or used material in new construction unless approved in writing by the Project Engineer

2.02 PRODUCTS FOR PATCHING, EXTENDING AND MATCHING

- A. Provide products or types of construction same as in existing structure, as needed to patch, extend or match existing work to make work complete and consistent to standards of quality of connected and / or similar adjacent construction. Except otherwise indicated all products shall be new.
- B. Where Contract Documents do not define products or standards of workmanship in existing construction, Contractor shall determine products by inspection and any necessary testing, and upgrade by use of the existing as a sample of comparison.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that demolition is complete and areas are ready for beginning of repairing, refinishing and new construction.

3.02 PREPARATION

- A. Cut, move, or remove existing construction as necessary for access to alterations and renovations work; repair, replace, and restore where existing affected construction is to remain a part of final completed work.

3.03 ADJUSTMENTS

- A. Where partitions are removed, patch floors, walls, and ceilings for installation of new materials.
- B. Where removal of partition(s) results in adjacent spaces becoming one space, rework floor surfaces and ceilings to provide smooth planes without breaks, steps, or bulkheads.
- C. Where extreme change of plane occurs, request instructions from MDOT Architect as to method of making transition.
- D. Where new work adversely affects existing conditions beyond work limits defined, new work shall extend to facilitate proper joining and finishing of work.

3.04 DAMAGED SURFACES

- A. Patch and replace any portion of an existing finished surface which as a result of this construction, is found to be damaged, lifted, discolored, or shows other imperfections, with matching material.
 - 1. Provide adequate support of substrate prior to matching the finish.
 - 2. Refinish patched portions of painted or coated surfaces in a manner to produce uniform color and texture over entire surface
- B. Patch and replace any portion of an existing surface to be refinished as a finished surface that is found to be damaged, lifted, discolored or show imperfections that renders surface or substrate unsuitable for application of new finish material.
 - 1. Refinish patched portion to match existing adjacent surface in order to produce a uniform color and texture.
- C. Where new or existing wall is patched or damaged, the wall surface shall be patched and refinished from base to ceiling and end to end, or nearest natural break, and shall match new work in quality.

3.05 TRANSITION FROM EXISTING TO NEW WORK

- A. When new work abuts or finishes flush with existing work, make a smooth and workmanlike transition. Patched work shall match existing adjacent work in texture and appearance.
- B. When finished surfaces are cut in such a way that a smooth transition with new work is not possible, terminate existing surface in a neat manner along a straight line at a natural line of division.

3.06 CLEANING - PERIODIC AND FINAL

- A. General Requirements:
 - 1. Maintain the Project Space, including areas used for passage of Project personnel and materials, in a neat, clean and orderly condition at all times.
 - 2. Do not allow the accumulation of scrap, debris, waste material, and other items not required for the Work.
 - 3. Provide adequate storage for all items awaiting removal from Site, observing all requirements for fire prevention and protection of the environment.
- B. Periodic Cleaning, as follows:
 - 1. Daily and more often if necessary, inspect the Project Space and pick up all scrap, debris, and waste material; remove to designated storage.
 - 2. At completion of work of each trade, clean area and make surfaces ready for work of successive trades.
 - 3. One each week, more often if necessary, remove all stored waste material and legally dispose of off the Site.
- C. Final Cleaning: Under provision of Section 01 74 19 – Construction Waste Management and Disposal.

END OF SECTION

SECTION 01 40 00

QUALITY REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
 - 2. Requirements for Contractor to provide quality-assurance and -control services required by MDOT Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
 - 3. Specific test and inspection requirements are not specified in this Section.
- C. The Contractor shall provide and pay for inspection, sampling and testing.

1.02 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Project Engineer or MDOT Architect.
- C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
 - 1. Laboratory Mockups: Full-size physical assemblies constructed at testing facility to verify performance characteristics.
- D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

- F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.03 CONFLICTING REQUIREMENTS

- A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Project Engineer for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Project Engineer for a decision before proceeding.

1.04 INFORMATIONAL SUBMITTALS

- A. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work.
- B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

1.05 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Materials will be inspected and sampled in accordance with current Mississippi Department of Transportation SOP pertaining to inspecting and sampling. Distribute copies of reports of inspections and tests to Project Engineer and one copy to the MDOT Architect. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, and telephone number of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.
 - 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 - 12. Name and signature of laboratory inspector.
 - 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Field Reports: Prepare written information documenting tests and inspections specified in other Sections. Include the following:
 - 1. Name, address, and telephone number of representative making report.
 - 2. Statement on condition of substrates and their acceptability for installation of product.
 - 3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 - 4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 - 5. Other required items indicated in individual Specification Sections.
- C. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.06 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

- D. **Installer Qualifications:** A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. **Professional Engineer Qualifications:** A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. **Specialists:** Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. **Testing Agency Qualifications:** An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329 and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. **Manufacturer's Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. **Preconstruction Testing:** Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - d. When testing is complete, remove test specimens, assemblies, and mockups do not reuse products on Project, unless indicated otherwise in other Sections.
 - 2. **Testing Agency Responsibilities:** Submit a certified written report of each test, inspection, and similar quality-assurance service to Project Engineer, MDOT Architect, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

- J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups in location and of size indicated or, if not indicated, as directed by Project Engineer.
 2. Notify Project Engineer and MDOT Architect three days in advance of dates and times when mockups will be constructed.
 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 4. Obtain Project Engineer's and MDOT Architect's approval of mockups before starting work, fabrication, or construction.
 - a. Allow ten days for initial review and each re-review of each mockup.
 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 6. Demolish and remove mockups when directed unless otherwise indicated.
- K. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Specification Sections.
- L. Tolerances:
1. Walls: Finished wall surfaces shall be plumb and shall have a maximum variation of 1/8 inch in 8 feet when a straightedge is laid on the surface in any direction, and no measurable variation in any 2-foot direction.
 2. Ceilings: Finished ceiling surfaces shall present true, level, and plane surfaces, with a maximum variation of 1/8 inch in 8 feet when a straightedge and water level are laid on the surface in any direction and no measurable variation in any 2-foot direction.
 3. Finished Floors: Level to within plus or minus 1/8 inch in 10 feet for hardwood and resilient floor coverings.
- M. Protection of Wood:
1. Provide protection of all wood materials and products, whether or not installed, including erected and installed wood framing and sheathing, from water and moisture of any kind until completion and acceptance of the project.
 2. Keep informed of weather conditions and forecasts, and when there is a likelihood of rain, shall protect installed and exposed framing and sheathing and stored lumber exposed to the elements with suitable water-repellent coverings, such as canvas tarpaulins and polyethylene sheeting.
 3. Millwork and trim, paneling, cabinets, shelving, and products manufactured from wood shall be kept under cover and dry at the shop until time for delivery. Such materials shall not be delivered to the site until the building is roofed, and exterior walls are sheathed and protected with building paper as a minimum, the doors and windows are installed and glazed, and there is ample interior storage space for such materials and products. Delivery shall not occur during periods of rain, heavy dew, or fog.
 4. Wood materials or products which become wet from rain, dew, fog, or other source may be considered to have moisture damage and may be rejected, requiring replacement by the Contractor with new, dry materials or products at no increase in the Contract Price.

- N. Grout Fill: In applications where the grout installation may be subjected to moisture, the manufacturer shall submit a letter stating that the entire grout matrix does not contain any of the following:

1. Added gypsum.
2. Plaster-of-Paris
3. Sulfur trioxide levels in a portland cement component exceeding ASTM C 150's published limits.

1.07 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.

1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
2. Notify testing agencies at least 48 hours in advance of time when Work that requires testing or inspecting will be performed.
3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

- C. Manufacturer's Field Services: Where indicated, engage a manufacturer's representative to observe and inspect the Work. Manufacturer's representative's services include examination of substrates and conditions, verification of materials, inspection of completed portions of the Work, and submittal of written reports. The manufacturer shall inspect and approve the application or installation work at no additional cost to Contractor or the Owner.

1. The Contractor shall make all necessary arrangements with the manufacturer of the products to be installed to provide onsite consultation and inspection services to assure the correct application or installation of the product, system, or assembly.
2. The manufacturer's authorized representative shall be present at the time any phase of this work is started.
3. The manufacturer's authorized representative shall inspect and approve all surfaces over which, or upon which the manufacturer's product will be applied or installed.
4. The manufacturer's representative shall make periodic visits to the site as the work proceeds as necessary for consultation and for expediting the work in the most practical manner.

- D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
 - E. Testing Agency Responsibilities: Cooperate with Project Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - 1. Notify Project Engineer, MDOT Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 - 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 - 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 - 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 - 6. Do not perform any duties of Contractor.
 - F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - 1. Access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 - 4. Facilities for storage and field curing of test samples.
 - 5. Delivery of samples to testing agencies.
 - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 - 7. Security and protection for samples and for testing and inspecting equipment at Project site.
 - G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
 - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- 1.08 SPECIAL TESTS AND INSPECTIONS
- A. Special Tests and Inspections: Engage a qualified testing agency / special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner and as follows:
 - B. Special Tests and Inspections: Conducted by a qualified testing agency / special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections and as follows:
 - 1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.

2. Notifying Project Engineer, MDOT Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Project Engineer, MDOT Architect with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
 1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Architect.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Project Engineer, MDOT Architect's reference during normal working hours.

3.02 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 00 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

SECTION 01 42 00

REFERENCES

PART 1 - GENERAL

1.01 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Reviewed": When used to convey MDOT Architect's action on Contractor's submittals, applications, and requests, "reviewed" is limited to MDOT Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Installer": An installer is Contractor or another entity engaged by Contractor, as an employee, subcontractor, or contractor of lower tier, to perform a particular construction operation, including installation, erection, application, and similar operations.
- J. "Experienced": The term "experienced," when used with the term "installer," means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with the special requirements indicated; and having complied with requirements of authorities having jurisdiction.
 - 1. Using a term such as "carpentry" does not imply that accredited or unionized individuals of a corresponding generic name, such as "carpenter", must perform certain construction activities. It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.
- K. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.02 INDUSTRY STANDARDS

A. Identification and Purpose:

1. Identification: Throughout the Contract Documents are references to nationally known and recognized Codes, Reference Standards, Reference Specifications, and similar documents that are published by Regulatory Agencies, Trade and Manufacturing Associations and Societies, Testing Agencies and others. References also include certain Project Documents or designated portions.
2. Purpose: All named and otherwise identified "Reference Standards" are "by reference" hereby incorporated into these Specifications as though fully written and hereby serve to establish specific requirements and pertinent characteristics for materials and workmanship as well as methods for testing / reporting on compliance thereto.

B. Procedures and Responsibilities:

1. Compliance with Laws and Codes of governmental agencies having jurisdiction shall be mandatory and take precedence over the requirements of all other Reference Standards. For products or workmanship specified by Associations, Trade, or Federal Standards, comply with the requirements of the standard, except when supplemented instructions indicate a more rigid standard and / or define more precise requirements.
 - a. Should specified reference standards conflict with regulatory requirements or the Contract Documents, request Project Engineer's / MDOT Architect's clarification before proceeding.
2. The Contractor (including any and all Parties furnishing and / or installing any portion of The Work) shall be familiar with the indicated codes and standards. It shall be the Contractor's responsibility to verify the detailed requirements of the specifically named codes and standards and to verify (and provide written certification, when required) that the items procured for use in this Work (and their installation, as applicable) meet or exceed the specified requirements.
3. The contractual relationship of the Parties to the Contract shall not be altered from the requirements of the Contract Documents by mention or inference otherwise in any reference document.

C. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated or when earlier editions are specifically required by Codes.

D. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.03 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

- B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

AABC	Associated Air Balance Council; www.aabc.com .
AAMA	American Architectural Manufacturers Association; www.aamanet.org .
AEIC	Association of Edison Illuminating Companies, Inc. (The); www.aeic.org .
AGA	American Gas Association; www.aga.org .
AHAM	Association of Home Appliance Manufacturers; www.aham.org .
AHRI	Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org .
AIA	American Institute of Architects (The); www.aia.org .
AISC	American Institute of Steel Construction; www.aisc.org .
AISI	American Iron and Steel Institute; www.steel.org .
AMCA	Air Movement and Control Association International, Inc.; www.amca.org .
ANSI	American National Standards Institute; www.ansi.org .
APA	APA - The Engineered Wood Association; www.apawood.org .
ARI	Air-Conditioning & Refrigeration Institute (See AHRI)
ARI	American Refrigeration Institute (See AHRI)
ASCE	American Society of Civil Engineers; www.asce.org .
ASCE/SEI	American Society of Civil Engineers / Structural Engineering Institute (See ASCE)
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org .
ASME	ASME International (American Society of Mechanical Engineers); www.asme.org .
ASSE	American Society of Sanitary Engineering; www.asse.org .
ASTM	ASTM International (American Society for Testing and Materials International); www.astm.org .
AWI	Architectural Woodwork Institute; www.awinet.org .
AWPA	American Wood Protection Association (Formerly: American Wood-Preservers' Association); www.awpa.com .
AWS	American Welding Society; www.aws.org .
BHMA	Builders Hardware Manufacturers Association; www.buildershardware.com .
CFSEI	Cold-Formed Steel Engineers Institute; www.cfsei.org .
CGA	Compressed Gas Association; www.cganet.com .
CIMA	Cellulose Insulation Manufacturers Association; www.cellulose.org .
CISCA	Ceilings & Interior Systems Construction Association; www.cisca.org .
CRI	Carpet and Rug Institute (The); www.carpet-rug.org .
CRSI	Concrete Reinforcing Steel Institute; www.crsi.org .
CSA	CSA International (Formerly: IAS - International Approval Services); www.csa-international.org
CSI	Construction Specifications Institute (The); www.csinet.org .
DASMA	Door and Access Systems Manufacturers Association; www.dasma.com .
DHI	Door and Hardware Institute; www.dhi.org .
ECA	Electronic Components Association; (See ECIA).
FM Approvals	FM Approvals LLC; www.fmglobal.com .
FM Global	FM Global (Formerly: FMG - FM Global); www.fmglobal.com .
GA	Gypsum Association; www.gypsum.org .
GANA	Glass Association of North America; www.glasswebsite.com .
HMMA	Hollow Metal Manufacturers Association (See NAAMM)
HPVA	Hardwood Plywood & Veneer Association; www.hpva.org .
ICBO	International Conference of Building Officials (See ICC)
ICC	International Code Council; www.iccsafe.org .
IES	Illuminating Engineering Society (Formerly: Illuminating Engineering Society of North America); www.ies.org .

IGMA	Insulating Glass Manufacturers Alliance; www.igmaonline.org .
IGSHPA	International Ground Source Heat Pump Association; www.igshpa.okstate.edu .
ISO	International Organization for Standardization; www.iso.org .
ISSFA	International Solid Surface Fabricators Association (See ISFA)
MCA	Metal Construction Association; www.metalconstruction.org .
MFMA	Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org .
MMPA	Moulding & Millwork Producers Association (Formerly: Wood Moulding & Millwork Producers Association); www.wmmpa.com .
MPI	Master Painters Institute; www.paintinfo.com .
NAIMA	North American Insulation Manufacturers Association; www.naima.org .
NCMA	National Concrete Masonry Association; www.ncma.org .
NEBB	National Environmental Balancing Bureau; www.nebb.org .
NECA	National Electrical Contractors Association; www.necanet.org .
NEMA	National Electrical Manufacturers Association; www.nema.org .
NETA	InterNational Electrical Testing Association; www.netaworld.org .
NFPA	NFPA (National Fire Protection Association); www.nfpa.org .
NFRC	National Fenestration Rating Council; www.nfrc.org .
NLGA	National Lumber Grades Authority; www.nlga.org .
NSPE	National Society of Professional Engineers; www.nspe.org .
PDI	Plumbing & Drainage Institute; www.pdionline.org .
RFCI	Resilient Floor Covering Institute; www.rfci.com
SDI	Steel Door Institute; www.steeldoor.org .
SEFA	Scientific Equipment and Furniture Association; www.sefalabs.com .
SEI/ASCE	Structural Engineering Institute/American Society of Civil Engineers (See ASCE)
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org .
SPFA	Spray Polyurethane Foam Alliance; www.sprayfoam.org .
SPIB	Southern Pine Inspection Bureau; www.spib.org .
SSPC	SSPC: The Society for Protective Coatings; www.sspc.org .
SWPA	Submersible Wastewater Pump Association; www.swpa.org .
TIA	Telecommunications Industry Association (Formerly: TIA/EIA – Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org .
UL	Underwriters Laboratories Inc.; http://www.ul.com .
WCMA	Window Covering Manufacturers Association; www.wcmanet.org .
WDMA	Window & Door Manufacturers Association; www.wdma.com .
WWPA	Western Wood Products Association; www.wwpa.org .

- C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

DIN	Deutsches Institut für Normung e.V.; www.din.de .
IAPMO	International Association of Plumbing and Mechanical Officials; www.iapmo.org .
ICC	International Code Council; www.iccsafe.org .
ICC-ES	ICC Evaluation Service, LLC; www.icc-es.org .

- D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

CPSC	Consumer Product Safety Commission; www.cpsc.gov .
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DOC	Department of Commerce National Institute of Standards and Technology; www.nist.gov .
DOE	Department of Energy; www.energy.gov .
EPA	Environmental Protection Agency; www.epa.gov .
FG	Federal Government Publications; www.gpo.gov/fdsys .
GSA	General Services Administration; www.gsa.gov .
LBL	Lawrence Berkeley National Laboratory Environmental Energy Technologies Division; www.eetd.lbl.gov .
OSHA	Occupational Safety & Health Administration; www.osha.gov . Rural Utilities Service; www.usda.gov .
USPS	United States Postal Service; www.usps.com .

- E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list.

CFR	Code of Federal Regulations; ; Available from Government Printing Office; www.gpo.gov/fdsys .
DOD	Department of Defense; Military Specifications and Standards Available from Department of Defense Single Stock Point; www.quicksearch.dla.mil .
FED-STD	Federal Standard (See FS)
FS	Federal Specification; Available from DLA Document Services; www.quicksearch.dla.mil . Available from Defense Standardization Program; www.dsp.dla.mil Available from General Services Administration; www.gsa.gov . Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org/ccb .
MILSPEC	Military Specification and Standards (See DOD)
USAB	United States Access Board; www.access-board.gov .
USATBCB	U.S. Architectural & Transportation Barriers Compliance Board (See USAB)

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 45 23

TESTING AND INSPECTION SERVICES - CONTRACTOR

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Laboratory selection and payment.
2. Laboratory duties.
3. Contractor's responsibilities.

B. Related Requirements:

1. Individual specifications sections contain specific tests and inspections to be preformed.

1.02 REFERENCES

A. ASTM International (ASTM):

1. D3666 - Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials.
2. E329 - Standard Specification for Agencies Engaged in Construction Inspection and / or Testing.
3. E543 - Standard Specification for Agencies Performing Nondestructive Testing.

1.03 QUALITY ASSURANCE

A. Employment of Testing Laboratory shall in no way relieve Contractor of his obligations to perform work in accordance with Contract Documents.

B. Contractor shall employ and pay for services of an independent testing laboratory to perform specified testing and inspection.

C. Refer to the Conditions of the Contract for provisions related to special inspections and testing.

D. Qualifications of Laboratory:

1. Meet requirements of ASTM D3666, E329, and E543.
2. Authorized to operate in State of Mississippi

1.04 LABORATORY DUTIES

A. Cooperate with Project Engineer, Architect and Contractor; provide qualified personnel after due notice.

B. Perform specified inspections, sampling, and testing of materials and methods of construction.

1. Comply with specified standards.
2. Ascertain compliance or noncompliance of materials with requirements of Contract Documents.

- C. Promptly notify Project Engineer, MDOT Architect, Architect and Contractor of observed irregularities or deficiencies of Work or products.
 - D. Promptly submit written report of each test and inspection; submit electronically in Adobe PDF format to Project Engineer, Architect, MDOT Architect and Contractor.
 - E. Each report to include:
 - 1. Date issued.
 - 2. Project title and number.
 - 3. Testing Laboratory name, address, and telephone number.
 - 4. Name of Inspector and signature of individual in charge.
 - 5. Date and time of sampling or inspection.
 - 6. Record of temperature and weather conditions.
 - 7. Date of test.
 - 8. Identification of product and specification section.
 - 9. Location of sample or test in project.
 - 10. Type of inspection or test.
 - 11. Results of tests and compliance or noncompliance with Contract Documents.
 - 12. Interpretation of test results when requested by Project Engineer, MDOT Architect, Architect or Contractor.
 - F. Perform additional tests when required by Project Engineer, MDOT Architect, Architect or Contractor.
 - G. Laboratory is not authorized to:
 - 1. Release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Approve or accept any portion of work.
 - 3. Perform duties of Contractor.
- 1.05 CONTRACTOR'S RESPONSIBILITIES
- A. Cooperate with Laboratory personnel, provide access to Work, and to manufacturer's operations.
 - B. When materials require testing prior to being incorporated into Work, secure and deliver to Laboratory adequate quantities of representative samples of materials proposed to be used.
 - C. Furnish copies of product test reports as required.
 - D. Furnish incidental labor and facilities:
 - 1. To provide access to work to be tested.
 - 2. To obtain and handle samples at site or at source of product to be tested.
 - 3. To facilitate inspections and tests.
 - 4. For safe storage and curing of test samples.
 - E. Notify Laboratory sufficiently in advance of operations to allow for Laboratory assignment of personnel and scheduling of tests.

- F. Make arrangements with Laboratory and pay for additional samples and tests required for Contractor's convenience.
- G. When tests or inspections cannot be performed after such notice, reimburse Owner for Laboratory personnel and travel expenses incurred due to Contractor's negligence.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section 01 10 00 "Summary" for work restrictions and limitations on utility interruptions.

1.02 USE CHARGES

- A. General: Installation and removal of temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Project Engineer, occupants of Project, testing agencies, and authorities having jurisdiction.
- B. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- C. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.03 INFORMATIONAL SUBMITTALS

- A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- B. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire prevention program.

1.04 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.

1.05 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts, with 1-5/8-inch-OD top and bottom rails. Provide concrete bases for supporting posts.

2.02 TEMPORARY FACILITIES

- A. Field Offices: The Contractor is not required to furnish a field office, but shall provide at the job site duplicates of all correspondence, shop drawings, plans, specifications, samples, etc. required to administer the Project. These duplicates will be permanently kept as reference and shall not be used in the field. Contractor shall provide the Project Engineer and the MDOT Architect with job site and emergency telephone numbers.
- B. Storage and Fabrication Sheds: It shall be the Contractor's option to provide watertight storage facilities for storage of cement, lime, and / or other materials subject to water damage. If storage facilities are used, it shall be of sufficient size to hold all materials required for logically grouped activities on the site at one time, and shall have floors raised at least 6 inches above the ground on heavy joists or sleepers. Fully enclosed trailer is allowed, but location must be coordinated with Project Engineer.

2.03 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
 - 3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 01 77 00 "Closeout Procedures".

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 - 1. Locate facilities to limit site disturbance as specified in Section 01 10 00 "Summary."
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.
- C. Powder Actuated Tools: The use of powder actuated tools shall be prohibited from use during all phases of the construction, unless explicitly approved in writing, prior to construction, by the Project Engineer.

3.02 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Completion, restore these facilities to condition existing before initial use.
- C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Toilets: Use of Owner's 3rd floor existing toilet facilities may be permitted, if acceptable with the Project Engineer, and as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Final Completion, restore these facilities to condition existing before initial use.
- D. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- E. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
- F. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

- G. Telephone Service: Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

3.03 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
 - 1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
 - 2. Maintain support facilities until Project Engineer schedules Final Completion inspection. Remove before Final Completion. Personnel remaining after Final Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Traffic Controls: Comply with requirements of authorities having jurisdiction.
 - 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
 - 3. The drive is to remain open at all times. A flagman will be required to control traffic when construction vehicles are present.
- C. Parking: Use designated areas of Owner's existing parking areas for construction personnel.
- D. Project Signs: Unauthorized signs are not permitted.
- E. Waste Disposal Facilities: Comply with requirements specified in Section 01 74 19 "Construction Waste Management and Disposal."
- F. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
 - 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- G. Existing Elevator Use: Use of Owner's existing elevators will not be permitted.
- H. Existing Stair Usage: Use of Owner's existing stairs will not be permitted.

3.04 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, or pollution or other undesirable effects.
- C. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Final Completion. Perform control operations lawfully, using environmentally safe materials.

- D. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.
- E. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- F. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- G. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.
- H. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Use existing fire protection equipment where applicable. Comply with NFPA 241; manage fire prevention program.
 - 1. Prohibit smoking in construction areas.
 - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 - 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

3.05 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Burning of Trash: No burning of trash or debris shall be done on Owner's property. All such materials shall be removed from the site and disposed of in accordance with local laws and ordinances.
- C. Maintenance: Maintain facilities in good operating condition until removal.
 - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- D. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Date of Completion.
- E. Conduct of workers: Workmen, who, because of improper conduct or persistent violation of Owner's requirements, become objectionable, shall be removed at the Owner's request. Inform all workmen of Owner's requirements.

- F. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Final Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
1. Materials and facilities that constitute temporary facilities are property of Contractor.
 2. At Final Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00 "Closeout Procedures."

END OF SECTION

SECTION 01 60 00

PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements: Section 01 25 00 "Substitution Procedures" for requests for substitutions.

1.02 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.03 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. MDOT Architect's Action: If necessary, MDOT Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. MDOT Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or ten days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: As specified in Section 01 33 00 "Submittal Procedures."
 - b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 "Submittal Procedures." Show compliance with requirements.

1.04 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

- B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

- C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.

1.06 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 - 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 - 3. Refer to other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 01 77 00 "Closeout Procedures."

PART 2 - PRODUCTS

2.01 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 - 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 - 4. Where products are accompanied by the term "as selected," MDOT Architect will make selection.
 - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. Product Selection Procedures:
 - 1. Products specified only by reference standards, select any product meeting standards by any manufacturer.
 - 2. Products specified by naming several (minimum of three) products or manufacturers, select any product and manufacturer named. Contractor must submit request, as required for substitution, for any product not specifically named and GIVE REASONS for not using product specified. Substitutions WILL NOT be granted unless reasons are considered justified.
 - 3. Products specified by naming one or more products, but indicating the option of selecting equivalent products by stating "or approved equal" after specified product, Contractor must submit request, as required for substitution, for any product not specifically named.
 - 4. Products specified by naming only one product and manufacturer, an equivalent product will always be accepted if it is equal in all respects (size, shape, texture, color, etc.). The Contractor must submit a request for substitution as set forth in this section.
 - 5. Products specified by naming only one product and manufacturer and stating no substitutions will be accepted, there is no option and no substitutions will be allowed.

- C. Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
 - 1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 01 25 00 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.02 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
 - 1. Evidence that the proposed product does not require revisions to the Contract Documents; that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 - 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 - 3. Evidence that proposed product provides specified warranty.
 - 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 - 5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 73 00

EXECUTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Progress cleaning.
6. Starting and adjusting.
7. Protection of installed construction.
8. Correction of the Work.

- B. Related Requirements:

1. Section 01 10 00 "Summary" for limits on use of Project site.
2. Section 01 77 00 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.
3. Section 07 84 00 "Firestopping" for patching penetrations in fire-rated construction.

1.02 INFORMATIONAL SUBMITTALS

- A. Certificates: Submit certificate signed by land surveyor or professional engineer certifying that location and elevation of improvements comply with requirements.
- B. Certified Surveys: Submit three copies signed by land surveyor or professional engineer.

1.03 QUALITY ASSURANCE

- A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
1. Structural Elements: When cutting and patching structural elements, notify Project Engineer of locations and details of cutting and await directions from Project Engineer before proceeding. Shore, brace, and support structural element during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
 2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in MDOT Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to MDOT Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 2. Examine walls, and floors for suitable conditions where products and systems are to be installed.
 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Existing Utility Information: Furnish information to local utility and the Project Engineer that is necessary to adjust, move, or relocate existing utility structures, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Project Engineer / MDOT Architect according to requirements in Section 01 31 00 "Project Management and Coordination."

3.03 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Final Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Project Engineer. Mounting heights shall comply with ADA and OSHA requirements.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.
- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.04 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Adjacent Occupied Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
- G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of other foreign matter after cutting.
 - 5. Proceed with patching after construction operations requiring cutting are complete.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
 - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 - 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.05 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Final Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Date of Completion.

- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.06 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00 "Quality Requirements"

3.07 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Date of Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION

SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Recycling nonhazardous demolition and construction waste.
 - 2. Disposing of nonhazardous demolition and construction waste.
- B. Related Requirements:
 - 1. Section 02 41 19 "Selective Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and improvements.

1.02 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

1.03 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 15 days of date established for the Notice to Proceed.

1.04 INFORMATIONAL SUBMITTALS

- A. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them.

1.05 QUALITY ASSURANCE

- A. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination."

1.06 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
 - 1. Distribute waste management plan to everyone concerned within five days of submittal return.
 - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Designate and label specific areas on Project site necessary for separating materials that are to be recycled.
 - 2. Comply with Section 01 50 00 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.02 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor
- C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
 - 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 3. Stockpile materials away from construction area. Do not store within drip line of trees.
 - 4. Store components off the ground and protect from the weather.
 - 5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.

3.03 RECYCLING DEMOLITION WASTE

- A. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- B. Metals: Separate metals by type.
 - 1. Structural Steel: Stack members according to size, type of member, and length.
 - 2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
- D. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
- E. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.
- F. Carpet: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
 - 1. Store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
- G. Carpet Tile: Remove debris, trash, and adhesive.
 - 1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
- H. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
- I. Conduit: Reduce conduit to straight lengths and store by type and size.

3.04 RECYCLING CONSTRUCTION WASTE

- A. Packaging:
 - 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 - 2. Polystyrene Packaging: Separate and bag materials.
 - 3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
 - 4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
- B. Wood Materials:
 - 1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
 - 2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

3.05 DISPOSAL OF WASTE

A. General: Except for items or materials to be recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Remove waste materials from Owner's property and legally dispose of them.

END OF SECTION

SECTION 01 77 00

CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Final completion procedures.
 - 2. Warranties.
 - 3. Final cleaning.
 - 4. Repair of the Work.
- B. Related Requirements:
 - 1. Section 01 32 33 "Photographic Documentation" for submitting final completion construction photographic documentation.
 - 2. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 3. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
 - 4. Section 01 79 00 "Demonstration and Training" for requirements for instructing Owner's personnel.

1.02 FINAL INSPECTIONS

- A. Engineer and Architect's Inspection: The Contractor shall make written request for a Final Inspection to the Project Engineer and MDOT Architect. Notice is to be given 10 calendar days prior to this inspection. At the day of inspection, the Contractor shall have in hand 6 copies of the HVAC Test and Balance Report, Reference Specification Sections in Division 23 and 6 copies of a list prepared by the Contractor of deficiencies, which will be edited by the Project Engineer, MDOT Architect and Consultants. A copy of these composite lists will be given to the Contractor for correcting the Work. Within 15 calendar days after this revised list is received, the Contractor shall make all corrections of the items listed. If, in the Project Engineer and MDOT Architect's judgment, the Project is not ready for an Inspection, the Project Engineer may schedule another inspection.
- B. Owner's Inspection: After the Project Engineer and MDOT Architect have determined the Project to be Complete and all punch list items have been corrected, an Owner's Inspection will be scheduled. The Contractor shall submit a letter that states all items have been corrected and submit required closeout Documents. The Owners may add to the punch list items; if it is determined that corrective work still needs to be done. Within 15 calendar days after this revised list is received, the Contractor shall make all corrections of the items listed.
- C. Correction of Work before Final Payment: Contractor shall promptly remove from the Owner's premises, all materials condemned for failure to conform to the Contract, whether incorporated in Work or not, and Contractor shall, at his own expense, replace such condemned materials with those conforming to the requirements of the Contract. Failure to remedy such defects after 10 days written notice will allow the Owner to make good such defects and such costs shall be deducted from the balance due the Contractor or charged to the Contractor in the event no payment is due.

- D. Should additional inspections by the MDOT Architect's Consultants of the Work be required due to failure of the Contractor to remedy defects listed, the Project Engineer may deduct the expense of additional Consultants inspections from the Contract Sum in the Owner / Contractor Agreement. The additional expense will be based on the rate shown for services in the Consultants' Architect or Engineering Services Contract.

1.03 FINAL ACCEPTANCE

- A. The Mississippi Department of Transportation does not recognize the term "Substantial Completion". The Project Engineer shall determine when the building is complete to the point it can be used for its intended purpose and occupied. This date shall be the Date of Completion.
- B. Final Payment shall not be made until items covered in Closeout Procedures are satisfied. This date shall be the Date of Final Acceptance.

1.04 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: All Warranties and Extended Warranties shall use this Date of Completion as the starting date of Warranty Period.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
 4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
- C. Provide additional copies of each warranty to include in operation and maintenance manuals.

1.05 CLOSEOUT DOCUMENTS

- A. Unless otherwise notified, the Contractor shall submit to the Owner through the Project Engineer to the MDOT Architect 2 copies the following before final payment is made:
 1. Request for Final Payment: AIA Document G702, current edition, completed in full or a computer generated form having similar data.
 2. Contractor's Affidavit of Payment of Debts and Claims: AIA Document G706, current edition, completed in full.
 3. Release of Liens and Certification that all Bills Have Been Paid: AIA Document G706A, current edition, completed in full or a sworn statement and affidavit from the Contractor to the Owner stating that all bills for this project have been paid and that the Owner is released from any and all claims and / or damages.
 4. Consent of Surety Company to Final Payment: AIA Document G707, current edition, completed in full by the Bonding Company.
 5. Power of Attorney: Closeout Documents should be accompanied by an appropriate Power of Attorney.

6. Guarantee of Work: Sworn statement that all Work is asbestos free and guaranteed against defects in materials and workmanship for one year from Date of Completion, except where specified for longer periods.
 - a. Word the guaranty as follows: "We hereby guarantee all Work performed by us on the above captioned Project to be free from asbestos and defective materials. We also guarantee workmanship for a period of one (1) year or such longer period of time as may be called for in the Contract Documents for such portions of the Work".
 - b. All guarantees and warranties shall be obtained in the Owner's name.
 - c. Within the guaranty period, if repairs or changes are requested in connection with guaranteed Work which, in the opinion of the Owner, is rendered necessary as a result of the use of materials, equipment, or workmanship which are inferior, defective, or not in accordance with the terms of the Contract, the Contractor shall promptly, upon receipt of notice from and without expense to the Owner, place in satisfactory condition in every particular, all such guaranteed Work, correct all defects wherein and make good all damages to the building, site, equipment or contents thereof which, in the opinion of the Owner, is the result of the use of materials, equipment, or workmanship which are inferior, defective or not in accordance with the terms of the Contract; and make good any Work or materials or the equipment and contents of said buildings or site disturbed in fulfilling any such guaranty.
 - d. If, after notice, the Contractor fails to proceed promptly to comply with the terms of the guaranty, the Owner may have the defects corrected and the Contractor and his sureties shall be liable for all expense incurred.
 - e. All special guaranties applicable to definite parts of the Work stipulated in the Project Manual or other papers forming part of the Contract shall be subject to the terms of this paragraph during the first year of the life of such special guaranty.
7. Project Record Documents: Furnish all other record documents as set forth in Section 01 78 39 - Project Record Documents.
 - a. Provide all certificates, warranties, guarantees, bonds, or documents as called for in the individual Sections of the Project Manual. The Contractor is responsible for examining the Project Manual for these requirements.
8. Additional Documents Specified Within the Project Manual:
 - a. General Provide all Operational and Maintenance documents as called for in the individual Sections of the Project Manual. The Contractor is responsible for examining the Project Manual for these requirements.
 - b. Maintenance Stock: Deliver to Owner all required additional maintenance materials as required in the various Sections of the Specifications.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.01 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting Engineer and Architect final inspection.
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - d. Remove snow and ice to provide safe access to building.
 - e. Clean exposed interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Restore reflective surfaces to their original condition.
 - f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - g. Sweep concrete floors broom clean in unoccupied spaces.
 - h. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - i. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - j. Remove labels that are not permanent.
 - k. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - l. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - m. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - n. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
 - o. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 01 50 00 "Temporary Facilities and Controls." Prepare written report.

3.02 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting Final Inspection.

- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
 4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective fixtures to comply with requirements for new fixtures.

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory.
 - 2. Emergency manuals.
 - 3. Operation manuals for systems, subsystems, and equipment.
 - 4. Product maintenance manuals.
 - 5. Systems and equipment maintenance manuals.

1.02 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. MDOT Architect will comment on whether content of operations and maintenance submittals are acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:
 - 1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to MDOT Architect.
 - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.
 - 2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. MDOT Architect will return one copy.
- C. Manual Submittal: Submit each manual in final form prior to requesting Final Inspection and at least 15 days before commencing demonstration and training. MDOT Architect will return one copy with comments.
 - 1. Correct or revise each manual to comply with MDOT Architect's comments. Submit two copies of each corrected manual within 15 days of receipt of MDOT Architect's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.01 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information.
- B. 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:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- C. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name and address of Owner.
 - 4. Date of submittal.
 - 5. Name and contact information for Contractor.
 - 6. Name and contact information for Architect.
 - 7. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 - 8. Cross-reference to related systems in other operation and maintenance manuals.
- D. 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. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- E. 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.
- F. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

G. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number(s) on bottom of spine. Indicate volume number for multiple-volume sets.
2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.02 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.
- 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.

2.03 OPERATION MANUALS

- 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. Use designations for systems and equipment indicated on Contract Documents.
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. Precautions against improper use.
10. License requirements including inspection and renewal dates.

- B. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
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.
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 or 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.

2.04 PRODUCT MAINTENANCE MANUALS

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, 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, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and 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. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds. Include procedures to follow and required notifications for warranty claims.

2.05 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment 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, and cross-reference Specification Section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard 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. Demonstration and training video recording, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. Schedule Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturers' 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 manufacturers' 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 warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

PART 3 - EXECUTION

3.01 MANUAL PREPARATION

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

- D. Manufacturers' Data: Where manuals contain manufacturers' 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 include 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.
- E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of operation and maintenance manuals.
 - 2. Comply with requirements of newly prepared Record Drawings in Division 01 Section 01 78 39 "Project Record Documents."
- F. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION

SECTION 01 78 39

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings.
 - 2. Record Project Manual (Proposal)
 - 3. Record Product Data.
- B. Related Requirements:
 - 1. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.02 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit copies of record Drawings as follows:
 - a. Submittal:
 - 1) Submit PDF electronic files of scanned record prints and two set(s) of marked-up record prints.
 - 2) Print each drawing, whether or not changes and additional information were recorded.
- B. Record Project Manual (Proposal): Submit two paper copies and one annotated PDF electronic files of Project Manual (Proposal), including addenda and contract modifications.
- C. Record Product Data: Submit two paper copies and one annotated PDF electronic files and directories of each submittal.

PART 2 - PRODUCTS

2.01 RECORD DRAWINGS

- A. Record Prints: Maintain two sets of marked-up paper copies of the Contract Drawings (half-size) and Shop Drawings, incorporating new and revised Drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Record data as soon as possible after obtaining it.
 - c. Record and check the markup before enclosing concealed installations.

2. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 4. Note Construction Change Directive numbers, alternate numbers, Change Order (Supplemental Agreements) numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Final Completion review marked-up record prints with Project Engineer and MDOT Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Annotated PDF electronic file.
 2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 3. Refer instances of uncertainty to Project Engineer and MDOT Architect for resolution.
- C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Consulting Architect (if applicable).
 - e. Name of Contractor.
- 2.02 RECORD PROJECT MANUAL (PROPOSAL)

- A. Preparation: Mark Project Manual (Proposal) to indicate the actual product installation where installation varies from that indicated in the Technical Specifications, addenda, and contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 4. Note related Change Orders (Supplemental Agreements), record Product Data, and record Drawings where applicable.
- B. Format: Submit record Project Manual (Proposal) as scanned PDF electronic file(s) of marked-up paper copy of Project Manual (Proposal).

2.03 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 - 3. Note related Change Orders (Supplemental Agreements), record Specifications, and record Drawings where applicable.
- B. Format: Submit record Product Data as scanned PDF electronic file(s) of marked-up paper copy of Product Data.

PART 3 - EXECUTION

3.01 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Project Engineer's and MDOT Architect's reference during normal working hours.
- C. The information, except Contract Drawings, shall be arranged and labeled by corresponding Specification Section, neatly bound in three ring binders, indexed, and all shop drawings readable without being removed or unstapled.
- D. The name and address of each subcontractor and material supplier shall be listed in front of each binder along with the Project Manual (Proposal).
- E. Sufficient information, such as as-built control drawings for air handling system and variable drive controls, shall be furnished to allow qualified personnel to service equipment.

END OF SECTION

SECTION 01 79 00

DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Demonstration and training video recordings.

1.02 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

1.03 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
 - 1. At completion of training, submit complete training manual(s) for Owner's use prepared and bound in format matching operation and maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 01 40 00 "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Preconstruction Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to demonstration and training.

1.05 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

- B. 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

2.01 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project record documents.
 - e. Identification systems.
 - f. Warranties and bonds.
 - g. Maintenance service agreements and similar continuing commitments.
 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.

- l. Required sequences for electric or electronic systems.
- m. Special operating instructions and procedures.
- 5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
- 6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
- 7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
- 8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 01 78 23 "Operation and Maintenance Data."

3.02 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare 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. 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 Project Engineer, with at least seven days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.

3.03 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. 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.
- B. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Project Engineer and MDOT Architect.
- C. Narration: Describe scenes on video recording by dubbing audio narration off-site after video recording is recorded. Include description of items being viewed.
- D. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

END OF SECTION

SECTION 01 91 00

GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Commissioning requirements common to all Sections.
- B. Systems and equipment 'Start-Up' and 'Functional Performance Testing'.
- C. Validation of proper and thorough installation of systems and equipment.
- D. Equipment performance verification.
- E. Documentation of tests, procedures, and installations.
- F. Coordination and requirements of 'Training Events'.
- G. Preparation and logistics of Systems Manual content.
- H. Management of record construction documentation.

1.2 GENERAL DESCRIPTION

- A. Commissioning (Cx) is the process of ensuring that (i) all building systems are installed and perform interactively according to the design intent; (ii) that systems are efficient and cost effective and meet the Owner's operational needs; (iii) that the installation is accurately documented; and (iv) that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.
- B. Commissioning Authority (CA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.
- C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.
- D. This Section and other sections of the specification details the Contractor's responsibilities relative to the Cx process. It expands on the Cx Plan, which covers the roles and responsibilities of Parties outside of the construction contract.

1.3 SCOPE

- A. This Section covers elements, requirements, procedures, and protocols common across all Divisions of the work. Requirements specific to individual Sections are generally specified in the technical specification as well as a dedicated Section for each of Divisions 22, 23 and 26.
- B. Specific systems to be commissioned are indicated in the following Divisions of the Specification:
 - 1. Divisions 02–12, 14: Conformance to the following provisions of the Cx requirements is required under Division 01 and this Section:
 - a. Equipment and Systems Training as required by individual Sections.
 - b. Systems Manual preparation and maintenance.
 - c. Record Document preparation and maintenance.
 - 2. Division 22 – Plumbing: Requirements for Cx are specified in Section 220800 as well as in individual Division 22 Sections.
 - 3. Division 23 - HVAC: Requirements for Cx are specified in Section 230800 as well as in individual Division 23 Sections.
 - 4. Division 23 – BAS: Requirements for Cx are specified in Section 230810 as well as in individual Division 23 Sections.
 - 5. Division 26 – Electrical: Requirements for Cx are specified in Section 260800 as well as in individual Division 26 Sections.

1.4 RELATED WORK AND DOCUMENTS

- A. Commissioning Plan: The Cx Plan outlines responsibilities outside of the construction contract and shall be available to all Parties for reference. It gives the Contractor a perspective with respect to the overall process. It encompasses the entire Cx process including design phase and post construction tasks.
- B. The Cx process references many related Sections, particularly Section 019100 - General Commissioning Requirements. It is important for all Contractors subject to the Cx process to be familiar with Section 019100.
- C. Section 019113.13 – General Commissioning Requirements for Functional Performance Testing.
- D. Section 220800 – Plumbing System Commissioning.
- E. Section 230810 – BAS Commissioning.
- F. Section 260800 – Electrical Systems Commissioning.
- G. Individual Specification Sections: Individual Sections stipulate installation, start-up, warranty, O&M documentation, and training requirements for the system or device specified in the Section.

1.5 DEFINITIONS AND ABBREVIATIONS

- A. Acceptance Phase: This is the phase of the project when the facility and its systems and equipment are inspected, tested, verified, and documented; and when most of the Functional Performance Testing and final training occurs. This will generally occur after the Construction Phase is complete (after Start-Up Documentation have been completed). The Acceptance Phase begins upon System 'Turn-Over' with certification by the Contractor that the systems have been placed into service in accordance with the approved protocols and after the submission of the

approved Start-Up Documentation. The Acceptance Phase ends with the successful completion of all Functional Performance Testing and sign-off by the CA.

- B. Action Item (AI): Any Cx-related issue that requires a response, completion, corrective or additional work, or any other action. Examples include a Request for Information (RFI), a work directive, a clarification request, a to-do item, an identified deficiency, or any other like item. Action Items must be categorized as appropriate.
- C. Action List: This is a list that is maintained and updated by the CA that includes all Action Items that relate to Cx activities.
- D. Activation: The process of relocating the occupants; fitting out the furniture, furnishings, and equipment (FF&E); and generally ensuring a smooth occupant transition.
- E. A/E: General reference to the Architect/Engineer lead-design entity.
- F. ASHRAE: American Society of Heating, Refrigerating, and Air Conditioning Engineers.
- G. Basis of Design (BOD) Document: The Basis of Design document is developed by the design team, and shall respond to and be consistent with the performance criteria specified in the OWNER's Project Requirements. The BOD illustrates the means by which the OPR criteria are to be achieved, documenting the assumptions and parameters used in the design, and documenting the primary thought processes or decisions made that resulted in the selected alternatives. At the end of the project, the final BOD content may be incorporated into the Systems Manual if desired in part or in its entirety. The BOD is a required component for LEED-certified projects, and is recommended by ASHRAE for all projects subject to the Cx process.
- H. Building Automation System (BAS): The computer-based control or automation system. BAS is used throughout these Sections. Alternate references common in the industry include facility management system, automatic temperature control system, direct digital control system, building management system, building management and control system, digital control system, Energy Management System, Energy Management and Control System or System Control and Data Acquisition (SCADA) System.
- I. Building Automation System Sub-System: This is a special case of the BAS definition presented earlier. These systems are representative of all control systems that must integrate with or be connected to the primary BAS infrastructure in the project. Division 23 covers all requirements for BAS Sub-Systems requirements in relation to the BAS. These sub-systems may be defined in many Sections.
- J. Checklist Item: An item to inspect to verify proper installation of equipment or systems by the Contractor. Checklist items simply require a 'Yes/No' or 'OK/Not' response. Start-Up Checklist items are one component of the Start-Up Documentation.
- K. Commissioning (Cx): The process of ensuring that all building systems perform interactively according to the design intent, that the systems are efficient and cost effective, and that they meet the OWNER's operational needs.
- L. Commissioning Authority (CA): The Party retained by the OWNER who will oversee and manage the Cx process, develop and stipulate many of the Cx requirements, and ensure and validate that systems and equipment are designed, installed and tested to meet the OWNER's requirements.
- M. Commissioning Coordinator (CxC): This refers to the Individual within each of the various Parties that is designated the POC for that Party relative to Cx activities. Each of the Contractors subject

to the Cx process should designate a CxC and make that person available to the CA as the point-of-contact for that Contractor.

- N. Cx Record Matrix: The Cx Record Matrix provides an ongoing and updated status of the Cx program as it is being executed. It is a table of all systems and equipment subject to the Cx process and the status and responsible party of Cx procedures relating to that equipment. Typical fields tracked include equipment tag, location, description, Start-Up Documentation status, FPT status, training status, status of submittals and record drawings, and final Cx disposition.
- O. Commissioning Specifications: Generic reference to any of the Cx-specific specification Sections, as inferred by the usage. Divisions 01, 22, 23, 26, and others contain Sections that are specific to or reference the Cx process. All Contractor requirements relating to Cx should be conveyed within the Cx Specs. Cx Specs should be referenced but not duplicated within the Cx Plan (the Cx Plan is designed to govern non-Contractor-related Cx issues).
- P. Commissioning Team (CxT): The group of Parties involved in the Cx process for any given system. The Cx Team will include a core group involved with all systems, consisting of the CA and CxC members representing the GC and the OWNER. On any given system, the Cx Team will additionally include the CxC's for the Contractors responsible for the system or equipment.
- Q. Contractor: As used herein, 'Contractor' is a general reference to the installing Party or the Parties that hired installing Parties and can therefore refer to the GC, subcontractors, or vendors as inferred by its usage.
- R. Construction Phase: Phase of the project during which the facility is constructed and/or when systems and equipment are installed and started. Contractor and subcontractors complete the installation, complete Start-Up Documentation, submit O&M information, establish trends, and perform any other applicable requirements to make systems operational. Contractor and Vendors may also conduct 'Equipment and Systems Training' events during this phase. The Construction Phase concludes upon completed Start-Up and TAB of systems and equipment.
- S. Contract Documents: The documents governing the responsibilities and relationships between Parties involved in the design and construction of this project including (but not necessarily limited to):
 - 1. Agreements/Contracts.
 - 2. Construction Plans and Drawings.
 - 3. Specifications.
 - 4. Addenda.
 - 5. Change Orders.
 - 6. Commissioning Plan (for reference only).
- T. Construction Documents: Refers generally to the Contract Documents that dictate the details of the installation (all but item 1. above).
- U. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents, does not perform properly or is not complying with the design intent.
- V. Design Engineer: Generic reference to the engineer-of-record or a specific engineering discipline as inferred by its usage.
- W. Design Intent Document (DID): Outdated term that is synonymous with OWNER's Project Requirements (see below).

- X. Electrical Contractor (EC): Contractor generally responsible for Division 26 work.
- Y. Factory-Authorized Representative: An individual fully trained on the equipment and certified by the manufacturer to perform the respective task.
- Z. Factory Testing: Testing of equipment off-site at the manufacturer's facility. May be witnessed by the members of the project team.
- AA. FF&E: Furniture, Furnishing, and Equipment. This term is used to refer to the generally movable fit-out elements of a building that are not included in the construction contract but are dealt with in the Activation.
- BB. Fire Alarm Contractor (FAC): Contractor generally responsible for the fire alarm system installation.
- CC. Fire Suppression Contractor (FSC): Contractor generally responsible for the installation of the fire suppression system (sprinkler, standpipe, and fire pump).
- DD. Fixed Construction: Elements of the building that are built in. This term is typically used in contrast to FF&E.
- EE. Functional Completion: A Cx program milestone that marks the successful completion of the FPTs by the CA and therefore completion of the Acceptance Phase. Functional Completion is a prerequisite for Substantial Completion.
- FF. Functional Performance Tests/Testing (FPT): The detailed and thorough tests (and test procedure) developed and performed by the CA to document proper operation of building systems and the components and equipment making up those systems during the Acceptance Phase. References made to FPT throughout the documents are inclusive of ISFPT unless specifically indicated otherwise.
- GG. General Contractor (GC): The prime contractor hired to execute the construction project. Generally, this contractor would hold the contracts for the majority of sub-contractors on the project.
- HH. Manufacturer's Representative: Either an individual in direct employ of the manufacturer of the applicable system, or an individual who is certified by that manufacturer to perform the applicable work for which the reference is made. This is synonymous with Factory-Authorized Representative.
- II. Mechanical Contractor (MC): Contractor generally responsible for Division 21-23 work.
- JJ. O&M Documentation: Contractor-developed documentation designed to address the needs of facilities personnel and customized for the context of the specific facility and installation. The foundation of O&M Documentation is manufacturer's literature (O&M Manuals), with additional Contractor-developed step-by-step instructions for manual start/stop, emergency procedures, operating sequences, preventative maintenance, and other installation-specific information. O&M Documentation content is indexed/organized by equipment-type. When a Systems Manual is being developed by the CA, some of the Contractor-developed content will need to be made available to the CA for inclusion into the Systems Manual.
- KK. O&M Manuals: Generic reference to manufacturer-published O&M materials, which have no information specific to the facility, but may be edited or marked up to indicate specific equipment or systems installed. O&M Manuals include documents covering installation, operation, maintenance, troubleshooting guides, parts numbers, engineering and design parameters,

applications manuals, and any/all information available from the manufacturer pertaining to the installed equipment or systems. Specifications should strive for this information to be submitted in electronic form whenever possible. The electronic versions of these documents can also be electronically edited to indicate equipment installed and to delete or mask-over equipment and content that is not installed on the project.

- LL. Observation Period (BAS): Period of time either prior to or immediately following Functional Performance Testing where the BAS is shown to operate properly 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.
- MM. Opposite Season: The season opposite that when the majority of the functional performance testing occurs.
- NN. OWNER (OWNER): Party acting as the OWNER's designated representative for the project. The OWNER is responsible for managing the entire project and to act as the OWNER in all design and construction-related issues. Generally, the OWNER will include multiple personnel such as the Project Manager, Field Manager, and MEP Project Engineer.
- OO. OWNER's Project Requirements (OPR): The OPR is intended to provide the basis from which all design, construction, acceptance, and operational decisions are made. It details the functional requirements of the project, including systems subject to commissioning. The OPR defines the benchmarks and metrics by which the success of the project is ultimately judged, and evolves through each project Phase. The OPR is typically developed early in the project cycle by the OWNER and the A/E and provides the user needs, requirements, goals, and metrics that are defined by the OWNER to be important. The OPR criteria are referenced by and should be the foundation of the BOD narrative. At the end of the project, the content of final OPR and BOD may be incorporated into the Systems Manual. The OPR and BOD are a required component for LEED-certified projects, and is recommended for all projects subject to the Cx process.
- PP. Party: Entity (company, corporation, etc.) legally responsible for portion of work.
- QQ. Point-of-Contact (POC): General reference to a key individual within each Party.
- RR. Prefunctional: The term "Prefunctional" is synonymous with "Start-Up", but not used in these specifications. It is a modifier for checks, tests, and other activities that occur prior to and are prerequisites for Functional Performance Testing.
- SS. Preliminary Service: Refers to initial operation of a system or piece of equipment to provide temporary service where initial Start-Up to determine safe operation has been performed. Final TAB and Functional Performance Testing proceeds while the system is in Preliminary Service.
- TT. Pre-Test: Preliminary testing accomplished to verify system functionality prior to placing the system/equipment into Preliminary Service.
- UU. Project Phases: Phases of the project include the Construction Phase, Acceptance Phase, Warranty Phase. Earlier Phases include Program Phase and Design Phase.
- VV. RFI: Request for Information.
- WW. Scheduled Outage: A period of time, scheduled by OWNER, in which the system is out-of- service or not to be used by occupants.
- XX. Security System Contractor (SSC): Contractor responsible for the installation of the Security Systems.

- YY. **Start-Up:** Refers to the quality control procedures whereby the Contractor verifies the proper installation of a device or piece of equipment, executes the manufacturer's starting procedures, completes the 'Start-Up Checklist', energizes the device, verifies that it is in proper working order and ready for dynamic testing, and completes the 'Start-Up Tests'. Start-Up procedures are performed by the Contractor with or without a formal Cx process, although the documentation is more formalized when the Cx process is used.
- ZZ. **Start-Up Checklist:** A list of items to inspect to verify proper installation of equipment or systems by the Contractor. Checklist items simply require a 'Yes/No' or 'OK/Not' response. These include primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension checked, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). Start-Up Checklist items are one component of the Start-Up Documentation (Start-Up Tests being the other).
- AAA. **Start-Up Documentation:** Refers to the combination of Start-Up Checklists + Start-Up Tests. The Contractor documents the Start-Up procedure by completing and submitting the Start-Up Documentation. Start-Up Documentation may be a combination of procedures prepared by the Contractor and/or the CA, those included in the Contractors in-house quality assurance process, and those required by the manufacturer start-up procedures. Regardless of the context of the checklist or format of the form used to document it, the reference to 'Start-Up Documentation' includes all of the stated checklists and tests.
- BBB. **Start-Up Test:** This is a quality-assurance test that is required to ensure the system is ready to be placed into service. It differs from a checklist item in that it requires more than a binary (yes/no, OK/Not OK) response. It is an observation, measurement, or sequence of events that must be documented. Start-Up Tests are one component of the Start-Up Documentation (Start-Up Checklists being the other).
- CCC. **Substantial Completion:** Milestone as defined in the OWNER-Contractor agreement and Specifications. This milestone also coincides with the start of the Warranty Period.
- DDD. **System Turn-Over Meeting ("STOM"):** Turn-Over is a quality control milestone in which all Contractors responsible for completing the installation and start-up of a system or equipment, along with the OWNER and GC, meet to validate that the system or equipment is completed and operational per the contract documents and ready for Functional Performance Testing, and that all the Start-Up Documentation and nameplate data is complete and accurate. The CA will in many cases participate in this. GC shall organize and lead the process in all cases.
- EEE. **Systems Manual:** The Systems Manual is the final deliverable from the Cx process, and provides the information needed to understand, operate, and maintain the facility and its systems. It is typically developed by the CA or A/E, but with content required to be provided by the design team and the Contractors. The Systems Manual expands the scope of standard O&M documentation to incorporate additional information developed through the Cx process. The Systems Manual should be the repository of all updates and corrections as they occur (even throughout Occupancy). It is narrative in nature and organized by system types and by area/usage of the facility (if applicable). Systems Manual content typically includes narrative descriptions of the facility and systems, sequences of operation, schematic diagrams, cuts from design drawings and equipment literature, photos, and manual start/stop and emergency operating procedures for important equipment. The content of the Systems Manual is dictated by budget, and usually consists of a single narrative document with references to and inclusive of the entire set of O&M and Training materials.
- FFF. **Systems Matrix:** A table that lists systems and equipment as individual rows (typically using the specifications sections as a guide) and columns that indicate different tasks, documentation, and work elements. The content of the cells of the matrix summarizes the requirement for system as

it relates to that column. It provides an effective summary of requirements that is approved by the OWNER and operator representatives during design phase.

- GGG. Test: A task, procedure or measurement that confirms capacity, functionality, accuracy, etc. Tests can have only 1 state at any given time; "Pass", "Fail", "Couldn't Test" or "Didn't Test". May refer to Start-Up or Functional Performance Tests.
- HHH. TAB: Can refer to the test, adjust, and balance process or the Testing, Adjusting, and Balancing Contractor as inferred by its usage.
- III. Temporary Conditioning Plan: A plan that summarizes the logistics, procedures and protocols for taking permanent equipment and using it to maintain conditions throughout construction. The Temporary Conditioning Plan must be approved by all members of the Cx Team prior to placing equipment into temporary service.
- JJJ. Testing Agency: An independent agency typically retained by the Contractor to perform specialized testing of systems or equipment (most commonly electrical). The Testing Agency shall be qualified and equipped to perform the testing and shall submit appropriate qualifications.
- KKK. Trending: Monitoring and recording a history of parameters typically using the building automation system.
- LLL. Vendor: Refers to the organization that sold a system or equipment to the subcontractor. This may be a branch office of the manufacturer or a value-added reseller.
- MMM. Warranty Period: The period defined by the construction documents where elements of the facility are under contractual warranty.
- NNN. Warranty Phase: Includes the early occupancy of the building and can continue through the contractual Warranty Period and at least into the opposite season from when the facility systems were initially tested.

1.6 REFERENCE STANDARDS

- A. ASHRAE Standard 202 – Commissioning Process for Buildings and Systems.
- B. ASHRAE Guideline 0 – The Commissioning Process.
- C. ASHRAE Guideline 1.1 – HVAC&R Technical Requirements for the Commissioning Process.
- D. ASHRAE Guideline 1.3 – Building Operations and Maintenance Training for the HVAC&R Commissioning Process.
- E. ASHRAE Guideline 1.4 – Procedures for Preparing Facility Systems Manual.
- F. NEBB – Procedural Standards for Building Systems Commissioning.
- G. SMACNA IAQ Guidelines for Occupied Buildings Under Construction.

1.7 DOCUMENTATION

- A. Contractor shall provide the following documentation to the CA per the procedures specified herein and in other Sections of the specification.

1. Shop Drawings and Product Data: CA shall be provided shop drawings and submittal data for systems and equipment that will be part of the Cx process. Some of these submittals will be reviewed by the CA and others are only needed for record. CA will mark up the Submittal Register to indicate the documents required. Electronic format shall be in PDF format and shall be capable of allowing electronic comments and markups.
 - a. Submittals to be Reviewed: GC shall provide the CA one electronic copy of Shop Drawings and Product Data concurrent with distribution to the A/E. CA shall review and incorporate comments via the A/E. GC shall then copy CA with the final reviewed submittal with A/E approval stamp.
 - b. Submittals for Record: GC shall provide to the CA the final electronic record copy of the submittal.
 2. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase.
 3. Schedule Updates: Issue periodic updates to the construction schedule as specified. Provide electronic copy of each update to the CA. Contractor shall use schedule updates to notify Cx Team of scheduled start-up and training activities.
 4. Temporary Operating and Conditioning Plan: Contractor shall provide initial Temporary Operating and Conditioning Plan for approval and then issue periodic updates to reflect actual conditions. At the completion of the temporary conditioning period, the final plan shall be submitted with completed maintenance records, inspection and check logs, operating logs, and narrative of any problems or issues that occurred during Temporary Conditioning (if applicable).
 5. Piping Cleaning, Flush, and Fill Plan: Contractor shall provide Piping Cleaning, Flush, and Fill Plan for approval at least 30 days prior to final cleaning, flush, and fill.
 6. Action Item Response: Respond to Action Items to which the CA assigns responsibility to the Contractor.
 7. Field Testing Agency Reports. Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase.
 8. Completed Start-Up Documentation: Provide completed Start-Up Documentation for all applicable equipment and systems. Provide prior to the start of the Acceptance Phase. CA will review prior to FPT.
 9. Nameplate Data Documentation: Provide prior to the start of the Acceptance Phase.
 10. Equipment Warranties: Provide prior to the start of the Acceptance Phase.
 11. Training Plan: Provide prior to the start of the Acceptance Phase.
 12. Record Training Documentation: Provide at least 7 days prior to the start of the applicable training session. The compiled and final record training documentation will be provided by the GC within 14 days of the last training session provided under the construction contract (this will typically be the site-specific controls training). This will take the form of the Training Plan supplemented with evaluations and actual dates and topics.
 13. O&M Documentation Content: Provide O&M Documentation content (including installation-specific instructions) to the CA for incorporation into the Systems Manual per the requirements of this Section, and Division 01 requirements. Submit at least one month prior to the beginning of the Acceptance Phase.
- B. Record Drawings: Contractor shall maintain an updated set of record or 'As-Built' documents at the jobsite and electronically reflecting actual installed conditions and all approved changes and modifications to the contract documents. Contractor shall provide access to the CA to review the As-Built and Record Drawings. Provide Record Drawings in accordance with Division 01.

1.8 COMMISSIONING SEQUENCING AND SCHEDULING

- A. Refer to the sequencing illustration at the end of this Section for a conceptual graphical representation of the precedents related to the Cx tasks. These precedents are generally to be applied per system and/or per area. Where applicable, in order to expedite the closeout of the facility, various systems can be in various stages of the Cx process. CA and Contractor shall cooperate to schedule the Cx tasks to minimize the duration of the Cx activities.
- B. The Cx process will be categorized into Phases as indicated below and defined under the definitions paragraph above. Note that per schedule, different systems and/or areas may be in different phases at any given time given that the Cx program will be integrated into the construction process:
 - 1. Construction Phase.
 - 2. Acceptance Phase.
 - 3. Endurance Phase.
 - 4. Warranty Phase.
- C. CA will provide a more detailed Cx tasking precedent diagram in Gantt chart format for direction of Cx precedents and approximate task durations.
- D. Prior to submission of the baseline schedule, the scheduler will coordinate with the CA to specifically include the detailed tasks involved in the Cx process. CA will provide an initial "Precedent Diagram" that outlines the optimal Cx process. Scheduler shall meet with the CA and the subcontractors to synthesize the Precedent Diagram with the general construction process constraints and integrate the agreed upon process into the main construction schedule. Commissioning-related tasks shall be coded as such to facilitate generating a Cx fragnet that will be used during Cx progress meetings.
- E. The Cx precedent schedule will outline generic Cx tasks with precedents or prerequisites to each task. These tasks, which will be shown generically for typical systems, will apply to many systems. Contractor shall incorporate the tasks into EACH SYSTEM. This will require a detailed track for each system and as such the scheduler must schedule and code by system as well as by area. The Cx precedent diagram will also indicate system precedent requirements for start-up and Functional Performance Testing. Contractor shall collaborate with the CA to determine impacts of project phasing as applicable. Examples of enumerated tasks include:
 - 1. Contractor preparation of draft Start-Up Documentation.
 - 2. Contractor preparation of Training Plan.
 - 3. Preparation of O&M Documentation content and other content for the Systems Manual.
 - 4. Testing Agency activities.
 - 5. Electrical Start-Up by system and zone group.
 - 6. Mechanical Start-Up by system and zone group.
 - 7. BAS Start-Up by system and zone group.
 - 8. TAB by system and zone group.
 - 9. Training Events.
 - 10. Functional Performance Testing by system and zone group.
- F. Contractor shall completely install; thoroughly inspect; start-up; and test, adjust, and balance systems and equipment. All activities shall be documented per specified procedures and progress tracked on the construction schedule.
- G. Contractor shall notify CA at least 14 days in advance for all system and equipment Start-Ups, training, pressure tests, or system flush and fill. At their discretion, the CA shall witness selected

Start-Ups, training events, or tests. Notification shall be accompanied by a schedule showing the coordinated start date and task duration and all currently open precedent requirements.

- H. GC shall schedule and conduct System Turn-Over Meetings for all systems and equipment in the Cx scope as specified below. GC shall notify CA, A/E, and OWNER in writing that systems are complete and ready for verification and Functional Performance Testing.
- I. Notification of utility or system outages affecting current mission shall require advance notification per applicable Division 01 section.
- J. Connections to or Interruptions of Existing Systems: Where the project entails connection to or interruption of existing functional systems that are supporting the OWNER's mission, such connection activities must be shown as a milestone on the project schedule. Generally, these connections will require extensive coordination and a long period of pre-notification. OWNER will not accept these connections unless the connection or outage is shown as a milestone 3 months prior to the event. The schedule will not be required to pinpoint the day and time 3 months in advance, however, it shall have been accurate to +/- 2 weeks. The actual notification of the exact day and time shall be processed per applicable Division 01 section.

1.9 SYSTEM TURN OVER MEETINGS ('STOM' OR 'TURN-OVER')

- A. GC shall schedule and conduct System Turn-Over Meetings ('Turn-Over') for all systems and equipment. Turn-Over is a quality control milestone in which all Contractors responsible for completing the installation and start-up of a system or equipment, along with the OWNER and GC, meet to validate that the system or equipment is completed and operational per the contract documents and ready for Functional Performance Testing, and that all the Start-Up Documentation and nameplate data has been completed and is accurate. The CA will in many cases participate in this. GC shall organize and lead the process in all cases.
- B. Notification shall be given of all System Turn-Over Meetings to the CA and the OWNER via an Action Item posted on the Portal at least 14 days in advance of the activity. CA and OWNER may elect to witness the Turn-Over, although it is not required. Primary responsibility of confirmation of the represented state of the equipment lies with the GC.

1.10 ELECGRONIC RECORD SUBMITTALS

- A. Contractor shall submit a final electronic version of the submittal for OWNER's future asset management within 14 calendar days after receipt of approval from the OWNER and the Architect on any submittal for equipment in Divisions 22, 23, and 26.
- B. Final Electronic Record Submittals shall:
 - 1. Be originally authored in electronic media and not scanned versions with hand mark-ups unless specifically approved otherwise.
 - 2. Be provided in Portable Document Format (*.pdf) with selectable text and graphics that are readable. The documents shall be merged into one bookmarked document up to 500 MB. Merged documents shall use hierarchical bookmarks to form a table of contents and provide hyperlinks to the subject topic. Submittals larger than 500 MB, provide a summary document in PDF or HTML format with relative hyperlinks to the associated document files within the same directory or in directories subordinate to the summary document.
 - 3. Include all final ratings, parameters, specifications, options, etc. In the case where the Architect returns the submittal "Approved-As-Noted, Resubmission-Not-Required" and includes mark-ups or comments that change the originally submitted ratings, parameters,

- specifications, options, etc., the Contractor shall correct the documents in the original electronic document prior to submitting the final electronic documents.
4. Highlight the specific rating, parameter, specification, option, etc. when the original document includes multiple alternatives. For instance, when a range of performance parameters are given or various sizes are shown, or various options are listed, the applicable item shall be indicated by highlight, circle, pointer, or other electronic marking. Partial-page material in the submittal that does not pertain to the project can be masked with a transparent gray screen over the text; entire pages that are not applicable may be electronically deleted.
 5. Do not include generalized direction from the Architect that does not relate to ordering and purchasing the equipment. For instance, notes such as "Coordinate with mechanical engineer for final motor horsepower" are not to be transferred to the electronic submittal. In that example, only the final coordinated sizes shall be indicated.
- C. Final Electronic Record Submittals shall be either posted to the project web site or provided on compact disc.

1.11 MANAGEMENT PROTOCOL COORDINATION

- A. Coordination responsibilities and management protocols relative to Cx are initially defined below but will be refined and documented in the Construction Phase Cx Kick Off meeting. Contractor shall have input in the protocols and all Parties will commit to process and scheduling obligations. The CA will record and distribute.
1. Submittals and Shop Drawings: Owner or A/E shall distribute these to the CA. CA shall edit the project's submittal log to communicate which submittals must be forwarded to CA.
 2. CA Review Comments on Shop Drawings: Comments shall be included in Cx issues log and a copy sent directly to the A/E and Owner by the CA. A/E shall consider and incorporate at their discretion.
 3. Deficiencies Identified by the CA: When the CA identifies a deficiency, CA shall make a good faith assessment of responsible parties. Those parties, as well as Owner and/or A/E shall be notified of the perceived deficiency. This communication is FOR INFORMATION ONLY and is not a directive to any party to resolve the deficiency. Contractor may accept responsibility and resolve the deficiency voluntarily. If Contractor contests either the deficiency or responsibility for that deficiency, Contractor shall respond to that deficiency indicating disagreement. If responsibility is not agreed to via the Cx dialogue, Owner shall issue a work directive or RFI via the normal contractual channels to resolve the issue.
 4. Requests for Meetings: Request by the Contractor for a meeting with the CA shall be routed through the Owner and/or A/E who will then determine the validity. Note that every attempt should be made to deal with Cx issues at regularly scheduled Cx Meetings.
 5. Control Sequence Modifications: CA shall make every attempt to thoroughly review the sequences during the submittal phase and address any issues prior to the submittal approval. However, CA and the BAC may incorporate minor changes to the sequence during testing when it is apparent that it improves the control of the equipment but does not fundamentally change the sequence. The time required by the BAC for this type of modification is addressed in Section 230800. Any and all changes must be thoroughly documented in the record documents.
 6. Scheduling Coordination: CA shall consult directly with the Owner and/or A/E to incorporate the Cx tasks in the project schedule. The process logic and integration shall ultimately be a collaboration between GC, CA, and subcontractors. The effort will start with CA and GC proposing initial logic. Then subcontractors will join the discussion and work out the final details, (precedent logic and durations).
 7. Notification of Completion Milestones: Contractor shall notify Owner and/or A/E at least two weeks prior to an anticipated Cx activity or milestone (such as Turn-Over). Owner and/or A/E shall then coordinate the scheduling of the activity (as applicable) between all required

- parties as applicable. Notification shall be posted using the Portal (events module) with an associated Action Item distributed to interested parties.
8. Action List: CA maintains a categorized Action List which tracks the Cx-related action items. All content of the Action List will be available to all parties who have credentials on the Portal. Any party with credentials may post an Action Item. Any party that is copied on an email resulting from an Action Item posting may respond to it and contribute to the dialogue.
 9. Start-Up Checklist and Test Documents: CA will provide initial 'generic' Start-Up Documents to the Contractor. The Contractor shall synthesize these with the manufacturer-specific start-up procedures and submit both to the CA for review and approval. The Contractor has the option of modifying the supplied generic procedures in the delivered format, or by supplementing these with their own procedures. The Contractor then executes, signs, and submits the final reviewed and approved Start-Up Documentation. The CA subsequently (and optionally) spot-checks the procedures and documentation at the 'System Turn-Over Meeting'. The Start-Up Documentation is then included in the Commissioning Record.
 10. Functional Performance Test Documents: Functional Performance Tests are prepared and completed by the CA. They are developed during the construction phase, after BAS submittals have been submitted and approved. CA forwards the FPT procedures to the GC to be subsequently distributed to the Contractors for review. Contractors approve the procedures. Throughout the Cx process, CA maintains a current record of the FPTs and their results and keeps the documentation up to date and accessible for all to access the current progress. CA distributes hard copies of the FPTs at the completion of any significant stage of commissioning.

1.12 CONTRACTOR RESPONSIBILITIES

- A. Construction Phase: The following delineates the commissioning-related responsibilities of the Contractor (and their subcontractors) during the Construction Phase.
 1. Include Cx requirements in price and plan for work.
 2. Designate a Commissioning Coordinator (Cx) from each major subcontractor with activities related to commissioning. These Commissioning Coordinators are to be the primary contacts for Cx activities.
 3. Attend Construction Phase Cx Kick Off Meeting. The Cx and Project Manager from each major subcontractor shall attend.
 4. The Cxs shall attend all Cx progress meetings unless otherwise agreed to by the CA.
 5. Remedy any deficiencies identified throughout construction.
 6. TAB shall submit sample balancing forms for approval prior to starting work.
 7. Schedule and coordinate Cx efforts into the construction schedule. Incorporate the precedent diagram provided by the CA into the construction schedule. Indicate at a minimum all tasks enumerated on the precedent diagram for all systems.
 8. Coordinate the work of subcontractors, vendors, manufacturers, and Testing Agencies provided with the bid, and ensure that they are informed of and are adhering to the requirements of the Cx process specified throughout the contract documents.
 9. Contractor-Developed Documentation: Contractor shall develop and submit the following information as specified:
 - a. Draft Start-Up Documentation (submit along with the manufacturer's application, installation and start-up procedures).
 - b. O&M Documentation content as specified.
 - c. Systems Manual content as specified.
 - d. Training Plan, and materials and documentation of training.
 - e. Temporary Operating and Conditioning Plan content as specified.
 - f. Piping Cleaning, Flush, and Fill Plan, content as specified.

- g. Comprehensive integrated procedures for scheduling and task notification and documenting them in a common format.
10. Provide assistance to the CA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.
 11. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.
 12. Start-up, test, adjust, and balance systems and equipment prior to verification and Functional Performance Testing by the CA. Start-Up Documentation shall be in accordance with Contract Documents, reference or industry standards, and specifically individual Cx specifications. Provide skilled technicians qualified to do the work required. Provide factory trained/authorized technicians where required by the contract documents and stated in the applicable technical section. Start-Up and Functional Performance Testing shall proceed from device checkout, to component checkout, to system checkout, to inter-system checkout.
 13. Prepare spaces with adequate security for on-site contractors to store equipment. Provide secure space with 120 volt AC power for the CA, TAB, and BAC to base their operations and store test equipment, drawings, files, and the like.
 14. Schedule for any required representative space mock-ups as early as possible to facilitate determining standards for closeout.
 15. Record Start-Up procedures on approved Start-Up Documentation and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above. Each task or item shall be indicated with the party actually performing the task or procedure.
 16. Provide skilled technicians qualified to perform the work required.
 17. Provide factory-trained and authorized technicians where required by the Contract Documents.
 18. Tag equipment that is started with the Individual's name and date.
 19. Demonstrate the operation of all systems as specified.
 20. Certify that systems have been installed and are operating per Contract Documents prior to Functional Performance Testing.
 21. Maintain an updated set of Record Documentation as required by the Contract Documents.
 22. Copy the CA on indicated documentation.
 23. Conduct and document Equipment and Systems Training events as required by this Section and by applicable sections of the Specifications pertaining to each piece of equipment or system.
- B. Acceptance Phase: The following delineates the Cx-related responsibilities of the Contractor (and their subcontractors) during the Acceptance Phase.
1. Assist CA in Functional Performance Testing. Assistance will typically include the following:
 - a. Manipulate systems and equipment to facilitate Functional Performance Testing (as specified in Section 019113.13 and the Cx Plan; in some cases this will entail only an initial sample).
 - b. Provide any specialized instrumentation necessary for Functional Performance Testing.
 2. Correct any work not in accordance with Contract Documents.
 3. Participate in Training Events relative to use of O&M information and the preventative maintenance program.

4. Maintain record documentation, and update and resubmit it when Acceptance Phase is completed.
5. Compensate CA for additional site time incurred due to incompleteness of systems or equipment at time of Functional Performance Testing.
6. Monitor systems, equipment and areas throughout the Endurance Period. Log and diagnose all alarms during this period. Maintain trends and logs of all critical parameters. Forward the logs and trends on a weekly basis throughout all Endurance Periods.

C. Warranty Phase: The following delineates the Cx-related responsibilities of the Contractor (and their subcontractors) during the Warranty Phase.

1. Provide warranty service.
2. Conduct Final Systems Operation Training (BAC lead).
3. Respond to and document warranty issues.
4. Participate as required in opposite season testing.
5. Correct any deficiencies identified throughout the Warranty Phase.
6. Update record documentation to reflect any changes made throughout the Warranty Phase and resubmit final Record Drawings at the close of the Warranty Phase.

1.13 EQUIPMENT SUPPLIER AND VENDOR RESPONSIBILITIES

A. Construction Phase: The following delineates the Cx-related responsibilities of the Equipment Supplier (and their subcontractors) during the Construction Phase.

1. Provide shop drawings and product data in hard copy and electronic format.
2. Provide manufacturer's application, installation and start-up instructions within 30 days of shop drawing/product data approval.
3. Where factory-authorized start-up is specified, coordinate and participate in the specified Cx process and document start-up on the appropriate forms.
4. Review and approve Functional Performance Test procedures affecting supplied equipment.
5. Where training is to be provided by factory-authorized personnel, provide required Training Plan information including course content for approval prior to conducting the training.
6. Conduct and document Equipment and Systems Training events as required by this Section and by applicable sections of the Specifications pertaining to each piece of equipment or system.
7. Provide spare parts and materials as required by the specifications.
8. Provide special tools as required by the specifications.
9. Provide Systems Manual content as required and develop project-specific O&M content as required by the Cx requirements.
10. Provide all warranties.

B. Acceptance Phase: The following delineates the Cx-related responsibilities of the Equipment Supplier (and their subcontractors) during the Acceptance Phase.

1. Participate in any Functional Performance Testing required.
2. Consult on issues identified relative to the supplied equipment.]

C. Warranty Phase: The following delineates the Cx-related responsibilities of the Equipment Supplier (and their subcontractors) during the Warranty Phase.

1. Provide any warranty service required to the supplied equipment as applicable with the agreement with the Contractor.
2. Maintain Systems Manual content relative to supplied equipment.

3. Provide technical support to the OWNER's facilities personnel.

1.14 COMMISSIONING KICK-OFF COORDINATION MEETING

- A. CA shall schedule and conduct a Cx coordination meeting near the beginning of construction. The following should be discussed at this meeting:
 1. The commissioning documents (specifications and Cx Plan).
 2. Requirements and sequence of commissioning.
 3. Responsibilities of the construction parties.
 4. Management protocols.
 5. Required submittals.
 6. Schedule.

1.15 START-UP AND START-UP CX PROCESS DOCUMENTATION

- A. Purpose: The Cx process requires that the normal quality control processes involved with preparing systems and equipment for operation are performed to a high standard of care and are thoroughly documented. The required Cx-related Start-Up Documentation is no more than that which would be provided for any good installation. These procedures shall be performed to all installed systems and equipment and no sampling strategy is used for the Start-Up process. The Cx process requires all Parties to collaborate to establish the optimal standard of care for starting systems and equipment. After the procedures are established, the Contractor performs them and documents them with the Start-Up Documentation that is developed through the joint effort of the Contractor and the CA.
- B. Creation of Start-Up Documentation: Start-Up Documentation (consisting of checklists and tests as defined above) shall be developed by the Contractor and appropriate manufacturers for each type of equipment and system being installed for this project. It shall be submitted to the CA for approval prior to actual equipment Start-Up. Contractor shall develop Start-Up Documentation based upon a combination of (i) the 'generic' procedures prepared by the CA (see below); (ii) existing procedures and checklists included in the Contractors in-house quality assurance process, and (iii) those procedures required by the manufacturer. Contractor shall provide the CA with an electronic copy of manufacturer's application, installation and start-up information at the time they submit the Start-Up Documentation. The CA shall then approve the Start-Up Documentation. Approved Start-Up Documentation shall reflect all project-specific values, settings, targets, acceptance criteria, and other parameters as appropriate. Final approved Start-Up Documentation shall be provided in electronic format.
- C. 'Generic' Start-Up Documentation: Refer to Sections 230800 and 260800 for 'generic' Start-Up Documentation for a variety of HVAC, mechanical and electrical systems. The content of the 'generic' Start-Up Documentation shall provide the minimally acceptable content. Generic refers to the fact that these procedures and protocols are common for most types of equipment and systems across different manufacturers. The Contractor is responsible for customizing this material to reflect the actual equipment and systems selected.
- D. Manufacturer/Vendor Installation and Start-Up Documentation: Contractor and Vendors shall provide manufacturer's preprinted and standard installation checklists, forms, and protocols both for review early in the construction process and to as required to document the Start-Up process towards the end of the Construction Phase. After the approval of the shop drawings and product data, Contractor shall submit manufacturer's start-up procedures and application guidelines for all systems, equipment, and components. These shall be submitted in electronic PDF format for review and approval. Submittal of the information shall be within 30 days of the submittal approval.

- E. Content of Start-Up Documentation: Start-Up Documentation shall generally include the following for each item of equipment or system (as applicable):
1. Project-specific designation, location and service.
 2. Indication of the Party performing and documenting the Start-Up.
 3. Clear explanation of the inspection, test, measurement, and outcome with a Pass/Fail indication and a record of measured parameters (as applicable).
 4. Include a checklist item indicating that all O&M Documentation, Warranties, and Record Documents have been completed and submitted.
 5. Include a Start-up Checklist item indicating that proper maintenance clearances have been maintained.
 6. Include a Start-up Checklist item indicating that special tools and/or spare tools required for normal operation and maintenance were turned over to the OWNER.
 7. Include Start-up Checklist item indicating that all required dependent or prerequisite equipment and systems were previously started successfully.
- F. Manufacturer's Requirements: Start-Up Documentation shall incorporate all manufacturer-specified procedures. As applicable, include acceptance criteria specified therein. The manufacturer's start-up and checkout procedures shall be submitted to the CA along with the Contractor's draft Start-Up Documentation.
- G. Recording and Documentation of the Start-Up: Manufacturer's start-up protocols shall be executed and forms shall be completed by a qualified/authorized technician. These shall be developed and submitted electronically or at the discretion of the CA they may be scanned and submitted electronically. Electronic documentation of manufacturer's start-up protocols shall be linked into the applicable test on the Portal.
- H. Recording and Completion of Start-Up Checklists and Tests: A qualified technician from the responsible installing Contractor or manufacturer's start-up technician shall document the Start-Up on the approved Start-Up Documentation forms. The individuals executing the Start-Up shall acknowledge acceptability of each item with the indication of who performed the associated task. The Start-Up is not considered complete until the Start-Up Documentation has been completed and entered electronically on the Portal. Information documented manually on paper in the field and/or installation or start-up information developed by the manufacturer must be transferred to the electronic file before Turn-Over can be scheduled. The completed documentation shall be presented and reviewed at the System Turn-Over Meeting.
- I. CA Review: CA shall review the completed and submitted Start-Up Documentation and request any incomplete data or additional information required to meet the Cx program criteria. CA will also review and spot-check procedures during Functional Performance Testing.
- J. Systems Subject to Start-Up Documentation and Turn-Over: All (100% of) systems shall undergo a documented Start-Up per the approved procedures and NO sampling strategy is used. Completed Start-Up Documentation for all pieces of equipment shall be submitted to CA prior to Turn-Over or any associated Functional Performance Testing. Any outstanding item shall be clearly indicated and an associated Action Item must be entered to track resolution.
- K. OWNER Access: Contractor shall allow access by OWNER representatives at any time to inspect the equipment and ensure its proper operation. OWNER will be allowed to affix service tags to equipment to track the proper maintenance.
- L. Mechanical Contractor -Specific Documentation Requirements:
1. The Division 23 Contractor shall provide the following documents as specified in Section 230800:

- a. Piping Cleaning, Flush, and Fill Plan.
- b. Temporary Operation and Conditioning Plan (if permanent systems are to be used to condition the building during Construction Phase).

1.16 EQUIPMENT NAMEPLATE DATA

- A. Contractor shall provide as-installed specific product nameplate data, product numbers, serial numbers, and other information required to fully define the asset for OWNER's use in maintenance management and asset tracking and BIM Modeling. This data shall be provided electronically to ease in the data transfer to the computerized maintenance management system. Coordination of the format required shall be arranged by the Contractor prior to initial construction implementation.
 - 1. Acceptable forms of electronic submittals are:
 - a. Microsoft Excel spreadsheet arranged with a separate 'Sheet' for each type of equipment and with individual pieces of equipment entered as rows and the applicable values to be recorded as column headings.
 - b. Microsoft Access database arranged with a separate 'Table' for each type of equipment and with individual pieces of equipment entered as rows and the applicable values to be recorded as fields. Field formats will be as determined at the Construction Phase Commissioning Kickoff Meeting.
 - c. Text document formatted as Comma Separated Values (csv) with a separate file for each type of equipment, the first row including the field or column names and subsequent entries for each individual piece of equipment as rows.
 - 2. Minimum nameplate data content shall include the following as applicable:
 - a. Construction document designation.
 - b. OWNER's designation if different than the construction document designation and if provided by the OWNER.
 - c. Contact information identification which shall reference the project's Contact List for installing contractor, vendor or representative, and manufacturer. Contractor shall also provide identification for suppliers of parts if different from the previous parties.
 - d. Model Number.
 - e. Serial Number.
 - f. Date of Manufacture.
 - g. All performance and sizing data required to operate, diagnose, or replace the system, equipment, component or systems with as a minimum that indicated in the construction documents.
 - h. General description or type classification of the system, equipment, component, or device.
- B. Contractor shall provide Equipment Nameplate Data for all equipment provided as work of this Division.

1.17 FUNCTIONAL PERFORMANCE TESTING

- A. The objective of Functional Performance Testing is to demonstrate that each system is operating according to the documented OPR/Basis of Design and Contract Documents. Functional Performance Testing facilitates bringing the systems from completed Start-Up to Functional Completion. During the FPT, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems. System parameters are further tuned and optimized to provide for stable control and interrelated system effects are also addressed.

1.18 FUNCTIONAL PERFORMANCE TESTING DEFICIENCIES

- A. Non-conformance deficiencies, e.g. test failures, installation and configuration errors, etc., identified during Functional Performance Testing shall be resolved as follows:
1. The CA will record the results of the functional test in the project database. All deficiencies or non-conformance issues shall be noted as Action Items and reported to the Owner and A/E.
 2. Corrections of identified minor deficiencies may be made during the tests at the discretion of the CA. In such cases, both the deficiency and associated resolution will be documented in the database.
 3. Every effort will be made by the CA to expedite the FPT process and minimize unnecessary delays, while not compromising the integrity of the procedures.
 4. As tests progress and a deficiency is identified, the CA will discuss the issue with the executing Contractor.
 - a. When there is no dispute on the deficiency and the Contractor accepts responsibility to correct it:
 - 1) The CA shall document the deficiency along with the Contractor's response and intentions, and then proceed forward to another test. A copy/email of the deficiency shall be generated and provided to the Contractor and CA. The Contractor shall then correct the deficiency, complete the Action Item response certifying that the issue is resolved and /or the equipment is ready to be retested, and sends it back to the CA.
 - 2) The CA reschedules the test and the test is repeated until satisfactory performance is achieved. CA then closes the Action Item.
 - b. If there is a dispute about a deficiency, regarding whether it is a deficiency and/or who is responsible:
 - 1) The deficiency shall be documented as an Action Item with the Contractor's response and the Owner and A/E will be notified. The Owner will track this issue under the construction contract dispute resolution provisions.
 - 2) Final interpretive authority is with the A/E. Final acceptance authority is with the OWNER.
 - 3) The CA documents the resolution to the Action Item.
 - 4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, and responds to the Action Item indicating completion. The CA reschedules the test and the test is repeated until satisfactory performance is achieved. CA then closes the Action Item.
- B. Failure Due to Manufacturer's Defects. If 10% or three, whichever is greater, of identical pieces of equipment fail to perform to the required Contract Document criteria (mechanically or substantively) due to manufacturing defect, all identical units may be considered unacceptable by the OWNER. (For the purposes of defining 'identical equipment' for this Section, size or capacity alone does not constitute a difference.) In case of failure due to manufacturer's defects, the Contractor shall provide the OWNER with the following:
1. Manufacturer's response in writing as to the cause of the failure and proposed resolution.
 2. Manufacturer shall implement their proposed resolution on a representative sample of the product.
 3. The OWNER will determine whether a replacement of all identical units or a repair is acceptable.

4. Upon acceptance, the manufacturer shall replace or repair all identical items at their expense and shall extend the warranty accordingly (if the original equipment warranty had begun).
5. Manufacturer or Contractor shall pay the costs of all retesting necessitated by the failure.

1.19 OBSERVATION PERIOD

- A. General: The Observation Period is defined as a period of time either prior to or immediately following Functional Performance Testing where the BAS is shown to operate properly without malfunction, without alarms caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications.
- B. Prerequisites: The CA will determine when the BAS has been substantially completed to allow for the start of an informal Observation Period as defined above. Observation Period may be witnessed in phases only on larger more complex projects where interdependencies between phases are not a factor.

1.20 TRAINING

- A. General: Adequate and thorough training of the Operators and the facilities staff is vital to effective transition and early occupancy of the building. A key goal of the Cx program is to ensure this is accomplished. Contractors, subcontractors, and Manufacturers/Vendors as specified shall prepare and conduct training sessions on the installed systems and equipment for which they are responsible. The Contractor shall be responsible for ensuring all training is performed in accordance with the Contract Documents.
- B. Training Events Overview: Training Events include all classroom and field-based training sessions that result in the training or transference of design team or Contractor knowledge to the OWNER. The following Training Events shall be executed as part of the Training Program:
 1. Design Orientation Training: The purpose of the one-time Design Orientation Training event is to acquaint the OWNER and Contractors with the facility design strategies and approach taken by the Design Team. The mechanical design engineer is responsible for conducting and documenting this training, with assistance and support from the CA. Material from the OWNER's Project Requirements and Basis of Design Documents shall be covered during this training. An overview of the facility and its systems, the system design goals and the reasoning behind the selection of the equipment will be reviewed. The CA will also review the upcoming Start-Up process and FPT/Acceptance Testing procedures. An optional tour will be provided at the conclusion of the event.
 2. Equipment and Systems Training: The Contractor (or Manufacturer's Representative) shall provide training to the OWNER/Operators on individual systems and equipment only after successful Start-Up. These training events cover proper operation, maintenance, repair, and diagnosis of the systems, equipment, and components installed by the Contractor. Details and required content are provided elsewhere in this Section.
 3. Final Systems Operation Training: The BAC shall provide this training to the OWNER and Operators on whole-building operation. This training shall focus primarily on BAS control of building systems and operation and its impact on building performance, and shall be conducted after Functional Completion.
- C. Training Means, Methods, and Documentation: The Contractor must document all training sessions. Details on the means and methods for conducting and documenting training, including location requirements, preparation, methods for presentation, scheduling, recording, instructor qualifications, and other details are specified below.

1. Trainer must supply a Training Plan Document as detailed below, at least 2 weeks prior to the scheduled training session for approval by the OWNER and CA.
2. Setting: Training sessions should typically start and end in a classroom setting. Field demonstrations shall be conducted to demonstrate the hands-on aspects of the required tasks.
3. Presentation: Training shall include electronic presentation materials. Presentation materials shall be submitted by the Contractor within the Training Plan. Contractor shall provide audio/visual equipment as required to communicate to a minimum of 10 attendees.
4. Documentation: Subcontractors or Vendors must document the training sessions in a Training Record. Beyond that included in the Training Plan, documentation shall include the names of the attendees and their evaluations. Training shall follow handouts that list the key points in bullet form presentation style or follow detailed written documentation. Training will not be approved unless it contains accompanying handout documentation to every attendee for their own use and record, separate from the master copy for the Training Record. All documentation must be provided in PDF electronic format. All handouts and presentation slides shall be included in the documentation.
5. Evaluations: All training sessions must be evaluated by the participants. CA shall develop an evaluation form that assesses the quality of the presentation, the quality of the content, and provides a forum for feedback of items the attendee feels should be provided or expanded on. The Contractor that organizes the sessions is responsible for distributing the evaluations, ensuring they are completed, and compiling them and forwarding them to the CA.

D. Training Plan Document.

1. The Training Plan shall outline the various Equipment and Systems Training events and Final Systems Operation Training event as proposed by the Contractors, and shall be approved by the CA. Contractor shall compile the individual training agendas of the subcontractors and vendors and submit a comprehensive Training Plan to the CA, Architect and the OWNER for review. Training Plan shall summarize all Equipment and Systems Training events with topics to be covered and approximate training duration.
2. The Training Plan shall include at a minimum:
 - a. Topic and applicable specification section.
 - b. Scheduled date(s) for the Events(s).
 - c. Location and setting (classroom or field).
 - d. Lead instructor and instructors qualifications.
 - e. Co-instructors and their qualifications.
 - f. Training objective.
 - g. Event outline/agenda.
 - h. Detailed breakout of content to be presented.
 - i. Anticipated duration.
 - j. Required attendees for each session.
3. Review: Contractor shall submit the Training Plan to the GC, who will then disseminate it for review to the Cx Team. Contractor shall incorporate comments and requirements resulting from the review and resubmit the Training Plan prior to conducting any training sessions.

E. Training Prerequisites: Equipment and Systems Training ("Training") shall not be conducted until the subject system or equipment has completed Start-Up Documentation requirements and Turn-Over. If the Contractor wishes to schedule both Turn-Over and Training on the same day/visit and if the systems are discovered to not be fully-functional at that time, Training shall be canceled and rescheduled.

F. Equipment and Systems Training – Description and Content.

1. Description: Equipment and Systems Training events will typically occur over a period of time as systems and equipment are brought online and Turned-Over. Training shall cover proper operation, maintenance, repair, and diagnosis of the systems, equipment, and components installed by the Contractor. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. These sessions shall use the manufacturer's printed installation, operation and maintenance instruction material and shall include a review of these instructions emphasizing safe and proper operating requirements and preventative maintenance. Training shall follow handouts that list the key points in bullet form presentation-style or follow detailed written documentation. Training will not be approved unless it contains accompanying written documentation.
2. Equipment Covered: Training shall be provided for all major items of equipment within the scope of commissioning and per the Specifications.
3. Minimum Training Content: Equipment and Systems Training shall include as a minimum for each type of equipment:
 - a. Presentation of the equipment within the context of this facility. Typically, the responsible subcontractor shall provide this introduction to the session. The trainer shall review how the equipment serves this specific facility. Information shall include equipment amounts, numbers, capacities, sizes and locations and shall show the equipment in applicable system schematics.
 - b. Conceptual overview of how the equipment works.
 - c. Names, addresses, phone numbers, websites of sources for information, tools, spare parts, and other details for the equipment.
 - d. Details of the warranty or guarantee.
 - e. Intended sequences of operation in all modes of operation.
 - f. Limits of responsibility (example: unit-mounted controls vs. BAS).
 - g. Sources of utility support.
 - h. Routine operator tasks involving monitoring and operation, covering all modes of operation and mode switching as applicable.
 - i. Relevant health and safety practices/concerns.
 - j. Common problems and their diagnosis and repair.
 - k. Proper maintenance schedules, tasks and procedures with demonstrations.
 - l. Emergency response, documentation and recovery procedures.
4. Scheduling: These events shall be coordinated through the CA, but be scheduled by the GC.
5. Attendees: Contractor shall insure that all appropriate subcontractors be present for these sessions. Any Cx Team member is eligible to attend. Required attendees include the applicable Contractors (Lead), CA, and the OWNER/Operator.

G. Final Systems Operation Training.

1. Description: Final Systems Operation Training provides the OWNER and Operators a training session on whole-building operation. It shall focus primarily on BAS control of building systems and operation and its impact on building performance. System interactions shall be presented and discussed (such as a combined air handler, chiller, boiler, and terminal unit system), along with a detailed presentation of the sequences of operation and their relationship to the BAS. This training shall be conducted by the BAC with assistance from the CA, and shall be attended by the OWNER, Operators, Contractor, Design Team, and by any other Cx Team members deemed necessary by the CA or the OWNER.
2. Coordination with BAS Training: Detailed BAS component training for the facility Operators shall be considered as part of Equipment and Systems Training. This training shall have been completed prior to Final Systems Operation Training.
3. Scheduling: Final Systems Operation Training shall be conducted after all FPTs have been successfully executed.

4. Attendees: Any Cx Team member is eligible to attend. Required attendees include the BAC (lead), CA (assist), GC, mechanical contractor, A/E, and OWNER/Operators.

1.21 CONTRACTOR REQUIRED O&M DOCUMENTATION

- A. Contractors are responsible for submitting their own developed O&M Manuals per the Contract Documents and for developing installation-specific O&M Documentation.
- B. O&M Documentation Content: Content for one system and all associated equipment must be organized and made in one submission. However, systems may be submitted separately based on the progress of the project. Content shall be provided and indexed separately as 'Operations Manual' and 'Maintenance Manual' as specified below.
- C. This Part shall be organized by Division then system/subsystem using a systems approach.
 1. Contact Information: Provide contact cross-references to the Parties applicable to the system being described and contained in the main Contact Directory in the Commissioning Plan.
 2. Start-Up and Shutdown Procedures: Provide step-by-step instructions to bring systems from static to operational configurations and from operating to shutdown status. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project.
 3. Normal Operating Instructions: Provide a discussion of the normal operation and control of the system. Address operating norms (for example, temperatures, pressures and flow rates) expected at each zone or phase of the system. Supplement the discussion with control and wiring diagrams and data. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project.
 4. Emergency Operating Instructions: Provide emergency operating procedures in the event of equipment malfunctions. Provide shutdown instructions for fires, explosions, spills, or other contingencies. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project. This content shall be in the context of the systems themselves and support the Emergency Operations manual to be created by the OWNER.
 5. Environmental Considerations: Provide a listing of the equipment that requires special operation, reporting, testing, analysis or inspection to comply with federal, state or local environmental laws. Examples of possible list items include backflow preventer inspections, underground storage tank testing, hazardous material or waste usage/storage documentation and air pollution control devices. For each item, include requirements for environmental operation, reporting, testing, analysis and inspection as well as references to respective implementing regulations, statutes or policies.
 6. Equipment and System Training Documentation: Include documentation of training for applicable system. Include training agenda, all handouts and presentation materials/content. Reference existence and index of DVD or video tape recording.
 7. Sequence of Operation/Control Schematic: Provide the written sequence of operation for the applicable system and the control schematic diagram. This information may be obtained from the A/E or design team members.
 8. Maintenance Service Agreements: Provide copies of maintenance service agreements where there pertain to systems involving multiple components and devices as indexed in Part 3.
 9. Testing, Adjusting, and Balancing Reports: Insert the TAB Reports provided under Section 230593 for the subject system.
- D. Maintenance Manual.
 1. Organize this section first by discipline then by equipment number or ID.
 2. Maintenance Index: Provide a summary table that indexes the equipment requiring maintenance and indicates the frequency each piece of equipment needs attention, and a

reference to the number of the Procedure associated with that frequency. GC shall provide Contractors with an Excel spreadsheet that will be completed by each applicable subcontractor and returned to the GC for incorporation in the Systems Manual.

3. Maintenance Information: Maintenance Information for each indexed entry shall contain the following:
 - a. Equipment Data Sheet: Provide a summary of key nameplate and performance data.
 - b. Procedures: Provide a 'Task Card' or step-by-step procedures for each individual maintenance procedure for a given frequency identified on the Maintenance Index. Include detailed PM procedures, safety instructions and precautions including Lock Out/Tag Out precautions, required skill level, number of personnel needed, frequency, special tools needed, parts needed and estimated time required to complete the task. These procedures shall be indexed in a manner approved by the OWNER. These shall be provided as Microsoft Word files or scanned documents from the manufacturer's O&M Manual in either PDF or JPG formats).
 - c. Field Test Reports: Provide Field Test Reports that apply to equipment associated with the system.
 - d. Troubleshooting Instructions: Provide detailed troubleshooting instructions indexed by common/expected symptoms. Alternatively, make specific reference to page in the manufacturer's O&M Manual where this information is provided.
 - e. Extended Warranty Information: Include all warranties for products, equipment, components, and sub-components whose duration exceeds one year. Include warranties on components with the system they are contained within. Reference all specific operation and maintenance procedures that must be performed to keep the warranty valid.
 - f. Special Tools: Provide a listing of any special tools required for servicing, diagnosis, or repair. Alternatively, reference specific page in the manufacturer's O&M Manual where this information is provided.
 - g. Supply Inventory Requirements: Provide a list of maintenance and repair supplies (e.g., spare parts, fuels and lubricants) required to ensure continued operation without unreasonable delays. Identify and list parts and supplies that have long purchase lead times. Alternatively, reference specific page in manufacturer's O&M Manual that contains this information.
 - h. Sources of Spare Parts: Provide list or reference to recommended spare parts and contact information where spare parts can be obtained.
 - i. Lubrication Schedule: Provide a lubrication schedule indicating types, grades, and capacities of lubricants for specific temperature ranges and applications. Alternatively reference the specific page in the manual that contains this information.
 - j. Maintenance Service Agreements: Provide copies of maintenance service agreements where they pertain specifically to indexed equipment.
 - k. Manufacturer's O&M Manual: Include manufacturer's printed O&M information. These shall be provided in PDF format. If unavailable as PDF from the manufacturer, hardcopy manual shall be scanned and provided as a single file.
 - l. Application and Installation Instructions: Where applicable and separate from the O&M information, provide the Application and Installation Instructions that indicate how to correctly apply and install/setup the equipment.
- E. O&M Documentation Format: Content authored, developed and compiled by the Contractor shall be available both electronically and hardcopy. Specific electronic format shall be coordinated with the CA. Acceptable electronic formats shall allow for editing and commenting, and include Microsoft Word, Excel, PowerPoint, Access, and Visio; Portable Document Format (PDF), AutoCAD, graphics/photo formats such as JPG,
- F. Mechanical Contractor O&M Documentation Submittal: The Division 22 and 23 Contractor shall compile and organize the content for all work of Divisions 22 and 23 and provide one organized submittal. Upon approval by the CA, the content may be provided in multiple system and

equipment-level submittals. Each submission shall be provided at least one month prior to the start of the Acceptance Period. This submittal will be reviewed by A/E, CA, OWNER, and GC within two weeks of the submission. Contractor shall incorporate comments and corrections and resubmit prior to the start of the Acceptance Period. Within two weeks of Functional Completion, the Division 22 and 23 Contractor shall provide the final version of all O&M Documentation information in one submittal.

- G. Other Contractor O&M Documentation Submittals: Submittals by all other Contractors (other than Div 22 and 23 shall be provided per specifications within their respective Division of work.
- H. Maintenance and Updates of O&M Documentation Content: Contractors shall maintain the applicable O&M Documentation content throughout the Warranty Period. All hard copies will be retained at the OWNER's facilities or electronically online at a web-based site. Changes throughout the Warranty Period shall be fully coordinated with the CA. Maintenance of O&M Documentation content shall include:
 - 1. Changing any indicated settings, parameters, and other operational parameters that were changed by the Contractor during the Warranty Phase.
 - 2. Changing any instructions as to procedures that needed to be changed during the Warranty Phase.
 - 3. Changing the Record Schedules and/or Sequences of Operation if they were changed during the Warranty Phase.
 - 4. Updating any O&M Documentation content if changed or updated by the manufacturer.
- I. Electronic Copies: Electronic copies may be posted to the Portal. When a posting is made, emails shall be sent to the receiving Parties (and copied to any other interested Parties) stating that the submission has been posted. Posting needs only to be the current submission. Contractor shall maintain all versions of the submission and provide upon request. When electronic submissions are made on electronic media such as CDs or memory sticks, six copies of the electronic media shall be provided.
- J. Paper-Based (Hard) Copies: The number of copies shall be as follows:
 - 1. Initial construction phase submission shall include 3 copies. All will be returned within two weeks.
 - 2. Pre-Acceptance Phase submission shall include 3 copies. All will be returned at the completion of Acceptance Testing.
 - 3. Final Systems Manual content submission shall include 3 copies. All will remain at the OWNER's facilities.
 - 4. Modifications made to the information shall be made to all Final Systems Manual copies.

1.22 SYSTEMS MANUAL PREPARATION AND LOGISTICS

- A. Definition: The Systems Manual is the final deliverable from the Cx process, and provides the information needed to understand, operate, and maintain the facility and its systems. It is typically developed by the CA but with content required to be provided by the design team and the Contractors. The Systems Manual expands the scope of standard O&M documentation to incorporate additional information developed through the Cx process. The Systems Manual should be the repository of all updates and corrections as they occur (even throughout Occupancy). It is narrative in nature and organized by system types and by area/usage of the facility (if applicable). Systems Manual content typically includes narrative descriptions of the facility and systems, sequences of operation, schematic diagrams, cuts from design drawings and equipment literature, photos, and manual start/stop and emergency operating procedures for important equipment.

- B. **Systems Manual Lead Developer Responsibilities:** The lead developer of the Systems Manual for this project shall be the CA. The lead developer is responsible for organizing and producing the Systems Manual and for managing the content and contributions from the Parties responsible for providing technical content. The Party responsible for each topic shall assemble, author, develop, coordinate, or otherwise produce the content for that topic as specified below and provide to the lead developer. Requirements as specified include requiring the applicable Contractors to author project-specific information in a consistent format in addition to submission of standard pre-printed manufacturer's O&M and product information.
- C. **Systems Manual Contractor Responsibilities:** Contractor, Subcontractors and Vendors/Factory Representatives shall prepare, organize and submit applicable content for the comprehensive and coordinated Systems Manual as specified below. Some of the material required from the Contractors will need to be authored or customized specifically for this project and facility. Contractor content is indicated by "GC" who is responsible for consolidating the content and materials from the various individual Contractors. Content for one system and all associated equipment must be organized and made in one submission. However, systems may be submitted separately based on the progress of the project. Each submission shall be indexed as a sub-entity to the overall Systems Manual submission.
- D. **Division 22 and 23 Contractor Responsibilities:** The Division 22 and 23 Contractor shall compile and organize the content for all work of Divisions 22 and 23 and provide one organized submittal. Upon approval by the CA, the content may be provided in multiple system and equipment-level submittals. Each submission shall be provided at least one month prior to the start of the Acceptance Period. This submittal will be reviewed by A/E, CA, OWNER, and GC within two weeks of the submission. Contractor shall incorporate comments and corrections and resubmit prior to the start of the Acceptance Period.
- E. **Final Systems Manual Content Submittal:** Within two weeks after Functional Completion, Contractors shall provide the final version of all Systems Manual information. Division 22 and 23 Contractor shall provide final version in one single submittal.
- F. **Maintenance and Updates of Systems Manual Content:** Contractors shall maintain the applicable Systems Manual content throughout the Warranty Period. All hard copies will be retained at the OWNER's facilities and electronically online through the Portal. Changes throughout the Warranty Period shall be fully coordinated with the CA. Maintenance of Systems Manual content shall include:
 - 1. Changing any indicated settings, parameters, and other operational parameters that were changed by the Contractor during the Warranty Phase.
 - 2. Changing any instructions as to procedures that needed to be changed during the Warranty Phase.
 - 3. Changing the Record Schedules and/or Sequences of Operation if they were changed during the Warranty Phase.
 - 4. Updating any Systems Manual content if changed or updated by the manufacturer.
- G. **Systems Manual Format and Submission:** The Systems Manual contents shall be provided in hard copy and electronic format.
 - 1. **Electronic Version:** The electronic version of the Systems Manual will be a series of files organized in subdirectories with a summary index with hyperlinks to the various documents and or references to separate CDs that contain the information. During authoring, sample format Microsoft Office documents (Word, Excel or Powerpoint) will be provided to be used by vendors and contractors to provide the custom-authored content to the lead developer for final compilation. Electronic copies of the product data shall be in PDF format. Drawings shall be in AutoCAD or PDF format.

2. Electronic File Submissions. Electronic files of Systems Manual content may be posted to the project website. When a posting is made, emails shall be sent to the receiving Parties (and copied to any other interested Parties) stating that the submission has been posted. Posting should only include the current submission, although the Contractor shall maintain all versions of the submission and provide upon request. When electronic submissions are made on electronic media such as CDs, six copies of the electronic media shall be provided.
3. Paper-Based (Hard) Copies: The number of copies shall be as follows:
 - a. Initial construction phase submission shall include 3 copies. All will be returned within two weeks.
 - b. Construction Phase submissions shall include 3 copies. All will be returned at the completion of Acceptance Testing.
 - c. Final Systems Manual content submission shall include 3 copies. All will remain at the OWNER's facilities from that time forward.
 - d. Modifications made to the information shall be made to all copies.

1.23 SYSTEMS MANUAL CONTENT AND ORGANIZATION

- A. Systems Manual Scope: The Systems Manual format and content requirements shall be as follows. Documents developed or otherwise provided as specified in the Contract Documents should be used directly or referenced to the extent possible, including but not limited to OPR/BOD narratives, shop drawings, submittals, and O&M Manuals. Responsible parties are as indicated in square brackets; tasks not delineated by a responsible party are the responsibility of the lead developer.
- B. Part 1 – Facility Information.
 1. Directory of Entire Manual: Provide a directory indexing the entire set of documents that comprise the Systems Manual.
 2. Contact Directory: Include the contact information for all contractors, subcontractors, vendors, manufacturers, and any other entity that has provided goods or services installed at the facility. Contact information should include name, website, address, phone numbers, and technical support phone numbers and email addresses.
 3. General Facility and System Description: A/E Describe the function of the facility. Detail the overall dimensions of the facility, number of floors, foundations type, expected number of occupants, and facility category code. List and generally describe all the facility systems listed in Part II - Primary Systems Information and any special building features (for example, cranes, elevators, and generators). Include photographs, marked-up and labeled to show key operating components and the overall facility appearance.
 4. Floor Plans: A/E Provide uncluttered, legible 11 x 17 inch floor plans. Exact copies of the design plans are usually not acceptable because of extraneous information. Include only room numbers, type or function of spaces, and overall facility dimensions on the floor plans. Do not include construction instructions, references, frame numbers, etc.
 5. Utility Connection and Cutoff Plans: Provide utility site and floor plans that indicate the exterior and main interior connection and cutoff points for all utilities. Include enough information to enable someone unfamiliar with the facility to quickly locate the connection and cutoff points. Do not include items such as contour lines, elevations, and subsurface information on the site plans. Indicate the room number, panel number, circuit breaker, valve number, etc., of each connection and cutoff point, and what that connection or cutoff point controls. These plans are in addition to the floor plans.
- C. Part 2 - Primary Systems Operating Information.
 1. This Part shall be organized by Division then system/subsystem using a systems approach. Part 2 contains system information, whereas Part 3 contains equipment information.

2. System Description: Provide a detailed discussion of the system composition and operation. Include technical details that are essential for an understanding of the system. A/E shall provide narratives to the GC who shall provide these to the major subcontractors for use in preparation of their required content. Also cross-reference O&M data contained in Part 4 and product data and submittals contained in Part 4.
3. Contact Information: Provide contact cross-references to the Parties applicable to the system being described and contained in the main Contact Directory in Part 1.
4. System Flow Diagrams : Provide a flow diagram indicating system liquid, air (do not include ductwork) or gas flow during normal operations. Integrate all system components into the diagram. Note that a compilation of non-integrated flow diagrams for the individual system components is not acceptable.
5. Diagrammatic Plans: Provide floor plans indicating the location of equipment and configuration of the system installation. Include the configuration of associated piping or wiring, subordinating structural features to utility features.
6. Start-Up and Shutdown Procedures: Provide step-by-step instructions to bring systems from static to operational configurations and from operating to shutdown status. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project.
7. Normal Operating Instructions: Provide a discussion of the normal operation and control of the system. Address operating norms (for example, temperatures, pressures and flow rates) expected at each zone or phase of the system. Supplement the discussion with control and wiring diagrams and data. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project.
8. Emergency Operating Instructions: Provide emergency operating procedures in the event of equipment malfunctions. Provide shutdown instructions for fires, explosions, spills, or other contingencies. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project. This content shall be in the context of the systems themselves and support the Emergency Operations manual to be created by the OWNER.
9. Environmental Considerations: Provide a listing of the equipment that requires special operation, reporting, testing, analysis or inspection to comply with federal, state or local environmental laws. Examples of possible list items include backflow preventer inspections, underground storage tank testing, hazardous material or waste usage/storage documentation and air pollution control devices. For each item, include requirements for environmental operation, reporting, testing, analysis and inspection as well as references to respective implementing regulations, statutes or policies.
10. Equipment and System Training Documentation: Include documentation of training for applicable system. Include training agenda, all handouts and presentation materials/content. Reference existence and index of DVD or video tape recording.
11. Sequence of Operation/Control Schematic: Provide the written sequence of operation for the applicable system and the control schematic diagram.
12. Maintenance Service Agreements: Provide copies of maintenance service agreements where there pertain to systems involving multiple components and devices as indexed in Part 3.
13. Testing, Adjusting and Balancing Reports: Insert the TAB Reports provided under Section 230593 for the subject system.

D. Part 3 - Maintenance Manual.

1. Organize this section first by discipline then by equipment number or ID.
2. Maintenance Index: Provide a summary table that indexes the equipment requiring maintenance and indicates the frequency each piece of equipment needs attention, and a reference to the number of the Procedure associated with that frequency. GC shall provide Contractors with an Excel spreadsheet that will be completed by each applicable subcontractor and returned to the GC for incorporation in the Systems Manual.
3. Maintenance Information: Maintenance Information for each indexed entry shall contain the following:

- a. Equipment Data Sheet: Provide a summary of key nameplate and performance data.
- b. Procedures: Provide a 'Task Card' or step-by-step procedures for each individual maintenance procedure for a given frequency identified on the Maintenance Index. Include detailed PM procedures, safety instructions and precautions including Lock Out/Tag Out precautions, required skill level, number of personnel needed, frequency, special tools needed, parts needed and estimated time required to complete the task. These procedures shall be indexed in a manner approved by the OWNER. These shall be provided as Microsoft Word files or scanned documents from the manufacturer's O&M Manual in either PDF or JPG formats).
- c. Field Test Reports: Provide any Field Test Reports that apply to equipment associated with the system.
- d. Troubleshooting Instructions: Provide detailed troubleshooting instructions indexed by common/expected symptoms. Alternatively, make specific reference to page in the manufacturer's O&M Manual where this information is provided.
- e. Extended Warranty Information: Include all warranties for products, equipment, components, and sub-components whose duration exceeds one year. Include warranties on components with the system they are contained within. Reference all specific operation and maintenance procedures that must be performed to keep the warranty valid.
- f. Special Tools: Provide a listing of any special tools required for servicing, diagnosis, or repair. Alternatively, reference specific page in the manufacturer's O&M Manual this information is provided.
- g. Supply Inventory Requirements: Provide a list of maintenance and repair supplies (e.g., spare parts, fuels and lubricants) required to ensure continued operation without unreasonable delays. Identify and list parts and supplies that have long purchase lead times. Alternatively, reference specific page in manufacturer's O&M Manual that contains this information.
- h. Sources of Spare Parts: Include reference to contact information where spare parts can be obtained.
- i. Lubrication Schedule: Provide a lubrication schedule indicating types, grades, and capacities of lubricants for specific temperature ranges and applications. Alternatively reference the specific page in the manual that contains this information.
- j. Maintenance Service Agreements: Provide copies of maintenance service agreements where they pertain specifically to indexed equipment.
- k. Manufacturer's O&M Manual: Include manufacturer's printed O&M information. These shall be provided in PDF format. If unavailable as PDF from the manufacturer, hardcopy manual shall be scanned and provided as a single file.
- l. Application and Installation Instructions: Where applicable and separate from the O&M information, provide the Application and Installation Instructions that indicate how to correctly apply and install/setup the equipment.

E. Part 4 - Construction Documentation.

- 1. Record Drawings: Provide an index of all Record Drawings with drawing number, title, and electronic file name(s) including electronically referenced drawings.
- 2. Record Specifications: Provide a detailed index of the Record Specification. Include sections and major items in the specification all indexed to the appropriate page number.
- 3. Approved Product Data and Shop Drawings.
 - a. Provide an index of all product data and shop drawings. This shall list all equipment with the associated submittal number.
 - b. Organize and compile only APPROVED product data and shop drawings. Providing these in a filing format is acceptable provided all files are identified and organized for easy access.
 - c. This information is required for this Part in its entirety regardless of inclusion in any other sections of the Systems Manual.

4. Commissioning Record: Provide complete Cx records including all Start-Up Documentation and Functional Performance Test documentation.

F. Part 5 – Preventative Maintenance / Recommissioning Manual.

1. Preventative Maintenance Specification: Specification for day to day maintenance of the facility, including operating log requirement, reports, and preventative maintenance tasks for each system, including recommended inspections, and tests.
2. Recommissioning Test Log: Blank testing plan for future use in recommissioning.

1.24 EXISTING SERVICES INTERRUPTIONS

- A. Contractor shall exercise great care in the connection to or interruption of existing functional services (utilities, systems, spaces, etc.) that support the facility. This shall only be done with advance notification, completion of appropriate OWNER's documentation to obtain approval, and final approval and supervision by the OWNER.
- B. Refer to applicable Division 01 sections for logistics and requirements for connection to or interruption of existing services.
- C. All events where an existing service will be connected to or interrupted shall be itemized as a milestone or task in the construction Cx schedule. OWNER will not approve the connection or interruption unless the event has been forecasted for at least three months. The schedule will not serve as the final notification but will support planning.
- D. Final notification shall be per the OWNER's process with all forms and submissions complete and accurate. OWNER shall provide information on processes and applicable forms on request.
- E. Depending on the service, OWNER may dictate that the interruption be during non-working hours. In other cases, OWNER will require the interruption be during working hours so mission can be monitored.
- F. Contractor shall summarize the potential impact and the maximum duration.
- G. OWNER reserves the right to cancel the connection or interruption at any time if it circumstances necessitate this. The OWNER also reserves the right to constrain the extent of any interruption.
- H. Connections to Hydronic Systems:
 1. Connections to existing hydronic systems shall be done only on mutual written approval of both parties to the connection. OWNER and Contractor shall review the fluid and piping condition and any applicable treatment and/or water analyses of the other parties system and agree to the connection.
 2. Contractor shall work with the OWNER to ensure the balance of the existing hydronic system is not affected to the extent that it will affect mission. Therefore, the Contractor shall attempt to plan connections or interruptions for times when the impact will be the least.
 3. Contractor shall record the balance of the existing system before and after the connection to document the impact. Balancing adjustments of the combined system shall commence immediately upon connection unless approved otherwise by the OWNER.
 4. Contractor shall work with the OWNER to ensure any applicable pumps do not overload or become dead headed.
- I. Connections to Air Systems:

1. Connections to existing air systems shall be done only on mutual written approval of both parties to the connection. OWNER and contractor shall review the air quality, inlets and ductwork condition and any applicable filtration of the other party's system and agree to the connection.
2. Contractor shall work with the OWNER to ensure the balance of the existing air system is not affected to the extent that it will affect mission. Therefore, the Contractor shall attempt to plan connections or interruptions for times when the impact will be the least.
3. Contractor shall record the balance of the existing system before and after the connection to document the impact. Balancing adjustments of the combined system shall commence immediately upon connection unless approved otherwise by the OWNER.
4. Contractor shall work with the OWNER to ensure any applicable pumps do not overload or become dead headed.

J. Connections to Electrical Systems:

1. Connections to existing electrical systems shall be done only on mutual written approval of both parties to the connection. OWNER and Contractor shall review breaker/fuse settings, short circuit studies, the load on the system, and condition of the electrical systems and equipment of the other party's system and agree to the connection.
2. Contractor shall work with the OWNER to ensure the loading and coordination of settings are such that the connection will not affect the mission. Therefore, the Contractor shall attempt to plan connections or interruptions for times when the impact will be the least. Contractor shall complete and document all interrupter settings and transfer switch timing per the short circuit study and design intent prior to the connection.
3. Contractor shall record the loads on the existing system before and after the connection to document the impact. Interrupter adjustments on the combined system shall commence immediately upon connection unless approved otherwise by the OWNER.
4. Contractor shall work with the OWNER to ensure any applicable distribution or generation equipment do not overload.

1.25 CONTACTOR PHASING PLAN

- A. If Contractor intends to start, run, or occupy portions of systems in phases, Contractor shall submit a Phasing Plan for phasing in areas/portions of systems that will be connected subsequent to the initial portions. Phasing Plan shall specifically address:
1. Pipe and Duct Cleaning: Indicate the configurations and protocols for isolating subsequent regions and then protecting the preceding regions when the subsequent region is cleaned/flushed and connected.
 2. Pipe Disinfection: Indicate the plan for disinfecting each region of potable water or medical gas pipe that requires disinfection. Indicate how the preceding regions of the system will be protected when connecting subsequent regions.
 3. Piping Certification/Testing: Indicate the plan for certifying each region of pipe that requires certification and or testing such as laboratory gases, medical gases, and RO/DI water (testing for water quality). Indicate how the preceding regions of the system will be protected when connecting subsequent regions. Indicate how you will verify that the certification/test results on the previous systems have not been invalidated.
 4. System Modifications: Indicate the protocols for making subsequent changes to the systems of pipe and duct when the systems have already been cleaned, flushed, pressure tested, disinfected, and certified.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

- A. General: All testing equipment used in the Cx process shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.
- B. Standard Testing Instrumentation: Standard testing instrumentation normally used for performance assessment and diagnosis will be provided by the CA. Refer to Sections 230800 and 260800 for a list of applicable test equipment.
- C. Special Tools: Special equipment, tools and instruments (only available from a vendor, and specific to a piece of equipment) that are required for testing equipment in accordance with these Contract Documents shall be included in the base bid price to the Contractor and turned over to the OWNER upon completion of the project.

2.2 TEST KITS FOR METERS AND GAUGES

- A. Test kits for meters and gauges shall be provided to the OWNER new and in good condition. Previously used test kits will be unacceptable. Kits shall be submitted prior to the Acceptance Phase. Kits required are specified in the individual technical specifications and in 230800 and 260800.

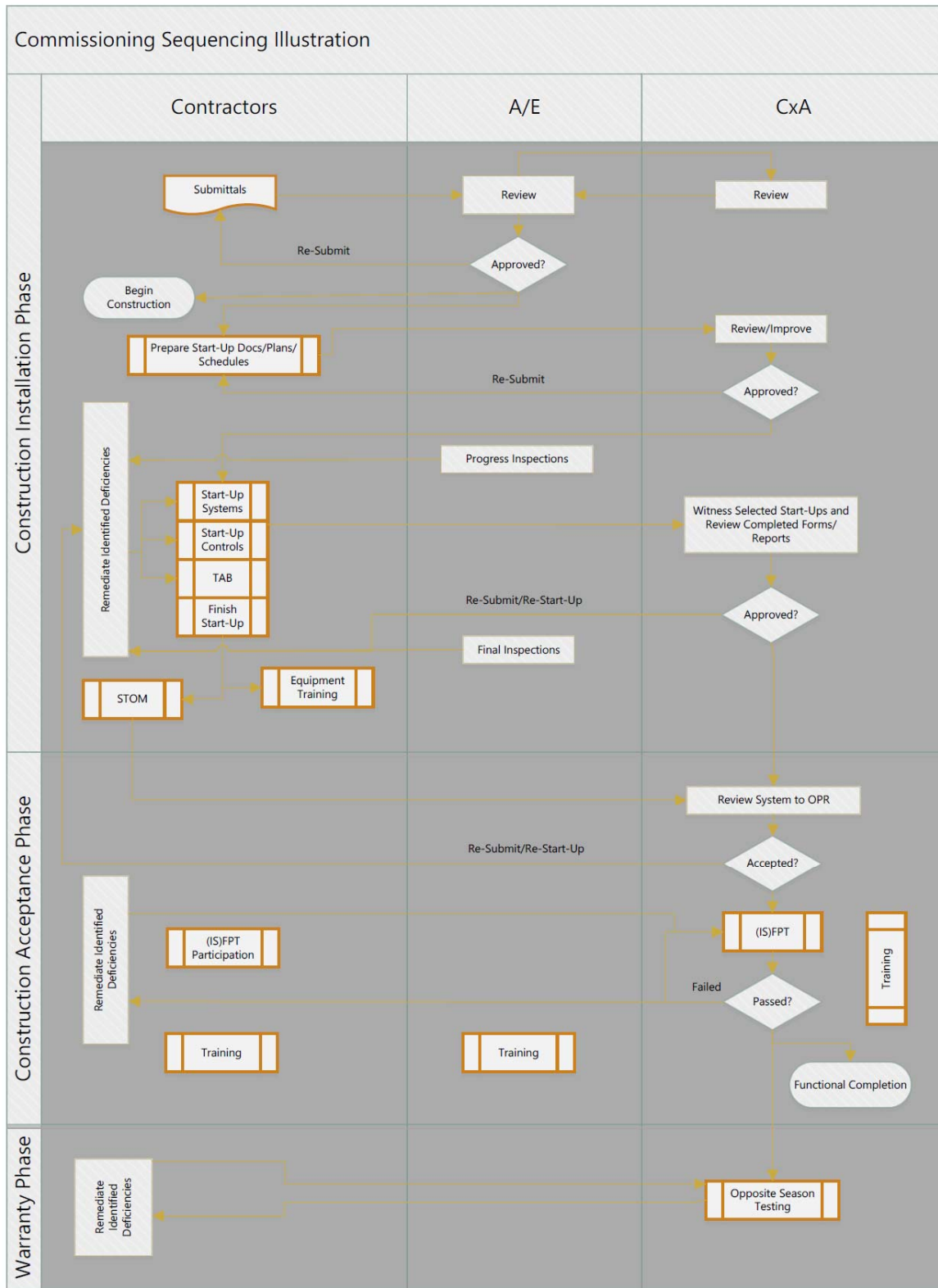
PART 3 - EXECUTION

3.1 GENERAL STARTUP STANDARD OF CARE

- A. Procedures that establish a minimum Standard-of-Care for the start-up, checkout and testing of applicable equipment are specified in the individual technical specifications, each commissioning section and in Section 019113.13. Contractor shall apply this Standard-of-Care and document per the Cx requirements.

3.2 FUNCTIONAL PERFORMANCE TESTING

- A. Functional Performance Testing procedures are specified in Section 019113.13. Contractor shall participate in the development and approval of the testing procedures, as well as participate as required in the initial sample of tests as indicated herein.



END OF SECTION

SECTION 01 91 13.13

GENERAL COMMISSIONING REQUIREMENTS FOR FUNCTIONAL PERFORMANCE TESTING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Functional Performance Testing (FPT or 'testing') of systems.
- B. Documentation of FPTs.
- C. Acceptance criteria.

1.2 SCOPE

- A. This section describes the Functional Performance Testing (FPT) process, procedures, and requirements. It is intended to illustrate (i) the Contractor's requirements for assisting the Commissioning Authority (CA) with the Functional Performance Testing of systems, and (ii) to demonstrate the level at which systems and equipment will be tested prior to being deemed 'Acceptable' to the Owner.
- B. The CA will prepare itemized and detailed FPT plans and procedures that:
 - 1. Specify individual tests and procedures that meet the general requirements of the Cx Plan and commissioning (Cx) process;
 - 2. Serve to document and record the testing procedures and the results of the tests.
- C. The Contractor shall provide technical input to the CA as needed during the development of the final project FPTs.
- D. Example (referred herein to as 'generic') FPTs are provided as illustration for the Contractors to represent the level of detail to which FPTs will be conducted.

1.3 RELATED WORK AND DOCUMENTS

- A. The Cx process references many related Sections, particularly Section 019100 - General Commissioning. It is important for all Contractors subject to the Cx process to be familiar with Section 019100.
- B. Refer to Section 019100 for a complete list of Sections on Related Work.

1.4 DEFINITIONS AND ABBREVIATIONS

- A. Refer to Section 019100 for a complete list of Definitions and Abbreviations. This paragraph includes a comprehensive list of acronyms describing the various required Parties referred to in the Section for individual FPTs.

1.5 REFERENCE STANDARDS

- A. Refer to Section 019100 for a complete list of Reference Standards.

1.6 FUNCTIONAL PERFORMANCE TESTING

- A. Objectives and Scope: Systems shall be tested to ensure proper operation through all modes of operation including normal expected operation, maintenance operation as well as proper response to system and component failures that are considered abnormal operation as indicated below.
 - 1. Normal Operation: Each system shall be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. These series of tests will demonstrate that the systems and equipment operate throughout typical operation including normal adjusting, cleaning, media replacement, and maintenance.
 - 2. Abnormal Operation: Test each system to simulate possible abnormal conditions and verify proper responses to such modes and conditions as power failure, equipment and component failure, freeze condition, deviation of operating parameters outside of normal, no flow, supporting utility failure, human error, etc. Abnormal operation tests shall demonstrate proper and safe response to the subject systems and the other systems that it affects or integrates with. These tests shall also demonstrate proper enunciation of abnormal conditions to quickly and effectively notify users and operators of such condition. Specific modes required in this project are given in this section and any other sections where test requirements are found.
- B. Development of Test Procedures: CA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Prior to execution, the CA shall provide a copy of the test procedures to the Contractor who shall review the tests for feasibility, safety, equipment and warranty protection, and scope. The CA will also submit the tests to the A/E for review.
 - 1. Contractor shall review the FPTs in detail and approve them.
 - 2. The CA shall review Owner-contracted testing, factory testing, or required Owner acceptance tests for which the CA is not responsible to oversee. Review shall include content, scope, and documentation format, and shall determine what further testing or format changes may be required. Redundancy of testing shall be minimized.
 - 3. The purpose of any given specific FPT is to verify and document compliance with the stated criteria of acceptance.
- C. Scheduling: Owner shall schedule the Functional Performance Testing after system 'Turn-Over' occurs (Turn-Over or STOM is the official Contractor notification that systems have completed Start-Up and are ready for testing with all required submissions and reviews of all the required submittals has occurred). To the extent practical, tests shall be scheduled to allow efficient and contiguous testing of inter-related systems and equipment.
- D. Participation: CA will direct and conduct Functional Performance Tests after Start-Up Documentation of systems and equipment has been reviewed and accepted and system 'Turn-Over' occurs. Conceptual procedures for the Functional Performance Testing are outlined elsewhere in this Section. CA will execute the FPTs unless otherwise specified. Contractor shall assist as described above with manipulation of the systems or equipment, provision of supporting equipment or materials (lifts, ladders, specialty test equipment, safety equipment), and on-the-spot remediation of minor identified deficiencies whenever possible. Required participation is outlined in the generic FPTs provided elsewhere in this Section.

1. Any Cx Team member may attend any FPT. Required Parties are as described below.
 2. Required participating Parties shall be indicated with the individual FPT. Typically, multiple Parties are required for any given test, yet participation for any given Party is only required for the respective portion of the test for which the Party is responsible. For instance, BAC does not have to be present for capacity testing of an air handler, only the control-related portion of the test. In many cases, the maximum required time in hours is indicated in parenthesis for any given test. The time is typically per unit system unless indicated otherwise (i.e.: 1-hr per air handler tested). If no time is indicated, participation is required throughout the entire test.
 3. Frequently, on multiple samples where a given Party does not directly conduct the test, the participation of that Party will only be required for an initial quantity of systems/equipment. Whenever practical and at the discretion of the CA, the CA will continue with the remaining portion of the sample without assistance from the Contractor. In this case the time requirement will be indicated as total. However, the Contractor is allowed to be present at their option for any or all FPTs conducted.
 4. It is required that the required Parties be available on-site throughout the testing of any given system for which they are required participants. Therefore, time for which they are not directly involved can be spent performing other work (typically addressing identified punch list items or failed tests).
 5. No Party involved with the project is prohibited from participation in or witnessing of any tests. Any Contractor may elect to witness all tests on their systems even if their involvement is not directly required (for instance, BAC involvement is sometimes required on the first few of a sample and not on the entire sample).
 6. CA will endeavor to coordinate effectively with the individual Contractors throughout FPT and minimize their required involvement.
 7. Contractor assumes responsibility for damage to systems conducted in accordance with the approved procedures.
- E. Detailed FPT Development and Contractor Review: CA will prepare detailed and itemized testing procedures to define and document the FPT. These will typically be developed during the Construction Phase and completed during the Acceptance Phase. The CA shall submit these procedures to the Contractor for review. Contractor shall indicate all required limitations, safety procedures, maximum thresholds, and any other parameters during the FPT development. Contract shall be responsible for any damage to the equipment caused by Functional Performance Testing done per the procedures and within the limitations of the approved procedures.
- F. Completeness: All systems must be completed and ready for FPT. All Start-Up Documentation, factory-authorized field testing, independent testing agency tests, and TAB procedures must be complete and the control systems must be tested and started for the respective system or component.
- G. Test Documentation: CA will conduct tests, and/or witness tests as applicable. CA will record all test results on the forms developed for the testing. CA will 'Pass' or 'Fail' the testing and record the date and time of the test. Deficiencies shall clearly be indicated when the test is failed. When all related testing is completed successfully, CA shall recommend acceptance of the system or component.
- H. Deficiencies and Retesting: When deficiencies are identified during testing, depending on their extent or magnitude, they can be corrected during the test and the testing can continue to successful completion. More significant deficiencies will require failure of the test and re-testing. Deficiencies of this magnitude will result in an Action Item on the Action List. The resolution of the deficiency will then subsequently be tracked by the CA via the Action List. All tests shall be repeated until successful completion. Refer to more specific provisions below.

- I. Sampling: Some types of identical equipment (such as terminal devices) will be tested using a sampling strategy. The sample percentage is indicated in the generic FPT provided elsewhere in this Section.
- J. Max Failure Limit and Sample Percentages: A 'Maximum Failure Limit' is indicated along with the 'Sampling Percentages'. The Max Failure Limit indicates the maximum percentage of the tested devices that may have any test that fails before an entirely new sample must be tested. This is based on the concept that if many failures occur, it is a result of inadequate start-up by the Contractor. When the maximum number of failures is reached, testing on that sample will be terminated and re-testing will be scheduled.
 - 1. If no Max Failure Limit is indicated, all tested samples must pass (Max Failure Limit = 0%).
 - 2. Where sample tests involve multiple systems (i.e., checking strainers on different hydronic systems), the Maximum Failure Limit will apply per system.
 - 3. The responsible Contractors shall pay the CA cost of that sample test, and redo the startup/TAB for the applicable devices/systems.
 - 4. All work necessitated by sample failures shall be at no cost to the Owner.
- K. Opposite Season Testing: Testing procedures shall be repeated and/or conducted as necessary during appropriate seasons. Opposite Season testing will be required where scheduling prohibits thorough testing in all modes of operation. Air handler and central heating system testing for heating-related modes of operation and control loops shall be tested during outside air temperatures below 40 °F.
- L. Approval. The CA passes each test and subsequently recommends approval to the Owner who reviews and approves the FPT.

1.7 COORDINATION BETWEEN TESTING PARTIES

- A. Factory Start-Ups: For many systems and equipment, Factory Start-Ups are specified. These Factory Start-Ups will be reviewed and checked during Functional Performance Testing. All costs associated with the Factory Start-Ups are included with the bid unless otherwise noted. Contractor shall make notification of when Factory Start-Ups are occurring and coordinate these with witnessing Parties. The CA and other Cx Team members may witness Factory Start-Ups at their discretion. Aspects of Functional Performance Testing accomplished during the Factory Start-Ups may be accomplished and approved by the CA if they meet the intent of the FPT.
- B. Independent Testing Agencies: For systems where Independent Testing Agencies are specified, the cost of this testing shall be included with the bid unless otherwise noted. Much of the testing performed by Independent Testing Agencies will cover aspects required in the Start-Up Documentation and Functional Performance Tests.
 - 1. Contractor and testing agencies shall coordinate with the CA so that the CA can witness the testing and approve the applicable aspects of the FPTs.
 - 2. The CA may in some cases independently spot-check work of the testing agencies if the tests were not witnessed. However, it is not the intent for the CA to re-accomplish testing by others that is specified in the construction specifications. For instance, much of the testing requirements for the electrical systems will be performed by the independent electrical testing agency provided under the bid. The CA shall witness the indicated sample of the testing and record the results in the record of Functional Performance Tests.
 - 3. Contractor is responsible for coordinating the efforts of testing agency with that of the Cx process. Documentation shall be contiguous and seamless and duplication should be avoided. Testing agencies shall complete the documentation of the Cx process as required.

1.8 FPT ACCEPTANCE CRITERIA

- A. The Acceptance Criteria shall be as follows unless more specifically indicated within individual tests. CA may exercise professional judgment to relax requirements and pass tests and recommend approval when appropriate.
1. Capacity: Capacity and/or equipment performance will generally be as specified $\pm 5\%$.
 2. Efficiency: Efficiency where specifically indicated in the documents will be $\pm 5\%$. When inferred from manufacturer's catalogue data, criteria will be $\pm 10\%$.
 3. Balancing: Balancing-related criteria will be $\pm 5\%$ for water and $\pm 10\%$ for air.
 4. Accuracy: Accuracy/repeatability on sensing devices will be as specified for the device. CA and TAB will use calibrated gages for independent validation and use judgment in passing or failing the devices. In many cases, the coordination of multiple related sensors is more important than absolute accuracy.
 5. Controls: Control feedback loop response and setpoint deviation criteria will be as specified in Sections 230800.
 6. Sequences: HVAC sequence-related criteria will be as explicitly specified in the documents and as interpreted by the CA. Code required sequencing shall be per the applicable code.
 7. System sequences shall be as required by the approved shop drawings.
 8. Motor Phase Imbalance: Shall be no more than 2% (Amps and Volts).
 9. Noise Levels:
 - a. Occupied Spaces: As indicated in the Owner's Project Requirements or Basis of Design (OPR/BOD) document. Otherwise, noise level shall be as recommended in the most current version of the ASHRAE Handbooks for the applicable occupancy.
 - b. Max 77dBA at 3' from a UPS.
 - c. Max 65dBA at 7' from an Engine Generator Set.
 - d. At limits of the enterprise or facility: As required by current local ordinances.
 10. Indoor Environmental Parameters (T, RH, CO₂, VOC): Shall be as indicated in the Basis of Design document. Otherwise, as recommended in the most current version of the ASHRAE Handbooks for the applicable occupancy.
 11. Air Pressurization: As indicated in the OPR/BOD document. Otherwise, as indicated in the most current version of the ASHRAE Handbooks for the applicable occupancy. Smoke/shaft pressurization shall be as required by NFPA to maintain maximum door opening forces and to restrict the passage of smoke.
 12. Indoor Lighting Levels: As indicated in the OPR/BOD document. Otherwise, as recommended in the most current version of the IES Handbooks for the applicable occupancy.
 13. Electrical Systems: Shall be in accordance with manufacturer's recommendations of individual components and devices, NFPA 70B and International Electrical Testing Association (NETA) testing specifications NETA ATS-Latest Version.
 14. Inter-system interfaces and coordination: As specified and generally to ensure safe, reliable, and robust operation.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

- A. General: All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance within the tolerances specified. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates

readily available. Supplier of instrumentation shall submit the calibration certificates along with the startup documentation.

- B. Standard Testing Instrumentation: Standard instrumentation normally used for performance assessment and diagnosis will be provided by the CA for tests being conducted by CA. All other instrumentation shall be provided by the Contractor. The instrumentation to be provided by the CA includes:
 - 1. Electronic manometer (for air and flow hood).
 - 2. Electronic manometer (for water).
 - 3. Temperature instruments and gauges.
 - 4. Humidity instruments and gauges.
 - 5. CO2 instrument.
 - 6. Sound meter.
 - 7. Light level meter.
 - 8. Electronic multimeter.
 - 9. Receptable tester.
- C. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and provided to the Owner.
 - 1. Provide a temporary license to software needed to access the BAS at both the terminal equipment and on the primary LAN/at primary controllers. Provide all configuration utilities needed to read all parameters and set up terminal boxes. Provide temporary graphic interface software license for use during the Acceptance Phase.

PART 3 - FUNCTIONAL PERFORMANCE TESTS (SYSTEMS AND EQUIPMENT RELATED)

3.1 PREREQUISITES

- A. All equipment, components, and devices applicable to the FPT must be started and operational and systems must have completed a STOM successfully or be 'Turned-Over' to the Cx Team. This includes completion of Start-Up Documentation, pressure testing of equipment, duct, piping; flushing/cleaning of applicable systems; completed labeling and identification; completed insulation of applicable systems; and all other requirements for placing system into dynamic operation.
- B. Unless specifically agreed upon by the Owner and CA, all support systems shall be complete prior to FPT. For instance, an air handler will require that:
 - 1. The electrical system serving it is completed and tested.
 - 2. The hydronic systems serving it have been pressure tested, flushed, and functional performance tested.
 - 3. Balancing has been accomplished on the air and water sides.
 - 4. The control systems have been started and calibrated.
- C. The CA shall determine the optimal sequence of testing.

3.2 FUNCTIONAL TESTING PROCESS

- A. Functional Performance Testing ('Functional Testing') on any given system shall typically begin with testing device-level elements such as sensors and actuators; progress to component-level assemblies of devices; then to system-level, then to inter-system level, then to building-level.
- B. Functional Testing of systems shall generally proceed from the utilities to the central systems, to the distribution systems, to the zone terminal units and services. CA shall plan this process and communicate it through a precedent diagram (in Gantt or Pert format). Construction Manager shall reflect that process in the Construction Schedule. Subcontractors shall perform work in accordance with the schedule.

3.3 COMMON ELEMENTS FOR ALL SYSTEMS

- A. Required submittal documentation shall be present and located convenient to testing area. Validate that all required documentation has been submitted and is per the contract requirements.
- B. Contractor shall provide the completed Start-Up Documentation and shall follow Turn-Over procedures as specified in Section 019100. CA shall review the Start-Up Documentation and spot-check the installation prior to or at the beginning of the FPT.
- C. Contractor shall demonstrate that access is sufficient to perform required maintenance.
- D. BAS trends shall have been established as required in the documents. These shall be available for review prior to or during the FPT.
- E. All dynamic systems powered by electricity shall be tested to simulate a power outage to ensure proper sequencing. Those on emergency power or uninterruptible power shall be tested on all sources.
- F. Capacities and adjusted/balanced conditions as applicable shall be subject to check.
- G. Sequencing Verification: All modes of operation and actions shall be verified for equipment/system samples.
- H. System and equipment configurations shall be compared against the contract documents.
- I. Verify functions (such as heating and cooling) are coordinated and do not overlap or 'fight'.
- J. All adjusted, balanced, controlled systems shall be assessed to determine the optimal setting for the system as applicable. The optimal settings should be determined to establish reliable, efficient, safe and stable operation.
- K. BAS or Local Panel Dynamic Graphics: The graphic displays for all components, systems, and areas required to be represented by a BAS graphic shall be checked for adequacy and accuracy. Furthermore, when setpoints or other parameters are required to be adjustable, CA shall verify that they can be adjusted directly from the graphic screen.
- L. Emergency power tests for mechanical systems will be conducted in concert with the testing of the emergency power systems. Mechanical contractor shall be available for the power outage test to test mechanical systems under a power outage. This is in addition to the requirements specified for the mechanical system.

- M. Where system and zones are designed for various modes of operations, test representative systems in all modes of operation. This includes:

1. Seasonal Modes.
2. Sequencing Modes.
3. Emergency Modes.

3.4 TAB VERIFICATION OF MECHANICAL SYSTEMS

- A. CA shall review TAB reports.
- B. Participants shall include: CA, Owner's Representative, and TAB.
- C. The CA will select up to 10% of the readings from the Balancing Reports and spot-check them. The maximum failure rate for this sample is 10% and the system shall be re-balanced and re-documented if this rate is exceeded. The readings selected by the CA may include supply air diffuser readings (both minimum and maximum readings for VAV boxes), main and branch supply duct traverse readings, outside/return air flow readings, exhaust air flow readings, water flow readings, amp readings, and water pressure drop readings through coils, heat exchangers, and other hydronic elements. For all readings a deviation of more than 10% between the verification reading and reported data shall be considered as failing the FPT. All readings that fail the FPT shall require re-balancing.

3.5 VARIABLE SPEED DRIVES (VSD)

- A. Participants shall include: CA, MC (2), BAC (2), EC (1). Additional time is generally included with the systems that include the drives.
- B. Sample: 50%; max failure limit: 20%.
- C. FPT shall include 'Common Elements for All Systems' (above) to the extent applicable.
- D. CA shall review Start-Up Documentation.
- E. Verify the overload protection.
- F. Test the operation of the controller local and remote start/stop and speed control. Spot-check insulation resistance on the controller bus and control circuits.
- G. Validate VSD setup parameters are coordinated with motor application.
- H. Validate VSD acceleration and deceleration rates on start and stop.
- I. Verify ranging of control input and coordination with that displayed on Operator Interfaces.
- J. Verify 'Bypass' functionality where applicable.
- K. Verify restart after power outage.
- L. Verify any 'Skipped Frequencies' are programmed and recorded.
- M. Verify alarming and shutdown sequences.

- N. Conduct insulation resistance, short circuit, and ground tests of motors.

3.6 AIR HANDLING UNIT

- A. Participants shall include: CA, MC (2), TAB (4), and BAC (8). Hours indicated are for first of each AHU type for all Parties.
- B. Sample: 50%, Max Failure Limit: 10%.
- C. FPT shall include 'Common Elements for All Systems' (above) to the extent applicable.
- D. CA shall review Start-Up Documentation and TAB reports.
- E. Verify automatic start/stop of fan and open/close of outdoor air damper(s).
- F. Start heating and cooling system, manipulate control device to obtain maximum cooling and heating. Measure temperatures and pressures to determine capacity.
- G. Weather permitting, cause all applicable modes of operation using false loading where practical. Check proper sequence for switching modes and proper operation within a mode.
- H. Check calibration of control devices and for stable control response and component performance including chilled water coils, hot water coils, steam coils, humidifiers, economizer cycles, and others. Ensure proper coordination of control loops and that no fighting or energy wastes result.
- I. Check for free and adequate flow of cooling coil condensate.
- J. For variable speed fans, manipulate air terminal units to change flow conditions and observe control response. Ensure stable control response to step-change in flow conditions. Manually ramp fan speed from minimum to maximum to ensure stable operation of fans. Record representative part load output from the drive. Check calibration of control input. Check drive bypass operation if applicable.
- K. For fans with inlet vanes, manipulate air terminal units to change flow conditions and observe control response. Ensure stable control response to step-change in flow conditions. Manually modulate vanes from minimum to maximum to ensure stable operation of fans. Record representative part-load power draw on the motor. Check calibration of control input.
- L. Ensure minimum required ventilation rates are maintained across the full range of control (where applicable).
- M. Test all interfaces with the fire alarm system and all smoke control sequences.
- N. Verify interlocks with exhaust fans where applicable.
- O. Test proof alarming where applicable.
- P. Test operation of applicable safeties including freezestats, high and low static devices, smoke detection, duct humidity, and others. Check AHU component status in each event.
- Q. Check system status and operation in the Off, Unoccupied, and Occupied modes of operation. Validate proper start up and shut down sequences.

- R. Test all 'Fireman Control and Override' sequences.
- S. Simulate power outage and ensure automatic and orderly restart.

3.7 VAV AIR TERMINAL (HVAC)

- A. Participants shall include: CA, MC, TAB, and BAC.
- B. Sample: 25%; Max Failure Limit: 10%.
- C. FPT shall include 'Common Elements for All Systems' (above) to the extent applicable.
- D. CA shall review Start-Up Documentation and TAB reports.
- E. Check the calibration of zone temperature sensors.
- F. Set boxes for both minimum and maximum flow (typically by setting the space temperature setpoint up and down) and check the calibration of the flow settings.
- G. Check the stability of the zone temperature control loop for the damper and any associated heating devices by changing the space setpoints and observing the response.
- H. Cause all applicable modes of operation using false loading where practical. Check proper sequence for switching modes and proper operation within a mode.
- I. Determine the optimal settings for the control parameters.
- J. Simulate and test the unoccupied and emergency mode response of the VAV box where applicable.
- K. Check the capacity of the heating device where applicable.

3.8 BUILDING AUTOMATION SYSTEM (BAS)

- A. Participants shall include: CA and BAC (Time is typically included in the individual systems. However, an additional 8 hrs shall be for workstation and administrative aspects.)
- B. Refer to Section 230810 for BAS Commissioning requirements.
- C. Refer to Section 230900 for General BAS Performance Requirements.
- D. FPT shall include 'Common Elements for All Systems' (above) to the extent applicable.
- E. CA shall review Start-Up Documentation.
- F. Controls system sampling will typically correspond to the sampling rate of a system or piece of equipment. These sampling rates are indicated above for the respective item.
- G. Operate the equipment and subsystems through all specified modes of control and sequences of operation including full and part load conditions, and emergency conditions.

- H. Verify that equipment operates in accordance with design intent and approved control diagrams. This shall include checking the operation of dampers, valves, smoke detectors, high and low limit controls, of a sample of 25% of components with a maximum failure limit of 10%.
- I. Analog Input (AI) Sensors: (at a sample of 50% of the inputs on the sampled devices (see above for device samples) with a maximum failure rate of 10%). Spot-check AI sensors (space temperature sensors, outside, return, and mixed air temperature sensors, discharge air temperature sensors, chilled water and hot water temperature sensors, and humidity sensors, air and water differential pressure sensors, airflow monitoring stations, etc.) for acceptable accuracy (which is generally as specified for the device).
- J. Analog Outputs - Valves, Dampers and Actuators: (at a sample of 50% of the inputs on the sampled devices (see above for device samples) with a maximum failure rate of 10%) Ensure that valves and dampers and their actuators close-off or seal against the maximum pressure differential. Ensure that the actuators stroke throughout the correct range (correlated with the programmed range) under operations pressures anticipated and that the positioners are set correctly where applicable.
- K. Trends: Establish trends of control system points for a minimum of a two-week period prior to and throughout the Acceptance period. Trends shall be analyzed to identify any control problems, lack of capacity, control loops fighting or unstable, or other operational anomalies.
- L. Automatic Switches: Spot-check (at a sample of 50% of the inputs on the sampled devices (see above for device samples) with a maximum failure rate of 10%) the operation of all automatic switches (pressure switches, current switches, flow switches, and others) to ensure that they are adjusted to proper make and break settings.
- M. Verify the standalone functionality of the controllers. Typically this will involve disconnecting LAN communication wiring and ensure that the controller functions properly and that the loss of communication is acknowledged by the interface. Restore communications and ensure an orderly restoration to normal control.
- N. Verify that the BAS interface, BAS software, graphics and functions are in accordance with design intent and approved control diagrams.
- O. Check dial-in communications and internet access where applicable to ensure functionality.

3.9 SHAFT (FIRE FLOOR, ELEVATOR AND STAIRWELL) PRESSURIZATION SYSTEMS

- A. Participants shall include: CA, MC, BAC, EC, and FAC.
- B. Sampling: 100%.
- C. FPT shall include 'Common Elements for All Systems' (above) to the extent applicable.
- D. CA shall review Start-Up Documentation.
- E. Check interfaces between the systems.
- F. Test should typically be conducted when it is as cold outside as can be scheduled during the Acceptance Phase. Final test must be conducted below 32°F to assess the worst case of pressure difference throughout the shaft with building stack affect.

- G. Notify proper authorities for fire alarm test.
- H. Initiate a Fire/Smoke Evacuation condition by releasing smoke into a smoke detector or tripping fire alarm. Observe system start-up and actuation.
- I. Measure the extremes of pressure at the top and bottom of the shaft relative to outside and the opposite side of doors. This measurement shall be with all doors closed, with the exit door open, and with two random floor doors open along with the exit door. Ensure door opening force is less than 35 lbs and that all floors are at least 0.1" w.c. positive with respect to atmosphere.
- J. Validate all enunciation and override functions.
- K. Verify 'Elevator Recall' functions when applicable.

3.10 BUS DUCTS

- A. Participants shall include CA and EC.
- B. Sample: 100%.
- C. FPT shall include 'Common Elements for All Systems' (above) to the extent applicable.
- D. Review Start-Up Documentation.
- E. As applicable, review the Independent Electrical Testing Agency report.
- F. Refer to Building Power Outage Test.

3.11 SWITCHGEAR

- A. Participants shall include CA and EC.
- B. Sample: 100%.
- C. FPT shall include 'Common Elements for All Systems' (above) to the extent applicable.
- D. Review Start-Up Documentation.
- E. As applicable, review the Independent Electrical Testing Agency report.
- F. Refer to Building Power Outage Test.

3.12 DISTRIBUTION TRANSFORMERS DRY TYPE

- A. Participants shall include: CA and EC.
- B. Sample: 20%; Failure Limit 10%.
- C. FPT shall include 'Common Elements for All Systems' (above) to the extent applicable.
- D. Review Start-Up Documentation.

- E. Review the Independent Electrical Testing Agency report (as applicable).
- F. Review thermographic images (as applicable).
- G. Measure current, voltage and harmonics under peak load conditions.

3.13 DISTRIBUTION PANELBOARDS AND ASSOCIATED LOADS

- A. Participants shall include: CA and EC.
- B. Sample: 20%; Failure Limit 10%.
- C. FPT shall include 'Common Elements for All Systems' (above) to the extent applicable.
- D. Review Start-Up Documentation.
- E. Review the Independent Electrical Testing Agency report (as applicable).
- F. Spot-check phase balance. Ensure proper, thorough, and accurate identification of load. Trip breakers and validate load identified. Test GFI breakers.
- G. Circuit Labeling Test – Connected Equipment (excluding Lighting): Check labeling of circuits with connected equipment by opening circuit breaker and inspecting equipment shutdown or by measuring loss of power at the equipment. Check labeling for consistency with existing facilities and/or record drawings.
- H. Circuit Labeling Test – Receptacles and Lighting: Panelboard circuit labeling and grounding continuity shall be verified (up to 10% of circuits in each panel). Check circuit labeling by de-energizing circuits while circuit tester is in the receptacle.
- I. Receptacle Polarity Test: Spot-check receptacles installed or reconnected under this contract with a receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open.
- J. As applicable, review the Independent Electrical Testing Agency report.

3.14 GROUND-FAULT RECEPTACLE CIRCUIT INTERRUPTER TESTS

- A. Participants shall include: CA and EC.
- B. Sample: 100%.
- C. FPT shall include 'Common Elements for All Systems' (above) to the extent applicable.
- D. Test each receptacle or branch circuit breaker having ground-fault circuit protection to assure that the ground-fault circuit interrupter will not operate when subjected to a ground-fault current of less than 4 mA and will operate when subjected to a ground-fault current exceeding 6 mA. Perform testing using an instrument specifically designed and manufactured for testing ground-fault circuit interrupters. 'TEST' button operation shall not be acceptable as a substitute for this test. Replace receptacles that do not shutoff power with 5/1000 of an ampere within 1/40th of a second and retest. Submit test report signed by the Test Engineer who performed this test.

3.15 EMERGENCY GENERATOR AND EMERGENCY DISTRIBUTION SYSTEM

- A. Participants shall include: CA and EC (entire test).
- B. Sample: 100% of generators; 100% Utility feeds; 25% Distribution breakers; 100% Automatic Transfer Switches.
- C. FPT shall include 'Common Elements for All Systems' (above) to the extent applicable.
- D. Witness specified Factory-Certified Start-Up Documentation and demonstrations.
- E. Review and check Start-Up Documentation and Factory-Certified Tests.
- F. Record system settings and parameters.
- G. Coordinate this test with facility power outage test.
- H. Open normal breakers to simulate various levels of power outages including all utility feeds, single feed, transformers, and distribution panels.
- I. With each outage test configuration, observe generators start and take load. Record volts, amps, frequency, power factor phase angle for all phases and for all generators. Monitor engine temperatures. Monitor battery charge.
- J. With each outage test configuration, fail generators successively (by simulating different support system component failures including fuel delivery as well as engine safety trips including high temp, high oil pressure, low oil pressure, and over-speed) and observe priority demand control dump load to the highest priority. Restore generators and see the demand control restore all priority blocks. Ensure generator support systems remain to highest priority.
- K. Observe fuel delivery capacity at peak loads. Fail sample delivery systems de-energizing the feed pumps. Verify low level alarms on the day tanks.
- L. With systems operating on emergency power, spot-check power parameters of all systems on emergency power. Emergency testing of individual systems are covered under those systems.
- M. Measure and document noise levels.
- N. Restore normal breakers and observe systems re-transfer to normal. Observe generator cool down and shutdown sequence and record parameters.
- O. Verify paralleling gear sequence of operation including generator start up, generator synchronizing, operation of all relaying and instrumentation
- P. As applicable, review the Independent Electrical Testing Agency report.

3.16 UNINTERRUPTIBLE POWER SYSEM (UPS)

- A. Participants shall include: CA, EC, and Factory Authorized Representative. All Parties shall be present during the entire test.
- B. FPT shall include 'Common Elements for All Systems' (above) to the extent applicable.

- C. Refer to Division 26. Functional testing will be performed in concert with the Factory Representative functional performance testing.

3.17 LIGHTING AND LIGHTING CONTROL SYSTEM

- A. Participants shall include: CA and EC.
- B. Sample: 20%, Failure Limit 10%.
- C. FPT shall include 'Common Elements for All Systems' (above) to the extent applicable.
- D. Witness specified Factory-Certified Start-Up Tests and demonstrations.
- E. Spot-check the lighting systems Start-Up Documentation and ensure that all luminaires and lamps are operational and fixtures are clean.
- F. Spot-check occupancy sensor placement and test reliability of activation/deactivation.
- G. Test photocells for functionality and accuracy.
- H. Spot-check switches to ensure proper operation and circuiting.
- I. Spot-check lighting schedules to ensure they are programmed per the Design Engineer's direction.
- J. Spot-check lighting levels to ensure compliance with IES and/or the design requirements for the respective occupancy.
- K. Test operation of circuits by changing system Date and Time to cause various circuits to switch modes. For rooms with occupancy sensors, validate the circuit energizes with occupancy in the space after the lights have been swept off. Test warning flicker prior to off sweep. Test cleaning and shed features.
- L. Test operation of daylight dimming control system if applicable.
- M. For exterior fixtures, simulate 'Night Mode' to validate function. Measure and record light level to ensure they meet the requirements and are generally provide adequate security. Check for excessive light level fluctuations or dark spots.

END OF SECTION

SECTION 02 41 19

SELECTIVE DEMOLITION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Selective demolition of building elements for alteration purposes.

1.2 RELATED REQUIREMENTS

- A. Section 01 10 00 - Summary: Limitations on Contractor's use of site and premises.
- B. Section 01 50 00 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- C. Section 01 70 00 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Not applicable.

PART 3 EXECUTION

3.1 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 1. Obtain required permits.
 2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 3. Provide, erect, and maintain temporary barriers and security devices.
 4. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 5. Do not close or obstruct roadways or sidewalks without permit.
 6. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
 7. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.
- B. Do not begin removal until receipt of notification to proceed from Owner.
- C. Protect existing structures and other elements that are not to be removed.
 1. Provide bracing and shoring.
 2. Prevent movement or settlement of adjacent structures.
 3. Stop work immediately if adjacent structures appear to be in danger.

3.2 EXISTING UTILITIES

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.
- E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.
- F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.3 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove items indicated on drawings.
- C. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 - 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - 3. Verify that abandoned services serve only abandoned facilities before removal.
 - 4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.
- D. Protect existing work to remain.
 - 1. Prevent movement of structure; provide shoring and bracing if necessary.
 - 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 - 3. Repair adjacent construction and finishes damaged during removal work.
 - 4. Patch as specified for patching new work.

3.4 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site.

- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 07 81 20

SPRAY APPLIED FIREPROOFING

PART 1 – GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Fireproofing, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.02 QUALITY ASSURANCE

- A. ASTM International (ASTM):
 - 1. ASTM E605 Standard Test Methods for Thickness and Density of Spray Fire-Resistive Material (SFRM) Applied to Structural Members
 - 2. ASTM E736 Cohesion/Adhesion of Spray Fire-Resistive Material (SFRM) Applied to Structural Members
- B. UL:
 - 1. Fire resistance ratings for assemblies: UL Fire Resistance Directory.
 - 2. Fire resistance ratings for materials: UL Building Materials Directory.
- C. Building Construction Parameters:
 - 1. Comply with following as locally adopted and amended:
 - a. International Building Code (IBC).
 - b. Year: 2015.
 - c. Building Use and Occupancy Classification: A & B (Press Tower), B (Operations).
 - d. Construction Type: 1B (Press Tower), IIB (Operations) .
 - e. Structural Steel Design: AISC Allowable Strength or Load and Resistance Factor Design, thus non- load restricted UL designs are required.
- D. Minimum hourly fire resistance of building structural elements as defined by Building Code:
 - 1. Primary structural frame: 2 HR.
 - 2. Primary structural frame supporting roof only: 2 HR.
 - 3. Floor deck and secondary structural members: 2 HR.
 - 4. Roof deck and secondary structural members: 1 HR.
- E. Apply only when ambient temperatures are above 40 DEGF and will remain so during curing period.
 - 1. Where temporary protection and heat is provided:
 - a. Maintain ambient temperatures at or above level indicated for 24 HRS; before, during and for 24 HRS after application.

- F. Ventilate spaces during and after application of spray applied fireproofing by natural means or forced-air circulation until fireproofing material dries thoroughly.
- G. Provide services of manufacturer's field service representative prior to, and during application for purposes of:
 - 1. Checking surfaces which fireproofing is to be applied for proper preparation.
 - 2. Provide instructions and technical assistance.
- H. Do not install fireproofing until structure is sufficiently enclosed and roofing is installed to prevent damage to material.
- I. Coordination:
 - 1. Sequence and coordinate application of spray applied fireproofing with other construction operations to comply with following requirements:
 - a. Provide temporary enclosures to confine spraying operations and to protect environment, and to prevent deterioration of fireproofing material due to exposure to weather or unfavorable ambient conditions of humidity, temperature or ventilation.
 - 2. Avoid exposure of fireproofing material to abrasion and other damage caused by construction operations after application.
 - 3. Do not apply concealed fireproofing until clips, hangers, supports, sleeves and other items penetrating fire protection are in place.
 - 4. Do not install ducts, piping and other items that would interfere with application of spray applied fireproofing until application is complete and approved by field testing.
 - 5. Do not install enclosing or concealing construction until spray applied fireproofing has been installed, inspected and tested, and corrections have been made to defective applications.
- J. Do not begin application of spray-applied fireproofing to underside of roof deck until roofing is complete, roof top units are installed, and construction roof traffic has ceased.
 - 1. Upon completion of project, manufacturer's representative to certify fireproofing system is properly installed in accordance with design requirements and manufacturer's instructions.

1.03 SUBMITTALS

- A. Product Data: Manufacturer standard literature indicating physical properties of proposed products
- B. Project Information:
 - 1. Detailed plans of sprayed fireproofing, or schedule of sprayed fireproofing, identifying project specific structural elements, floors and roofs.
 - a. Select UL designs and prepare under direction of fireproofing manufacturer, indicating physical properties of proposed products including:
 - b. Complete UL design data for each system selected.
 - c. Verification that design is not load restricted.
 - d. Thickness of sprayed fireproofing for specific structural elements.
 - e. Densities of sprayed fireproofing and where used.

C. Contract Closeout Information: Letter of Certification

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Fireproofing:

1. Base: Grace Construction Products

C. Optional:

1. Carbolite Company
2. Isolatek International
3. Promat Firetemp

2.02 DESIGN CRITERIA

A. Select UL approved fireproofing assemblies which meet or exceed the hourly fire resistive requirements indicated by table in Part 1.

1. For each density classification: Utilize materials that comply with Minimum Physical Properties indicated by table in Part 2.
2. Utilize formulations with minimum density classification according to location and exposure condition indicated by table in Part 3.
 - a. Restrained or unrestrained classification of structural members as defined by ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials.
 - b. Select designs determined by Allowable Strength Method or Resistance Factor Method.
 - c. Utilize fireproofing systems which have been tested for use in proposed manner.
 - d. Where steel bar joists are used fireproofing thicknesses shall be based on UL floor or roof test assemblies tested in fully loaded condition, with maximum allowable tensile stress of joist equaling 30 KSI .

2.03 MATERIALS

A. Provide products containing no detectable asbestos as determined in accordance with method specified in 40 CRF 763, Subpart E, Appendix E, Section 1, and Polarized Light Microscopy.

1. Free from forms of asbestos, including actinolite, amosite, anthophyllite, chrysotile, crocidolite and tremolite.
2. Standard Density:
 - a. For use in buildings not defined as high-rise.
 - b. Monokote MK-6 or MK-6/HY or both by Grace Construction Products.
3. Medium Density:
 - a. For use in high-rise buildings from 75 to 450 FT in height.
 - b. Monokote MK-10HB or Monokote Z-106G by Grace Construction Products.

4. High Density:
 - a. For use in high-rise buildings over 450 FT in height.
 - b. Monokote MK-1000HB by Grace Construction Products.
5. Comply with following minimum properties:

Minimum Physical Properties by Density Classification Load Restricted				
Property	Test Method	Standard Density	Medium Density	High Density
Binder Type	--	Gypsum or Portland Cement	Portland Cement 1	Portland Cement
Dry Density	ASTM E605	15 PCF	15 PCF	18 PCF
Bond Strength	ASTM E736	200 PSF	600 PSF	1000 PSF
Compression (at 10 PCT Deformation)	ASTM E761	1200 PSF	4500 PSF	7344 PSF
Maximum Air Erosion	ASTM E859	0.000 G/FT2 Category A	0.000 G/FT2 Category A	0.000 G/FT2 Category A
Corrosion	ASTM E937	Does not contribute	Does not contribute	Does not contribute
Bond Impact	ASTM E760	No cracking, spalling or delamination	No cracking, spalling or delamination	No cracking, spalling or delamination
Deflection	ASTM E759			
Resistance to Mold Growth	ASTM G21	No growth after 28 days	No growth	No growth
Combustibility	ASTM E1354	< 5 MJ/M2	< 5 MJ/M2	< 5 MJ/M2
Flame Spread	ASTM E84	0	0	0
Smoke Developed	ASTM E84	0	0	0

B. Footnotes:

1. Gypsum-based products may be substituted where prolonged exposure to water is unlikely.

C. Fibrous Products:

1. Fibrous spray-applied fire-resistive products will not be permitted on project.
2. Fibrous products, made by any of the Acceptable Manufacturer's listed, will be allowed, provided product meets Minimum Physical Properties listed on Table above.

D. Adhesive:

1. As required for bonding spray applied fireproofing.
2. Products as approved by fireproofing manufacturer.

E. Metal Lath:

1. Expanded metal lath fabricated from material, weight, configuration and finish required to comply with approved UL design designations and fireproofing manufacturer's written recommendations.
2. Include clips, lathing accessories, corner beads and other anchoring devices required to attach lath to substrates and to receive spray applied fireproofing.

F. Water: Potable

G. Cellular Metal Decking:

1. Include manufacturer's standard spatter coat or primer where required by UL Design or where recommended by manufacturer for optimal bond to substrate types.

H. Fungicidal Additive:

1. Include fungicide additive containing sodium propionate, or another approved fungus inhibitor as necessary to comply with Minimum Physical Properties and ASTM-G21.
2. Mix with fireproofing mixture before application.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Verify suitability of substrates to accept application.
- B. Application constitutes acceptance of conditions and responsibility for performance.

3.02 PREPARATION

- A. Clean off materials which impair bond from surfaces to be fireproofed.
- B. Mark location of hangers, inserts, straps, anchors, supports, and similar items by other trades that may be concealed by fireproofing to permit locating after fireproofing is applied.
- C. Schedule installation to allow time for installation of hangers, inserts, straps, anchorages, supports, and similar items by other trades.
- D. Prepare substrates, areas, and conditions for compliance with requirements affecting performance of work.
 1. Substrates shall be free of oil, grease, rolling compounds, incompatible primers, loose mill scale, soil and other foreign substances capable of impairing bond of fireproofing under conditions of normal use or fire exposure.
 2. Objects penetrating fire resistive material, including clips, hangers, supports, sleeves and similar items, shall be securely attached to substrates.
 3. Substrates shall not be obstructed by ducts, piping, equipment and other suspended construction that will interfere with application of spray applied fireproofing.
- E. Conduct tests in accordance with fireproofing manufacturer's written recommendations to verify substrates are free of substances capable of interfering with bond.
 1. Correct unsatisfactory conditions.
 2. Start of application constitutes acceptance of conditions and responsibility for performance.

- F. Cover other work subject to damage from fallout or overspray of fireproofing during application.
- G. For exposed fireproofing applications, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of spray-applied fireproofing.
 - 1. Remove minor projections.
 - 2. Fill voids that would telegraph through fireproofing after application.

3.03 INSTALLATION

- A. General:
 - 1. Install fireproofing of density types listed in this section for exposure locations and that provide fire resistance ratings indicated for components and assemblies.
 - 2. Thickness: Minimum average thickness indicated for UL design designation, but not less than 3/8 inch.
 - 3. Apply in accordance with manufacturer and UL requirements.
 - 4. Provide preparation, primers, adhesives, materials, taping and sealers necessary to provide required fire resistance ratings.
- B. Where required to achieve fire resistance rating or rating recommended in writing by fireproofing manufacturer, coat metal deck substrates with adhesive before applying fireproofing material.
- C. Extend fire resistive material in full thickness over entire area of each substrate to be protected.
 - 1. Install body of fire resistive covering in single course, unless otherwise recommended in writing by SFRM manufacturer.
- D. Connections of Dissimilar Structural Elements:
 - 1. Definition: Where structural elements are joined to other, often different type, of structural elements having a lesser SFRM protection requirement.
 - 2. Overlap the lesser priority structural element with superior SFRM thickness required by the higher priority element.
 - 3. Minimum Width of Overlap: As required in design system published by UL or similar testing agency, but not less than 6 inches.
- E. Install metal lath if required to comply with fire resistance ratings or fireproofing manufacturer's written recommendations for conditions of exposure and intended use.
 - 1. Securely attach lath to substrate in position required for support and reinforcement of fireproofing material.
 - 2. Use anchorage devices of type recommended in writing by fireproofing manufacturer.
 - 3. Attach lathing accessories where required for secure attachment to substrate.

- F. Spray apply fireproofing to maximum extent possible.
 - 1. Apply fireproofing in thicknesses and densities not less than required for fire resistance ratings for each condition; however, apply in greater thicknesses and densities if indicated.
 - 2. Following the spraying operations in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.
 - 3. Where sealers are used, apply products tinted for differentiation from spray applied fireproofing.
- G. Exposed Fireproofing:
 - 1. Apply fireproofing in thicknesses and densities not less than required for fire resistance ratings for each condition, or apply in greater thicknesses and densities indicated.
 - 2. Finish:
 - a. Following the spraying operations in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.
 - b. In addition, provide uniform even spray textured finish up to 8 FT above finished floor.
 - c. Roll flat surfaces with damp paint roller to remove drippings and excessive roughness of applied exposed fireproofing.
 - d. Provide rolled flat fireproofing surfaces in mechanical rooms, elevator machine rooms, emergency generator rooms, electrical switchgear rooms, and rooms containing similar equipment items.
 - e. Exposed fireproofing higher than 8 FT above finished floor is not required to have rolled flat surface finish using paint roller.
- H. Cure exposed fireproofing in accordance with manufacturer's written recommendations to prevent premature drying.
- I. Fireproof accessory items including but not limited to X-bracing, struts, outriggers, hangers and attachments, and similar items.
- J. At elevated slab depressions, including regions sloped to drain:
 - 1. Apply additional fireproofing as required to compensate for reduced overall floor slab thickness.
 - 2. Extend 2 FT beyond perimeter of depressed region.

3.04 SCHEDULE OF DENSITIES REQUIRED BY EXPOSURE CONDITIONS

- A. Determine appropriate density required for project conditions based on following:
 - 1. Some conditions may not apply to subject project.
 - a. INT. CON. = Interior Concealed
 - b. INT. EXP = Interior Exposed
 - c. EXT. CON. = Exterior Concealed
 - d. EXT. EXP = Exterior Exposed

Minimum Density Required for Location/Exposure Condition					
Location/Exposure Condition of Structural Members			Minimum Density Required		
			Standard Density	Medium Density	High Density
Interior	Concealed	Members that are fully concealed behind permanent Wall or Soffit Construction. Refer to Exposed if any portion of a member is not concealed.	S		
	Exposed	Members that are entirely above ordinary (non-walkable) Suspended Ceilings.	S ^{1,2}		
		Members where any exposed portion occurs within interstitial spaces above walk-able Ceiling Systems (i.e. Laboratories, Clean Rooms, etc).		M ¹	
		Members where any exposed portion occurs within Elevator Shafts, Air Shafts or Air Plenum Space.		M ¹	
		Members where any exposed portion occurs within 8 FT (2.44 m) of Floors, Stair Landings, Treads or similar walking surface.		M ¹	
		Members in Parking Structures, Mechanical Rooms and Storage Rooms where any portion is exposed.			H
		Members where any portion is protected with Deluge Fire Suppression System.			H
Exterior	Concealed	Members that are fully concealed by weathertight construction.	S		
		Members that are fully concealed by exterior soffit construction.	S		
		Members that are concealed by construction that is not completely weathertight.			H
	Exposed	Members that are exposed to weather (permanently).			H

B. Notes

1. Use above Table to select appropriate minimum density, based on the Location/Exposure criteria which best describes the condition. It is acceptable to provide material of a higher density.
2. Where a member or various portions of a member fits multiple Location/Exposure categories, select highest density product from among potential choices and apply to entire member.
3. Refer to Part 2 for minimum properties of each density classification.
4. Refer to Part 1 for hourly fire resistance requirements of various structural elements on this project.

C. Footnotes

1. Ensure the use of Portland Cement-based formulas where prolonged exposure to water or humidity greater than 70 PCT RH is likely.
2. Upgrade to Medium where above-ceiling space is designed as an Air Plenum.

3.05 FIELD QUALITY CONTROL

A. Testing Requirements:

1. Thickness and density testing:
 - a. Test Standard: ASTM E605 Thickness and Density of Spray Fire Resistive Materials (SFRM) Applied to Structural Members.

- b. Minimum Test Frequency: In accordance with building Code, as locally adopted; however, not less than frequency prescribed below:
 - 1) Thickness of sprayed fireproofing applied to floor and roof assemblies will be by taking the average of not less than four measurements for each 1,000 square feet, or portion thereof, of sprayed area in each story (for each hourly rating and material) in accordance with ASTM E605. Test locations will be selected at random.
 - 2) Thickness of sprayed fireproofing applied to structural framing members will be performed on not less than 25 PCT of the structural members in each story in accordance with ASTM E605. Test locations will be selected at random.
 - 3) Floor, roof and wall assembly: at least one sample for every 2,500 sq. ft. or portion thereof of sprayed area in each story in accordance with ASTM E605.
 - 4) Beams, Girders trusses and columns: at least one sample for each type of structural member for each 2,500 sq. ft. or portion thereof in each story in accordance with ASTM E605.
- 2. Bond adhesion and cohesion testing:
 - a. Test Standard:
 - b. ASTM E736 Cohesion and Adhesion of Spray Fire Resistive Materials (SFRM's) Applied to Structural Members.
 - c. Minimum Test Frequency: In accordance with building Code, as locally adopted; however, not less than frequency prescribed below:
 - d. Bond strength of sprayed fireproofing applied to floor, wall and roof assemblies will be by taking the average of not less than one sample for each 2,500 square feet, or portion thereof, of sprayed area in each story (for each hourly rating and material) in accordance with ASTM E736. Test locations will be selected at random.
 - e. Bond strength of sprayed fireproofing applied to structural members will be performed on not less than one sample for each type of structural member (for each hourly rating and material) for each 2,500 SQFT, or portion thereof of floor area, in each story in accordance with ASTM E736. Test locations will be selected at random.
 - f. Bond strength is to consist of a minimum of two tests done at each location, with one being the top of the bottom flange. For steel deck locations, bond strength shall consist of a minimum of two tests done at each location, one being at the top of the flute and one being at the bottom of the flute in accordance with ASTM E736
- 3. Testing Procedure:
 - a. Contractor provide fireproofing systems schedule, prepared by spray fireproofing manufacturer, to independent testing laboratory.
 - b. Contractor arrange with independent testing laboratory to take samples and perform required tests.
 - 1) Contact laboratory, solicit proposals, and provide additional information about laboratory Owner requires.
 - 2) Provide information to Owner for review.
 - 3) Obtain written Owner approval of selected laboratory.
 - 4) If laboratory is unacceptable, investigate others until Owner accepts a testing laboratory.

4. Test in field, per ASTM standards indicated to ensure conformance with applicable building Code and UL requirements for thickness, density and bond strength. For reference, utilize AWCI - Inspection Procedure for Field-Applied Sprayed Fire-Resistive Materials, Technical Manual 12-A; an annotated guide.
 - a. Should test fail, take additional tests until extent of defective area has been determined.
 - b. Repair or remove and replace defective material and retest until requirements are met.
 - c. Cost of initial tests paid by Owner.
 - d. Retesting due to test failure paid by Contractor.

3.06 CLEANING, PROTECTION AND REPAIR

A. Cleaning:

1. Immediately after completing fireproofing in each containable area, remove material overspray and fallout from surfaces of other construction.
2. Clean exposed surfaces to remove soiling.

B. Protection:

1. Protect fireproofing from damage or deterioration resulting from construction operations.
2. Coordinate application of fireproofing with other construction to minimize need to cut or remove fireproofing.

C. Repair: Patch, repair and restore fireproofing to complete UL required where areas of fireproofing is damaged.

END OF SECTION

SECTION 07 84 00 FIRESTOPPING

PART 1 – GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Firestopping, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Certified, licensed or approved by firestopping manufacturer, trained to install firestop products per specified requirements.
 - 2. Licensed by State or local authority, where applicable.
 - 3. Shown to have successfully completed not less than 5 comparable scale projects.
- B. Provide firestop systems in compliance with following requirements:
 - 1. Obtain firestop system for each type of penetration and construction condition from a single firestop systems manufacturer.
 - 2. Firestop products and systems shall bear classification marking of qualified testing and inspection agency.
 - 3. Firestopping tests, performed by qualified, testing and inspection agency.
 - a. UL or other agency, performing testing and follow up inspection services for firestop systems, acceptable to local authorities having jurisdiction.
 - 4. Existing applications for which no tested and listed classified system is available through a manufacturer:
 - a. Provide Engineering Judgment or Equivalent Fire Resistance Rated Assembly (EFRRA) for submittal derived from similar UL system designs or other tests approved by local authorities having jurisdiction, prior to installation.
 - b. Engineering judgment drawings must follow requirements set forth by International Firestop Council.
 - 5. Mold Resistance:
 - a. Less than 1 per ASTM G21.
- C. UL:
 - 1. UL 263, Fire Tests of Building Construction and Materials
 - 2. UL 723, Surface Burning Characteristics of Building Materials
 - 3. UL 1479, Fire Tests of Through Penetration Firestops
 - 4. UL 2079, Tests for Fire Resistance of Building Joint Systems
- D. Underwriters Laboratories (UL) Fire Resistance Directory:
 - 1. Through Penetration Firestop Systems (XHEZ).
 - 2. Joint Systems (XHBN).
 - 3. Fill, Void or Cavity Materials (XHHW).

4. Firestop Devices (XHJI).
 5. Forming Materials (XHKU).
 6. Wall Opening Protective Materials (CLIV).
 7. Fire Resistance Ratings (BXRH)
- E. ASTM International (ASTM):
1. ASTM E84 Surface Burning Characteristics of Building Materials
 2. ASTM E119 Fire Tests of Building Construction and Materials
 3. ASTM E136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750F
 4. ASTM E814 Fire Tests of Through Penetration Fire Stops
 5. ASTM E1399 Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems
 6. ASTM E1966 Test Method for Fire Resistive Joint Systems
 7. ASTM E2174 Standard Practice for On-site Inspection of Installed Fire Stops
 8. ASTM E2307 Standard Test Method for Determining the Fire Endurance of Perimeter Fire Barrier Systems Using the Intermediate-Scale, Multi Story Test Apparatus (ISMA)
 9. ASTM E2393 Standard Practice for On-site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers
 10. ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
- F. National Fire Protection Association (NFPA):
1. NFPA 70: National Electrical Code
 2. NFPA 101: Life Safety Code
 3. NFPA 221: Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls
 4. NFPA 251: Fire Tests of Building Construction and Materials
- G. Firestop Contractors International Association (FCIA): MOP-FCIA Firestop Manual of Practice
- H. International Firestop Council (IFC):
1. Recommended IFC Guidelines for Evaluating Firestop Engineering Judgments, latest revision.
 2. Inspectors Field Pocket Guide, latest edition.
- I. Identification Labels for Firestopping Assemblies: Follow guidelines set in Chapter 7 of International Building Code.
- J. Pipe insulation shall not be removed, cut away or otherwise interrupted at wall penetrations or floor openings: Provide products appropriately tested for the thickness and type of insulation utilized.
- K. Cabling where frequent cable moves, additions, and changes are likely to occur in future:
1. Where cable trays are used:
 - a. Utilize re-enterable products (e.g. removable intumescent blocks) specifically designed for retrofit.

2. Where cable trays are not used:
 - a. Utilize fire rated cable pathway devices.
 - b. Where not practical, re-enterable products designed for retrofit may be used.
- L. Protect penetrations passing through fire resistance rated floor-to-ceiling assemblies contained within chase wall assemblies with products tested by being fully exposed to fire outside of chase wall.
- M. Identify systems within UL Fire Resistance Directory with the words: Chase Wall Optional.
 1. Fire-resistive Joint Sealant:
 - a. Provide flexible fire resistive joint sealants to accommodate normal and thermal building movement without seal damage.
 - b. Provide fire resistive joint sealants designed to accommodate a specific range of movement.
 - 1) Test in accordance with cyclic movement test criteria as outlined in: ASTM E1399, ASTM E1966 or UL 2079.
 - c. Provide fire resistive joint systems subjected to an air leakage test.
 - 1) Conduct in accordance with UL 2079, with published L-Ratings for ambient and elevated temperatures.
 - d. Coordinate firestopping with acoustical sealant requirements in Section 07 92 16.
- N. Subject smoke wall containment systems to air leakage test: Conduct in accordance with UL 1479, with published L-Ratings for ambient and elevated temperatures.
- O. System Description:
 1. Through Penetration Firestop Systems for protection of penetrations through following fire resistance rated assemblies, including both blank openings and openings containing penetrating items:
 - a. Roof assemblies.
 - b. Floor assemblies.
 - c. Wall and partition assemblies.
 - d. Fire rated smoke barrier assemblies.
 - e. Existing, fire and smoke rated assemblies.
 - f. Construction enclosing compartmentalized areas.
 2. Fire Resistive Joint Assemblies for linear voids where fire rated floor, roof, or wall assemblies abut one another, including following types of joints:
 - a. Top and bottom of wall interface with overhead roof or floor structure:
 - 1) Coordinate with acoustical sealant specified in Section 07 92 16.
 - 2) Select products to maintain acoustical, smoke and fire ratings indicated.
 - b. Fire Rated Expansion Joints: Specified in Section 07 95 13.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's standard information indicating certification of products proposed for use on project.
- B. Project Information: UL reports with illustration of systems, system numbers, temperature ratings, and products proposed for use on project.
- C. Contract Closeout Information: Warranty

1.4 WARRANTY

- A. Written five (5) year warranty guaranteeing quality of installation and meeting requirements of manufacturer's written instructions and tested systems.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Firestopping:

- 1. Base:
 - a. Hilti Inc.
- 2. Optional:
 - a. 3M
 - b. Tremco, Inc.

B. Forming Materials:

- 1. Base:
 - a. Hilti Inc.
- 2. Optional:
 - a. Rock Wool Manufacturing.
 - b. Roxul Inc.

C. Fire Rated Enclosures:

- 1. Base:
 - a. Tenmat, Inc.
- 2. Optional:
 - a. EZ Barrier, Inc.

2.2 MATERIALS

A. Through Penetration Firestop Systems:

- 1. VOC content not to exceed 250 g/L.
- 2. Base Products:
 - a. FS-ONE MAX Intumescent Firestop Sealant.
 - b. CFS-S SIL GG Elastomeric Firestop Sealant.
 - c. CFS-S SIL SL Elastomeric Firestop Sealant.
 - d. CP 620 Fire Foam.
 - e. CP 606 Flexible Firestop Sealant.

B. Fire resistive Joints:

- 1. VOC content not to exceed 250 g/L
- 2. Base Products:
 - a. CFS-SP WB Firestop Joint Spray.
 - b. CFS-S SIL GG Elastomeric Firestop Sealant.
 - c. CFS-S SIL SL Elastomeric Firestop Sealant.
 - d. CP 606 Flexible Firestop Sealant.

C. Firestop Devices:

1. Factory assembled collars lined with intumescent material sized to fit specific outside diameter of penetrating item.
2. Base Products:
 - a. CP 680-P Cast-in-Place Firestop Device.
 - b. CP 680-M Cast-in-Place Firestop Device.
 - c. CP 681 Tub Box Kit.
 - d. CFS-DID Firestop Device.

D. Intumescent Pads, Wall Opening Protective Materials:

1. Intumescent, non-curing pads or inserts for protection of electrical panels, switch and receptacle boxes, medical gas outlets and valve boxes and other items recessed in face of fire rated walls.
2. Base Product:
 - a. CFS-P PA Firestop Putty Pad.
 - b. CP 617 Firestop Putty Pad.
 - c. Hilti Biox Insert.

E. Fire Rated Cable Pathways:

1. Steel raceway and intumescent pads with adjustable smoke seal sleeve.
2. Fire rating equal to rating of barrier device penetrates.
3. Pathway devices:
 - a. Allow 0 to 100 PCT fill of cables.
 - b. Adjust automatically to cable additions or subtractions.
4. Size to accommodate quantity and size of electrical wires and data cables indicated plus 100 PCT expansion.
5. Provide cable management devices with gang plates for single or multiple devices.
6. Base products:
 - a. CP 653 BA Speed Sleeve.
 - b. CFS-SL GP Gangplate.
 - c. CFS-SL GP CAP Gangplate Cap.
 - d. CFS-CC Firestop Cable Collar.
 - e. CFS-SL SK Firestop Sleeve.
 - f. CFS-SL RK Retrofit Sleeve.
 - g. CFS-COS Composite Sheet.

F. Smoke and Acoustic Cable Pathways:

1. Non-rated steel raceway with adjustable smoke seal polyurethane sleeve for single cables and cable bundles.
2. Re-penetrable and self-closing.
3. Base product:
 - a. CS-SL SA Smoke and Acoustic Sleeve.

G. Single Cable and Cable Bundles to 1 IN Diameter: CFS-D Firestop Cable Disc.

H. Firestop Putty:

1. Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds.

2. Provide firestop putty at, but not limited to, the gap between wire, cabling, or both, exiting an open end of conduit, where conduit penetrates one or both sides of a smoke or fire rated wall assembly.
3. Base products:
 - a. CP 618 Firestop Putty Stick.
 - b. CFS-PL Firestop Plug.

I. Wrap Strips:

1. Single component intumescent elastomeric strips faced on both sides with a plastic film:
2. Base Products:
 - a. CP 643N Firestop Collar.
 - b. CP 644 Firestop Collar.
 - c. CP 648E/648S Wrap Strips.

J. Firestop Blocks and Plugs:

1. Non-curing, flexible intumescent device.
2. Re-enterable.
3. Base products:
 - a. CFS-BL Fire Block.
 - b. CFS-PL Firestop Plug.

K. Mortar:

1. Portland cement based dry-mix product formulated for mixing with water at Project site to form a non-shrinking, water-resistant, homogenous mortar.
2. Base product:
 - a. CP 637 Firestop Mortar.

L. Silicone Sealants:

1. Moisture curing, single component, silicone elastomeric sealant for horizontal surfaces pourable or nonsag or vertical surface nonsag.
2. Base product:
 - a. CFS-S SIL GG Elastomeric Firestop Sealant.
 - b. CFS-S SIL SL Elastomeric Firestop Sealant.

M. Preformed Mineral Wool:

1. CP 767 Speed Strips
2. CP 777 Speed Plugs

N. Fire Sealant:

1. Single component latex or acrylic formulations that upon cure do not re-emulsify during exposure to moisture.
 - a. CFS-S SIL GG Elastomeric Firestop Sealant.
 - b. CFS-S SIL SL Elastomeric Firestop Sealant.
 - c. CFS-SP WB Firestop Joint Spray.

O. Composite Sheet:

1. Non-curing, re-penetrable material.
2. Base Products:
 - a. CP 675T Firestop Board.
 - b. CFS-BL FireBlock.

P. Forming Materials:

1. Materials listed as components in laboratory approved designs.
2. Mineral Wool:
 - a. Base Product: SAF by Thermafiber, or
 - b. Similar product specifically named as components in laboratory approved designs.

Q. Acoustical Sealant: Specified in Section 07 92 16.

R. Through Penetration Firestop Systems:

1. Comply with building code and fire code as locally adopted and amended.
2. Requirements for single membrane penetrations and through penetration firestops are identical.
 - a. Unless otherwise noted, treat penetrants which pass through a single membrane same as though passed through entire fire resistive assembly.
3. Select each firestop system based on actual field conditions, including penetration type, shape, size, quantities and physical position within opening.
4. See Drawings for indication of the required ratings of fire resistive wall, floor, and roof assemblies.
 - a. Indicated ratings are minimum and may be exceeded.
5. Firestop assemblies at fire rated walls:
 - a. Minimum fire (F) rating for firestop assemblies in walls shall equal that of wall, but not less than 1 HR.
 - b. Minimum temperature (T) rating of firestop assemblies in walls may equal zero.
 - c. Smoke barrier:
 - 1) In addition to (F) rating, (L) rating of maximum 5 CUFTM/ SF .
 - d. Non-rated walls and smoke partitions with no fire resistive requirement:
 - 1) Assembly with (L) rating.
6. Firestop assemblies at fire rated floors and roofs:
 - a. Minimum fire (F) and temperature (T) ratings of firestop assemblies used in floors or roof shall equal hourly rating of floor or roof being penetrated, but not less than 1 HR.
 - 1) Exception 1: T-rating may equal zero when portion of penetration, above or below floor, is contained within a wall.
 - 2) Exception 2: Firestops are not required for floor penetrations within a 2-hour rated shaft enclosure.

S. Voids in Wall with No Penetrations:

1. Fill with approved through penetration firestopping system.
2. Contractor's option: Patch void in wall with like construction.

T. Penetrating Ducts with Dampers:

1. Utilize only firestop materials which are included in damper's classification.
2. Do not install firestop systems that hamper performance of fire dampers.

- U. Cable Trays and Similar Devices: Provide re-enterable products specifically designed for removal and re-installation at openings within walls and floors designed to accommodate voice, data and video cabling.
- V. Electrical panels and devices, medical gas outlets and valve boxes, film illuminators, and other items recessed in to face of rated walls:
 - 1. Where electrical devices are placed on opposite sides of wall, and are less than 24 IN apart measured horizontally, install intumescent pads over back of devices in approved manner or maintain continuity of rated barrier within wall cavity surrounding recessed item.
- W. Fire Resistive Joint Assemblies:
 - 1. Where joint will be exposed to elements, fire resistive joint sealant must be approved by manufacturer for use in exterior applications and shall comply with ASTM C920.
 - 2. Head of Wall Assemblies:
 - a. Use at top of fire rated and smoke barrier walls and partitions where they abut floor and roof structures above.
 - b. Select systems with D designation, rated for dynamic movement capability.
 - c. Select systems that can accommodate deflection of structure above.
 - d. Maximum Leakage for Fire resistive Joints in Smoke Barriers: 5 CUFTM or less per linear foot as tested in accordance with UL 2079.
 - e. Seal non-fire rated sound control walls and smoke partitions with acoustical sealant as specified in Section 07 92 16.
 - 3. Minimum F and T ratings:
 - a. The minimum fire rating for firestop assemblies in walls shall equal that of wall, but not less than 1 HR.
 - b. The minimum temperature rating of firestop assemblies in walls may equal zero.
 - 4. Acceptable Systems:
 - a. Metal stud and drywall partitions: Select system from UL HW-D-0000 Series.
 - b. For metal stud partitions installed on flat concrete slab use one piece, pre-formed polyurethane foam firestop seal designed for use with standard head joint top tracks and bottom joint tracks or slip-type head joints to maintain continuity of the fire resistance rated assembly indicated.
 - c. Provide in width and configuration required to accommodate depth and installation of studs and designed to saddle over the top track or under the bottom track.
- X. Concrete and Masonry Walls: Select system from UL HW-D-1000 Series.
 - 1. Fire Rated Enclosures:
 - a. Provide where required as part of a UL Fire Resistance Directory design for fixtures mounted in rated walls or ceilings.
 - 1) Field constructed enclosures meeting Fire Resistance Directory designs will be accepted.
 - 2. Include accessories and install according to enclosure manufacturer's written instructions.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
- B. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion.
- C. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
- D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install firestop systems in accordance with manufacturer's instructions and conditions of testing and classification as specified in UL or other acceptable third party testing agency listing.
 - 1. Penetrations through fire resistive floor assemblies shall be sealed with firestop system providing minimum Class 1 W-rating as tested in accordance with UL 1479 and ensure air and water resistant seal.
 - 2. Protect materials from damage on surfaces subjected to traffic.
 - 3. Identification Labels:
 - a. Identify each firestop assembly as defined in Quality Assurance.
 - b. Do not locate identification labels, tags, or both, on finished surfaces or where exposed to view by public.

3.3 FIELD QUALITY CONTROL

- A. Maintain areas of work accessible until inspection by authorities having jurisdiction.
- B. Where deficiencies are found, repair or replace assemblies to comply with requirements.

3.4 ADJUSTING AND CLEANING

- A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.
- B. Clean surfaces adjacent to sealed openings free of excess materials and soiling as work progresses.
- C. Perform patching and repair of firestopping systems damaged by other trades.

END OF SECTION

SECTION 07 92 16

INTERIOR JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Interior Joint Sealants, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.02 QUALITY ASSURANCE

- A. Definitions:
 - 1. Caulk and Caulking are synonymous with sealant work.
 - 2. Interior Wet Areas includes toilets, showers, kitchens and similar areas where sealant is subject to moisture.
- B. Seal joints which permit penetration of moisture or air, unless sealant work is specifically required under other sections.
- C. Provide sealants at the following:
 - 1. Masonry control joints, and between masonry and other materials.
 - 2. Flooring joints.
 - 3. Isolation joints.
 - 4. Joints at penetrations of walls, floors and decks by piping and other services and equipment not requiring firestopping.
 - 5. Perimeters of door and window frames, louvers, grilles, etc.
 - 6. Between cabinets, casework, countertops and back splashes where adjacent to walls.
 - 7. Joints between dissimilar materials, to provide visually acceptable closures.
 - 8. Other joints where caulking, or sealant is indicated.
- D. ASTM International (ASTM):
 - 1. ASTM C510 Standard Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants
 - 2. ASTM C711 Standard Test Method for Low-Temperature Flexibility and Tenacity of One- Part, Elastomeric, Solvent-Release Type Sealants
 - 3. ASTM C719 Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement
 - 4. ASTM C792 Standard Test Method for Effects of Heat Aging on Weight Loss, Cracking, and Chalking of Elastomeric Sealants
 - 5. ASTM C793 Standard Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants
 - 6. ASTM C910 Standard Test Method for Bond and Cohesion of One-Part Elastomeric Solvent Release-Type Sealants
 - 7. ASTM C920 Standard Specification for Elastomeric Joint Sealants
 - 8. ASTM C1193 Standard Guide for Use of Joint Sealants
- E. South Coast Air Quality Management District (SCAQMD), Rule #1168.

1.03 SUBMITTALS

A. Shop Drawings:

1. Sealant Schedule with the following information:
 - a. Generally describe locations requiring sealants (i.e. GWB to Aluminum Window).
 - b. List type of sealant and name of product proposed for each location.
 - c. Include a blank Color Column on schedule for selection.
 - d. Architect to complete Color Column upon selection from submitted samples.

B. Product Data:

1. Performance characteristics and limitations.
2. Recommended installation.

C. Samples:

1. Submit cured sample of each color with Sealant Schedule.

D. Contract Closeout Information:

1. Warranty.

1.04 WARRANTY

A. Provide written warranty that sealant work will remain free of defects for a period of three (3) years from Date of Substantial Completion:

1. Failure of water or air tightness constitutes defect.
2. Loss of adhesion, cohesion or failure to cure constitutes defect.
3. Remove defective work and materials and replace with new work and materials.
4. Repair other work damaged as a result of defective sealant work at no additional expense to Owner.
5. Non- prorated warranty to include labor and material.
6. Warranty signed by Installer, Contractor, or both.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Polyurethane Sealants:

1. Base:
 - a. Tremco
2. Optional:
 - a. Pecora
 - b. Sonneborn/ChemRex
 - c. Sika
 - d. Bondaflex Technologies

B. Silicone Sealants:

1. Base:
 - a. As noted for individual items.

2. Optional:
 - a. Bondaflex Technologies
 - b. Color Rite
 - c. Dow Corning
 - d. GE Silicones
 - e. Pecora
 - f. Sonneborn/ChemRex
 - g. Tremco

C. Acoustical Sealant:

1. Base:
 - a. Hilti
2. Optional:
 - a. Grabber
 - b. Pecora
 - c. STI
 - d. 3M
3. Other Sealants:
 - a. Base: As indicated.

2.02 MATERIALS

A. General:

1. ASTM C920 Type S or M, Grade-NS, minimum Class 25.
2. Non-staining sealant complying with ASTM C510.
3. Where sealant is not exposed to view, use manufacturer's standard color which has best performance.
4. Use non-sag sealant in vertical joints.
5. Use self-leveling or non-sag sealant in horizontal joints.
6. Before use of sealant, investigate its compatibility with surfaces, fillers and other materials in joint system.

B. Volatile Organic Compounds (VOC):

1. Comply with South Coast Air Quality Management District (SCAQMD), Rule 1168.
 - a. Sealants: 250 g/L.
 - b. Sealant Primers for Nonporous Substrates: 250 g/L.
 - c. Sealant Primers for Porous Substrates: 775 g/L

C. Elastomeric Sealant:

1. Refer to Sealant Selection Guide for types required.
2. Comply with VOC limits as required by local laws or specified otherwise.

D. Casework Sealant:

1. Solid Colors.
2. 100 PCT silicone.
3. Color-Sil by Color Rite

E. Acoustical Sealant:

1. Flexible, non-hardening.
2. UL listed.

3. Seal perimeter of sound rated partitions.
 4. Seal perimeter and cover outside faces of electrical boxes and similar utilities in sound rated partitions.
 5. Base Products:
 - a. Gun - CP 506 by Hilti
 - b. Spray - CP 572 by Hilti
- F. Joint Cleaner, Primer, Bond Breaker:
1. As recommended by sealant manufacturer.
- G. Backer Rod:
1. Polyethylene, polyethylene jacketed polyurethane foam, flexible, non-absorbent, non-bituminous material recommended by sealant manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Do not proceed with installation of joint sealants under following conditions:
- B. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 DEGF.
- C. When joint substrates are wet.
 1. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
 2. Apply only to joints free of material which may inhibit bond.
 3. Apply to cementitious materials only when thoroughly cured and dry.

3.02 PREPARATION

- A. Clean joints and prime as required by sealant manufacturer.
- B. Install sealant after finish coating or covering is scheduled to be applied.
- C. Limit application to surfaces to receive sealants and mask edges of joints to protect adjacent surfaces.

3.03 INSTALLATION

- A. Install sealant backings to support sealants during application.
 1. Control joint depth.
 2. Break bond of sealant at bottom of joint.
 3. Provide proper shape of sealant.
 4. Do not leave gaps between ends of sealant backings.
 5. Do not stretch, twist, puncture, or tear sealant backings.
 6. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- B. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

- C. Install sealants using proven techniques that comply with the following and at same time backings are installed:
 - 1. Place sealants to directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths allowing optimum sealant movement capability.
- D. Prime joint surfaces as recommended by sealant manufacturer for conditions:
 - 1. Limit application to surfaces to receive sealants.
 - 2. Mask off adjacent surfaces.
- E. Sub-caulk joints without suitable backstop, to proper depth.
- F. Tool sealants using sufficient pressure to fill voids.
- G. Remove excess sealant adjacent to joints.
- H. Hollow Metal Frames:
 - 1. Seal frames to wall.
 - 2. Seal frames to floor substrates and hard floor finishes.
 - 3. Do not seal frames to previously installed carpet and similar finishes.
 - 4. Seal hairline gaps where stops and rabbets of frame members intersect.
- I. Acoustical Sealant:
 - 1. General:
 - a. Apply acoustical sealant at joints, voids, and penetrations through wallboard to maximize sound control.
 - 1) Seal wallboard edges to adjacent construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant.
 - 2) Install acoustical sealant at both faces of partitions at perimeters and through penetrations.
 - 3) Comply with ASTM C919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
 - b. Base of walls:
 - 1) Apply acoustical sealant to bottom edge of gypsum wallboard at floor.
 - c. Head of walls:
 - 1) Apply acoustical sealant to top edge of gypsum wallboard at building structure.

3.04 SEALANT USAGE GUIDELINES

Guide to Sealant Types - Interior				
Location	Materials	Sealant Type	Base Product	Remarks / Exceptions
Interior (General)	Window Sills / Stools	100 PCT silicone	Color-Sil Poly-Sil	--
	Cabinets and Casework to wall			
	Countertops and Backsplashes			
	Sinks in Countertops			
	Interior Alum Doors and Window Frame Perimeters	Multi-part, chemically curing Polyurethane	Tremco Dymeric 240FC	--
	Non-rated wall, floor and deck penetrations.			
	Hollow Metal Door and Window Frames	Siliconized Acrylic Latex (paintable)	Tremco Tremflex 834	Exception: Where sealant will not be subsequently painted and white color will not be visually compatible with adjacent finishes: Use Dymeric 240FC of matching color.
	Acoustical Sealant Joints at top and bottom terminations of Interior Walls	Acrylic	Hilti CFS-SP WB	--
		Silicone	Hilti CP 601S	
Interior Flatwork	Control Joints in Concrete Floors in Mechanical Rooms and other unfinished spaces	Multi-part Polyurethane	Tremco THC 900 / 901	Exception: Where subject to continual water emersion; use Vulkem 45 or 245
	Stone and Precast Flooring			
Interior Wet Areas	Porcelain, Ceramic Tile, Metals, and surfaces with Epoxy Paints	Silicone; Air cure	Tremco Tremsil 200	--
Laboratories	Sanitary seal at joints between ceramic and prefinished surfaces	Sanitary Silicone	Tremco Tremsil 200	White only
	Sanitary seal at joints between epoxy painted and prefinished surfaces	Sanitary Silicone	Pecora 898	White only
	Airtight seal at openings in walls and ceilings	Structural Silicone	GE SilPruf SCS2000	Includes electrical conduits
		Heat Shrink Polyolefin Tubing	NP-700md	
Clean Zone / Cleanrooms	Cleanroom Sealant	Polyurethane	Sikaflex-1A Or Dow Corning 6-1125 CV	White only

A. NOTES:

1. The above is intended to be an overall guide. Additional conditions and materials may be required. Notify Architect if additional Guidance is required to select unlisted items.
2. Optional sealant products shall offer same number of color choices as the Base Product listed.
3. All of the conditions and materials listed may not necessarily apply to subject project.
4. Not all project conditions may be addressed on above table; Refer also to other specification sections and install sealants where called for by other sections.
5. Materials and Conditions conventionally occurring on Exterior but used on Interior (e.g. Brick Masonry on interior) may not be listed on this Table.

END OF SECTION

SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Hollow Metal Doors and Frames in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.02 QUALITY ASSURANCE

- A. ASTM International (ASTM):
 - 1. ASTM A568 Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled
- B. Hollow Door and Frame Standards:
 - 1. ANSI A250.4 Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors
 - a. ANSI A250.8 / SDI 100 Recommended Specifications for Standard Steel Doors and Frames
 - b. ANSI A250.11 Recommended Erection Instructions for Steel Frames
- C. Fire Rated Doors and Frames:
 - 1. Label and list for ratings indicated by ITS - Warnock Hersey, UL or other testing and inspection agency acceptable to authorities having jurisdiction.
 - 2. Affix physical label or approved marking to fire door or fire door frame at an authorized facility as evidence of compliance with procedures of labeling agency.
 - 3. Where pairs of doors require fire rating (90 minute maximum), doors shall have passed appropriate test without the use of astragals.
 - 4. Positive Pressure:
 - a. Comply with Positive Pressure Requirements UL 10C, Category A or NFPA 252.
- D. Smoke and Draft Control Assemblies:
 - 1. Maximum Leakage: 3 CUFTM per SF of door face area when tested at pressure of 0.10 IN water per UL 1784.
 - 2. Applicability:
 - 3. Doors in Smoke Barriers and fire-rated Corridor walls.
 - 4. Doors forming part of an Elevator Lobby enclosure.
 - 5. Provide S-Labels on smoke and draft control openings.

1.03 SUBMITTALS

- A. Shop Drawings:
 - 1. Use same reference numbers for openings as those listed in Door and Frame Schedule in Drawings

2. Indicate door elevations, gages; frame configuration; anchor types and spacing; location of reinforcement and preparations for hardware, including items recessed within door edges; details of moldings, removable stops, glazing and louvers; details of conduit and preparations for power, signal, and control systems.

B. Product Data:

1. Include construction details, material descriptions, core descriptions, fire resistance rating and finishes.
2. Shop primer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Hollow Metal Doors and Frames:

1. Base:
 - a. Curries
2. Optional:
 - a. Ceco Door Products
 - b. Philipp Manufacturing Company
 - c. Republic Doors and Frames
 - d. Steelcraft Manufacturing

B. Galvanizing Repair Coating:

1. Base:
 - a. Tnemec
2. Optional:
 - a. ZRC Worldwide
 - b. SherwinWilliams

2.02 MATERIALS

A. Steel Sheet and Strip:

1. Comply with ASTM A568.

B. Corrosion Resistant Coating:

1. Standard:
 - a. Hot dip galvanized: A60 per ASTM A653.
 - b. Minimum zinc-iron alloy coating: 0.6 OZ/FT².
2. Provide above corrosion resistant coating at door and frame components where used at wet and humid locations as defined by following:
 - a. Openings located in an exterior wall.
 - b. Interior openings:
 - 1) Rooms with showers, tubs or pools.

C. Primer:

1. Shop prime.
2. Clean and phosphatize doors and frames.

3. One coat of baked-on rust inhibiting primer paint in accordance with ANSI A250.10.
4. Suitable and compatible as base for specified finish paints.

D. Galvanizing Repair Coating:

1. Galvanized coating repair.
2. VOC 250 g/L maximum.

E. Hollow Metal Doors:

1. Comply with ANSI/SDI A250.8.
2. Determination of performance level for each door:
 - a. Use level of HM door indicated for its location, size and other listed criteria.

Schedule of HM Door Levels			
Location	Additional Criteria	HMMA Level	Miscellaneous
Exterior Doors ¹ (flush)	Openings where each leaf is less than 47 IN	Level 3 (Extra Heavy duty)	Galvanized / galvanized, Thermally Insulated
	Openings where one or more of the leaves exceeds 47 IN	Level 4 (Maximum-duty)	
Exterior Doors ¹ (stile and rail)	All	Level 3 (Extra Heavy duty)	Galvanized / galvanized, Thermally Insulated
	2		
Interior Doors	Non-fire rated	Level 3 (Extra Heavy duty)	--
	Fire rated	Level 3 (Extra Heavy duty)	Labeled as indicated (w/out astragal wherever possible)
	Wet / Humid Areas ²	Level 3 (Extra Heavy duty)	Galvanized / galvanized; Moisture-resistant core - Fire resistant were required

Notes

- a. Refer to Door Schedule for indication of the Door Type (i.e. Width, Fire Rating, Flush vs. Stile & Rail, etc.) Refer to Plans for door location (Exterior vs. Interior).
- b. Where Hurricane or Tornado resistant openings are specified: Refer to ADDITIONAL REQUIREMENTS for appropriate
- c. door/frame construction.
- d. Not all items included in table may apply to subject project.

Footnotes

- a. Refer to Part 2.2 MATERIALS for definition of Exterior locations.
 - 1) Refer to Part 2.2 MATERIALS for definition of Wet/Humid locations.
1. Door Thickness: 1-3/4 IN .
 - a. Door Thickness: 1-3/8 IN 35 MM.
2. ANSI A250.8 Level 4, Maximum duty, physical performance Level A.
 - a. Face Sheet Thickness: 0.067 IN (14 GA) .
3. ANSI A250.8 Level 3, Extra Heavy duty, physical performance Level A.
 - a. Face Sheet Thickness: 0.053 IN (16 GA) .
4. ANSI A250.8 Model 2, Seamless.
5. End closures at top and bottom of door:
 - a. Top: Flush closure top cap. Minimum Sheet thickness: 0.032 IN (20 GA)
 - b. Bottom: Flush closure. Minimum Sheet thickness: 0.032 IN (20 GA) .
 - c. Bottom: Inverted channel. Minimum Sheet thickness: 0.053 IN (16 GA) 1.3 MM.

6. Vertical door edges:
 - a. Lock Stile Edges: Beveled 1/8 IN per 2 IN .
 - 1) Exception for inactive leaves: Fabricate inactive leaves with a square edge at the lock stile edge. Active leaves to be beveled per above.
 - 2) Hinge Stiles Edge: Beveled 1/8 IN per 2 IN .
 - 3) Exceptions for Double Acting Doors: Provide convex, radiused edges at lock stiles and hinge stiles.
7. Hardware Reinforcement (doors):
 - a. Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as door face sheets.
 - b. Minimum thickness: As prescribed in ANSI/SDI A250.6; Upgrade as necessary for conditions such as door weight, size, frequency, etc. and as follows:
 - c. Butt Hinges: 0.167 IN (7 GA) .
 - d. Continuous hinges: Reinforce with 0.067 IN (14 GA) thick x 1-1/4 IN wide strapping extending full height and welded to hinge edge of door.
 - e. Closers and Overhead Stops: 0.067 IN (14 GA) .
8. Cores:
 - a. Steel stiffeners where structurally required.
 - b. Exterior Doors:
 - 1) Thermally insulated core.
 - (a) 1.0 LBS/CF Polystyrene.
 - 2) Minimum R-value: 2.0 when tested according to ASTM C1363.
 - c. Interior doors:
 - 1) Non-rated doors: Kraft honeycomb laminated to face sheets.
 - 2) Rated doors: Fire resistant core as required by label.
 - 3) Wet/humid Areas: Moisture resistant materials, fire resistant where applicable.
 - d. Specific materials used for above listed core types: Manufacturer's option.
 - e. Reinforce for Hardware.
9. Fixed louvers:
 - a. Base Product: FDLS by Anemostat.
 - b. Slat Design: Inverted split Y.
 - c. Minimum Free Air Flow: 50 PCT Free Area.
 - d. Material: 0.042 IN (18 GA) carbon steel.
 - 1) Finish: Baked Enamel; Standard Color to be selected by Architect.
 - 2) Finish: Baked Enamel; Custom Color to be selected by Architect.
 - e. Material: 0.042 IN (18 GA) galvanized/galvannealed steel.
 - 1) Finish: Baked Enamel; Standard Color to be selected by Architect.
 - 2) Finish: Baked Enamel; Custom Color to be selected by Architect.
 - f. Material: #304 Stainless Steel with #4 finish.
 - g. Material: #316 Stainless Steel with #4 finish.
 - h. Factory installed and finished to match door.
 - i. Sizes and locations: As indicated.
10. Louvers in exterior doors:
 - a. Weatherproof, stationary.
 - b. Blades spaced 1-1/2 IN .
 - c. Removable insect screens on interior face of doors, 14 x 18 IN mesh rigid frame.
11. Astragals:
 - a. Provide approved overlapping astragals where required by label.

F. Hollow Metal (HM) Frames:

1. Comply with ANSI/SDI A250.8 and with details indicated for type and profile in accordance with SDI 111.

2. Fabricate frames with mitered or coped corners and 1/2 IN nominal backbend.
 - a. Provide extended backbend at wall tile applications as detailed in drawings.
 - b. Touch-up galvanized/galvannealed frames with zinc-rich primer.
3. Fabricate frames as Face Welded (modified ANSI definition):
 - a. Face Joints: Continuously back weld face joints (weld on concealed side).
 - b. Fill and finish exposed sides to be free of visible seams.
 - c. Intersections of Rabbets, Stops and Soffit Joints: Fabricate to hairline joints. Stitch weld on concealed side.
 - d. Split type frames and knock down type frames are not acceptable.
 - e. Fasteners which are exposed to view are not acceptable.

Schedule of HM Frames			
Location	Criteria	Minimum Thickness	Miscellaneous
Exterior Frames ¹	Standard and Thermally Enhanced	0.067 IN (14 GA)	Galvanized / galvannealed
	Non-fire rated	0.053 IN (16 GA)	--
Interior Frames ¹	Fire rated	0.053 IN (16 GA)	--
	Frames for doors with automatic openers	0.067 IN (14 GA)	--
	Wet / Humid Areas ²	0.053 IN (16 GA)	Galvanized / galvannealed

Notes

- a. Gauge of frame listed is the minimum. Use heavier gauge as required due to size, physical configuration or if required to meet fire label requirements.
- b. Refer to Door Schedule for indication of the Frame Type (I.e. Width, Single vs. Pair; Fire Rating, etc) Refer to Plans for door location (Exterior vs. Interior).
- c. Where Hurricane or Tornado resistant openings are specified: Refer to ADDITIONAL REQUIREMENTS for appropriate door/frame construction.
- d. Some items listed may not apply to subject project.

Footnotes

- a. Refer to Part 2.2 for definition of Exterior locations.
- b. Refer to Part 2.2 for definition of Wet/Humid locations.

G. Light Kits:

1. Label for intended opening.
2. Fixed Stop:
 - a. Locate at exterior face.
 - b. Integral to door/frame.
3. Removable Stop:
 - a. Locate on interior face.
 - b. Snap-in stops or stops secured with countersunk Phillips head machine screws.

H. Silencers:

1. Quantity:
 - a. Three on strike jamb of single frames.
 - b. Two per door for pair doors. Locate at head.
2. Space per manufacturer's recommendations.
3. Use plastic plugs to keep holes clear during construction.

I. Hardware Reinforcement:

1. Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.
2. Minimum thickness: As prescribed in ANSI/SDI A250.6; upgrade as necessary for conditions such as door weight, size, frequency, etc. and as follows:
 - a. Butt Hinges: 7 GA.
 - b. Continuous hinges: Reinforce with 0.067 IN (14 GA) thick x 1-1/4 IN wide strapping extending full height and welded to hinge jamb door rabbet of frame.
 - c. Closers and Overhead Stops: 0.093 IN (12 GA) thick x 12 IN long strapping welded to vertical flange of frame.

J. Head Stiffeners:

1. Provide at double egress frames:
2. Position stiffeners at mid span of frame opening.

K. Junction Boxes:

1. Sheet metal enclosure:
 - a. Provide to facilitate pulling of wires and making electrical connections.
 - b. Weld to back side of frames.
2. Material: 0.032 IN (20 GA) sheet steel.
3. Size and shape: As required by hardware device.
4. Include knockout to receive 1/2 IN conduit.
5. Locate Junction Boxes in frames scheduled to receive electrified security, door hardware devices, or both.

L. Jamb Anchors:

1. ASTM A879 Commercial Steel, 4 OZ/SF coating; mill phosphatized.
 - a. Frames in exterior walls:
 - 1) Steel sheet complying with ASTM A1008 or ASTM A1011, hot-dip galvanized according to ASTM A153, Class B.
2. Provide anchors in accordance with manufacturer's recommendations on fire rated doors.
3. Provide minimum number as indicated in following table:

Minimum Quantity of Jamb Anchors	
Nominal Frame Height	Minimum Quantity per Jamb
Less than 60 IN 1.5 m	2
60 IN to 90 IN 1.5 M to 2.3 m	3
90 IN to 120 IN 2.3 M to 3 m	4
120 IN to 150 IN 3 M to 3.8 m	5
Greater than 150 IN 3.8 m	Add 1 additional for each 30 IN increase in height thereafter

- a. Jamb anchors for stud framed walls:
 - 1) Z-shaped clips, welded to inside of frames; not less than 0.042 IN (18 GA) thick, or compression anchors to suit frame size.
 - 2) Attach anchors to studs with screws.

- b. Jamb anchors for masonry walls:
 - 1) Adjustable strap-and-stirrup or T-shaped anchors to suit frame size.
 - 2) Minimum 0.042 IN (18 GA) .
 - 3) Corrugated or perforated straps:
 - (a) Minimum 2 IN wide by 10 IN long.
 - 4) Wire anchors:
 - (a) Minimum 0.184 IN (6 GA) thick.
 - 5) Embed long leg into masonry wall as units are placed.
 - 6) Post installed expansion type for in place concrete or masonry:
 - (a) Minimum 3/8 IN countersunk, flat head expansion bolts with expansion shields or inserts.
 - (b) Include pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
 - (c) Minimum embedment length: 1-3/4 IN .
- c. Floor Anchors:
 - 1) Same for Jamb Anchors but not less than 0.053 IN (12 GA) thick.
 - (a) Anchors built into exterior walls:
 - (1) Steel sheet complying with ASTM A1008 or ASTM A1011, hot-dip galvanized according to ASTM A153, Class B.
 - (b) Monolithic concrete slabs:
 - (1) Clip type anchors, with two holes to receive fasteners.
 - (c) Topped slabs:
 - (1) Adjustable anchors with extension clips allowing not less than 2 IN height adjustment. Terminate bottom of frames at finish floor surface.
 - 2) Include concealed fasteners.
 - 3) Provide anchors in accordance with manufacturer's recommendations at fire rated openings.
- d. Head Anchors for Double Egress Frames:
 - 1) Provide two head frame anchors for Double Egress frames.
 - 2) Locate at third points of span.
- 4. Spreaders:
 - a. Provide removable spreaders at bottom of door frames.
- 5. Inserts, bolts and fasteners:
 - a. Manufacturer's standard units
 - b. Galvanize items built into exterior walls ASTM A153, Class C or D as applicable.
 - c. Accessories:

2.03 FABRICATION

A. Factory fit doors to frame openings with uniform clearances in accordance with:

- 1. NFPA 80 for fire rated doors.
- 2. NFPA 105 for smoke control doors.
- 3. ANSI A250.8
- 4. Locally adopted Building Code.
- 5. SDI 117.

Door To Frame Clearances Table		
Location		Clearance
Door to Frame at top and sides		1/8 IN 3 MM
Meeting Stiles at Pair Doors		1/8 IN 3 MM
Face of door to face of Stop		3/32 IN 2.4 MM
Door Bottom to Floor / Flooring	Top of floor covering	Less than 1/2 IN 13 MM
	Non-combustible sills	3/8 IN
	Bare floors; No flooring or sills	Greater than 3/4 IN

B. Hardware Preparation:

1. Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to Door Hardware Schedule and templates furnished.
2. Locate hardware indicated, or if not indicated, according to ANSI/SDI A250.8.
3. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
4. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
5. Coordinate locations of conduit and wiring boxes for electrical connections.
6. Remove mill scale and foreign materials, touch up damaged galvanized or galvanized surfaces.

C. Hollow Metal Doors:

1. Exterior:
 - a. Provide weep openings in bottom of exterior doors.
 - b. Seal joints in top edges of doors against water penetration.
2. Glazed lites:
 - a. Factory cut openings in doors.
 - b. Locate bottom of glazed panel 43 IN maximum above finish floor.
3. Astragals:
 - a. Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire performance rating or where indicated.

D. Fire Labels:

1. Affix permanent labels to fire rated units in accordance with testing agency requirements.
2. Where labels are stamped or embossed directly into frame, ensure label will remain legible upon application of finishes.
3. At openings where continuous hinges or other items conceal fire label, locate labels on alternative locations as allowed by listing agency and local authorities.

E. Door Position Switches (DPS):

1. Coordinate locations with Security System provider.
2. Locate DPS frame head approximately 4 IN from latching door edge.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine structure, substrates, and conditions under which work is to be installed for conditions detrimental to correct and timely completion.
- B. Installation constitutes acceptance of responsibility for performance.

3.02 INSTALLATION

- A. Frames:
 - 1. Place frames before construction of adjacent walls.
 - a. Where adjacent walls are cast in place concrete, set frames after wall is constructed.
 - 2. Adjust hollow metal door frames for square, alignment, twist, and plumb to following tolerances:
 - a. Plumb: Plus or minus 1/16 IN , measured at jambs at floor.
 - b. Level: Plus or minus 1/16 IN per leaf, measured across width of header.
 - c. Square: Plus or minus 1/16 IN , measured at door rabbet on a line 90 DEG from jamb perpendicular to frame head.
 - d. Alignment: Plus or minus 1/16 IN , measured at jambs on horizontal line parallel to plane of wall.
 - e. Twist: Plus or minus 1/16 IN , measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - 3. Do not remove spreaders until surrounding wall construction is complete.
 - 4. After surrounding walls have been constructed, verify frames remain in alignment.
 - a. Re-check for level, plumb, square, twist and issues that will prevent proper fitting of doors.
 - b. Correct deficiencies before allowing surrounding construction to proceed.
 - c. Coordinate with other trades to correct alignment problems.
 - 5. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
 - 6. Verify frame alignment, and correct deficiencies prior to hanging doors.
 - 7. Install frames with removable glazing stops located on secure side of opening.
 - 8. Provide anchor type specified for wall condition.
 - 9. Align anchors at hinge centers on hinge jamb and at corresponding heights on strike jamb.
 - 10. Secure frame to wall per manufacturer's instructions.
- B. Prime Coat Touchup:
 - 1. Immediately after erection, sand smooth rusted or damaged areas of primer coat.
 - 2. Touch up primer coat with compatible air drying primer.
 - 3. Leave surfaces smooth for finish painting.
- C. Field Painting of HM Frames and Doors:
 - 1. Painting of Interior openings: Specified in Section 09 91 23.
- D. Install Sealants:
 - 1. Seal frames to walls.
 - 2. Seal frames to floor slabs and hard floor finishes.

3. Hairline gap at intersections of head and jamb frames intersections of rabbets and stops:
 - a. Fill exposed seam with painter's caulk.
4. Sealants:
 - a. Interior: See Section 07 92 16.
5. Install silencers.

3.03 ADJUSTING AND CLEANING

- A. Verify frames remain in proper alignment.
- B. Correct deficiencies before proceeding with surrounding construction.
- C. Remove protective wrappings from doors and frames.
- D. Verify fire labels are intact, and readily visible.

END OF SECTION

SECTION 08 14 16

FLUSH WOOD DOORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Flush Wood Doors, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.02 QUALITY ASSURANCE

- A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.
- B. Window and Door Manufacturer's Association (WDMA): I.S. 1A Industry Standard for Architectural Wood Flush Doors
- C. American National Standards Institute (ANSI): ANSI A115. W Series, Wood Door Hardware Standards.
- D. Fire Rated Door Standards:
 - 1. Label and list for ratings indicated by ITS - Warnock Hersey, UL or other testing and inspection agency acceptable to authorities having jurisdiction.
 - 2. Factory apply physical label or approved marking to fire door or fire door frame.
 - 3. Positive pressure:
 - a. Comply with Positive Pressure Requirements UL 10C, Category A or NFPA 252.
 - 1) The use of surface applied intumescent tape is not acceptable.
 - b. Comply with ASTM E2074.
- E. Smoke and Draft Control Assemblies:
 - 1. Maximum air leakage rate of door assembly:
 - a. 3.0 CUFTM/SF of door opening at a 0.10 IN of water in accordance with UL 1784.
 - 2. Applications:
 - a. Doors in smoke barriers with fire ratings and fire rated corridor walls.
 - b. Doors forming part of an elevator lobby or doors placed at elevator hoistway openings.
 - 3. Provide S-Labels on smoke and draft control openings.

1.03 SUBMITTALS

- A. Shop Drawings:
 - 1. Indicate location, size, and hand of each door; elevation of each kind of door; location and extent of hardware blocking.
 - 2. Indicate dimensions and locations of cutouts.
 - 3. Indicate requirements for veneer matching.
 - 4. Describe factory finish and finish requirements.
 - 5. Indicate fire ratings for fire doors.

B. Product Data:

1. Include details of construction for each type of door.
2. Include factory finishing specifications.
3. Provide manufacturer's technical data for each type of door including details of core and edge construction, trim for openings and factory finishing specifications.

C. Samples:

1. Color Samples to match architect's control sample.
2. Factory finishes applied to actual door face materials for each material and finish.
 - a. Provide one piece of specified finished work for each wood species and finish.
 - b. Minimum Size: 8 x 10 IN indicating finish.

D. Contract Closeout Information: Warranty.

1.04 WARRANTY

A. Provide written warranty for doors for full life of installation against defects including:

1. De-lamination, warp, twist, bow, telegraphing, and other defects that may impair or affect performance of door for purpose intended, meeting allowable values prescribed by WDMA Standard.
2. Remove and replace defective doors; include cost of removal of defective units, re-hanging and refinishing of replacement units.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Flush Wood Doors:

1. Base:
 - a. VT Industries.
2. Optional:
 - a. Marshfield-Algoma Mohawk Doors by Masonite Architectural.
 - b. Eggers Industries.
 - c. Graham/ Maiman Wood Doors by ASSA ABLOY.
 - d. Oshkosh Door Company.
 - e. Assa Abloy.

2.02 DESIGN CRITERIA

A. Wood Door Manufacturers Association (WDMA):

1. Performance: WDMA I.S.1A-11- Extra Heavy Duty.
 - a. Meet specified performance level without use of additional hardware blocking and without use of through bolts.
2. Aesthetic Grade: WDMA I.S.1A-11, - Premium Grade except as modified.

B. Thickness: 1-3/4 IN unless noted otherwise.

2.03 MATERIALS

A. Veneer:

1. Veneer thickness: 1/50 IN at 12 PCT moisture content.
2. Veneer grade: HPVA Grade A.
3. Veneer Species (both faces unless otherwise noted):
 - a. Select White Maple.
4. Veneer cut:
 - a. Quarter Cut.
5. Veneer leaf match:
 - a. Slip match
6. Face assembly match:
 - a. Center match
7. Pair and Set match:
 - a. Center match
8. Door vertical edges: Veneer edge banding, same species as face, no joints.

B. Core:

1. Select core types which comply with label for scheduled ratings, sizes and hardware devices.
2. Bond cores to stiles and rails; drop-in, unbonded cores are not acceptable.
3. Non-Fire Rated Doors:
 - a. PC-5, Extra Heavy Duty Wood Particleboard Core.
4. Stiles:
 - a. Provide manufacturers standard edge to meet required fire rating.
 - b. Fire rated doors: Fabricate stiles from fire retardant material as allowed by label.
 - c. Meeting stiles where concealed vertical rod (CVR) exit devices are scheduled.
 - 1) Avoid use of applied metal channels where label allows fire retardant material as an alternative.

C. Rails: Solid hardwood or structural composite lumber (SCL).

D. Cross-banding:

1. Engineered wood or wood-based composite, securely bonded to core.
2. Medium density fiberboard (MDF) not acceptable.

E. Adhesives:

1. Face adhesive per WDMA TM-6.
2. Utilize waterproof adhesives for doors indicated near potentially wet conditions.

F. Glazing stops:

1. Select assemblies certified for fire ratings indicated and physically compatible with glazing type indicated.
2. Non-fire rated doors:
 - a. Solid hardwood.
 - b. Same species or compatible species with door facing.

G. Glazing:

1. Glass specified in Section 08 81 26.
 - a. Non-Fire Rated Openings: 6mm (1/4 IN nom) Tempered Safety Glass.

2.04 FABRICATION

A. Factory fit doors to suit frame openings with most stringent criteria for uniform clearances in accordance with:

1. National Fire Protection Association NFPA 80 for fire rated doors.
2. National Fire Protection Association NFPA 105 for smoke control doors.
3. American National Standards Institute ANSI A250.8.
4. Locally adopted Building Code.
5. Wood Door Manufacturers Association (WDMA) pre-fit clearances for factory fit doors.

Door To Frame Clearances		
Location		Clearance
Door to Frame at top and sides		1/8 IN
Meeting Stiles at Pair Doors		1/8 IN
Face of door to face of Stop		1/8 IN
Door Bottom to Floor / Flooring	Typical; all floor covering types	Up to 1/2 IN
	At non-combustible sills	3/8 IN
	Bare floors- No flooring or sills	Up to 3/4 IN

B. Factory machine doors for hardware that is not surface applied.

1. Comply with final hardware schedules, shop drawings, and hardware templates.
2. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
3. Factory pre-drill pilot holes for surface applied items.

C. Hardware Preparation:

1. Make cutouts accurately and neatly.
2. Glazed lites:
 - a. Factory cut openings in doors.
 - b. Locate bottom of glazed panel 43 IN maximum above finish floor.
 - c. Do not exceed area allowed by code for rated assemblies.
3. Provide two sets of glazing stop moldings for openings to completely cover cut edges.
 - a. Neatly miter stops at corners.
4. Cut and trim openings through doors to comply with applicable requirements of referenced standard for kinds of doors required.
5. Finish as appropriate for material and type:
 - a. Veneer wrapped stops: Finish to match face veneer on doors.
 - b. Solid wood stops: Finish to match face veneer on doors.
6. Fill nail holes in wood stops.

D. Top and Bottom Edges:

1. Render top and bottom edges smooth, non-absorptive and readily cleanable.
2. SCL rail finish: Make smooth with the application of veneer tape, plastic laminate or clear sealer to finish rough or porous edges.

E. Fire Labels:

1. Affix permanent labels to fire rated units in accordance with agency requirements.
2. On openings where continuous hinges or other items would conceal label, place label in alternate location allowed by listing agency and authorities having jurisdiction.

F. Finishes:

1. Comply with WDMA finish requirements.
2. Completely finish doors at factory.
3. Stain (STN):
 - a. Type: Manufacturer's standard type.
 - b. Stain color:
 - 1) Custom color to be selected by Architect.
 - 2) System WDMA TR-6 catalyzed polyurethane.
 - 3) Sheen: 30 to 40.

G. Vertical Door Edges:

1. Lock stile edges: Beveled 1/8 IN per 2 IN.
 - a. Fabricate inactive leaves with a square edge at lock stile edge.
 - 1) Active leaves to be beveled per above.
2. Hinge stiles edge: Beveled 1/8 IN per 2 IN.
3. Double acting doors:
 - a. Provide convex, radiused edges at lock stiles and hinge stiles.
 - b. Kerf for privacy gaskets.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Verify suitability of openings to accept installation.
- B. Verify frames comply with indicated requirements for type, size, location and swing characteristics and have been installed with level heads and plumb jambs.
- C. Reject doors with defects prior to hanging.
- D. Normalize wood doors to ambient conditions and to temperature and humidity levels recommended by manufacturer.
- E. Do not hang doors in frames set out of plumb, out of square, or out of parallel.
- F. Work with frame installer and wall installer to correct misalignment issues.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

- H. Installation constitutes acceptance of responsibility for performance.

3.02 INSTALLATION

- A. Comply with door manufacturer's written instructions, referenced quality standard, and as indicated.
- B. Drill pilot holes for screws attaching hinges, closers, lock hardware and other devices to stile or face of door.
 - 1. Diameter of pilot hole shall not exceed 90 PCT of the root diameter of the screw.
- C. Fit doors to frames and machine for hardware, to extent not previously worked at factory.

3.03 ADJUSTING

- A. Adjust and check doors for proper fit function and uniform clearance at each edge to swing and operate freely.
- B. Leave work complete and in proper operating condition.
- C. Ensure fire labels are intact, and readily visible.

END OF SECTION

SECTION 08 41 18

INTERIOR ALUMINUM STOREFRONT

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Interior Aluminum Door and Window Frames, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.02 QUALITY ASSURANCE

- A. Provide complete system including sills, mullions, division bars, special shapes, anchors and accessories under single responsibility.
- B. Provide structural strength to meet performance requirements.
- C. Fabrication, tolerance, erection and finishing standards: Applicable standards of AA, AAMA and AWS.

1.03 SUBMITTALS

- A. Shop Drawings: Elevations, sections and details.
- B. Samples: Three aluminum finish range samples.
- C. Project Information: Certified, independent test reports verifying requirements.
- D. Contract Closeout Information:
 - 1. Warranty.
 - 2. Maintenance data.

1.04 WARRANTY

- A. Manufacturer's standard warranty agreeing to repair or replace work performed under this section which fails.
 - 1. Failure includes defects in anodized finish including cracking, crazing, flaking, blistering, or combination thereof.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Aluminum Door and Window Frames:
 - 1. Base:
 - a. Kawneer Company Inc.
 - 2. Optional:
 - a. EFCO Corp.
 - b. Oldcastle Building Envelope

2.02 MATERIALS

- A. Interior, non-fire rated, fixed window frames and doors.
- B. Framing:
 - 1. Base Product: Tri-Fab 400 System by Kawneer.
 - 2. Nominal Size of Framing Members: 1-3/4 IN x 4 IN.
 - 3. Position of Glass in Frame:
 - a. Center.
 - 4. Provide system to receive 1/4 IN, monolithic glass, unless otherwise indicated.
- C. Doors:
 - 1. Fabricate of extruded sections assembled with tension rods or welded corners.
 - 2. Dimensions:
 - a. Member wall thickness: 0.125 IN, minimum.
 - b. Member depth: 1-3/4 IN.
 - c. Stiles and top rail:
 - d. Narrow:
 - 1) 2-1/8 to 2-1/4 IN.
 - 2) b) Base Product: 190 Swing Door, Narrow Stile by Kawneer.
 - e. Bottom rail: 10 IN.
 - 3. Provide manufacturer's standard weatherstripping at edges and door bottom.
 - 4. Provide strike boxes in framing system at openings.
- D. Gaskets: Extruded EPDM.
- E. Brackets, anchors and reinforcements:
 - 1. Aluminum wherever possible.
 - 2. Where steel is used: Include dissimilar metals protection to prevent galvanic action.
- F. Fasteners:
 - 1. Anodized aluminum or non-magnetic (300 series) stainless steel which will not promote electrolytic action or corrosion.
 - 2. Provide Phillips flat head screws where exposed.
 - 3. Finish exposed aluminum fasteners to match aluminum finish.
- G. Sealants:
 - 1. See Section 07 92 16.
 - 2. Use exposed sealants of color to match aluminum finish.
 - 3. Provide sealants and caulking required within and around units as work of this section.
- H. Glass: See Section 08 81 26.

2.03 FINISHES

- A. Anodic finish:
 - 1. Architectural Class I per AAMA 611: 2-step electrolytic.
 - 2. Minimum Coating Thickness: 0.7 mils.

3. Color: No. 14, Clear, AAM10C21A41.

2.04 FABRICATION

- A. Fabricate components per manufacturer's installation instructions and with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
- B. Accommodate expansion, and structural movement of adjacent materials.
- C. Fit and assemble work at shop to maximum extent possible.
 - 1. Accurately fit and secure joints and corners.
 - 2. Make flush, hairline joints.
 - 3. Maintain true continuity of line and accurate relation of planes and angles.
 - 4. Weld by methods recommended by manufacturer and AWS to avoid discoloration at welds.
 - 5. Grind exposed welds smooth and restore finish.
 - 6. Ease corners of cut edges to radius of 1/64 IN.
- D. Prepare components to receive anchor devices.
 - 1. Fabricate anchors.
 - 2. Provide secure attachment and support at joints, with hairline fit of contacting members.
 - 3. Reinforce work as necessary to withstand lateral loadings and to support system.
 - 4. Separate dissimilar metals with bituminous paint or separators to prevent corrosion.
 - 5. Separate metal surfaces at moving joints with plastic inserts or other non-abrasive concealed inserts.
- E. Arrange fasteners and attachments to conceal from view.
- F. Fully degrease and clean members prior to assembly or application of sealing compound or protective coatings.
- G. Reinforce frames and doors for hardware.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Site Verification of Conditions:
 - 1. Verify substrate conditions are acceptable for product installation.
 - 2. Verify openings are sized to receive framing system and sill is level within manufacturer's acceptable tolerances.
- B. Field Measurements:
 - 1. Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on Shop Drawings.
 - 2. Coordinate field measurements, fabrication schedule with construction progress to avoid construction delays.

3.02 INSTALLATION

- A. Install units plumb, level, and true to line, without warp or rack of frames with manufacturer's prescribed tolerances and installation instructions.
 - 1. Provide support and anchor in place.
 - 2. Anchor securely.
- B. Comply with manufacturer's shop drawings, erection drawings, and recommendations.
- C. Provide separation of aluminum materials from sources of corrosion or electrolytic action contact points.
- D. Coordinate installation with adjacent walls and other components of construction.
- E. Provide joint fillers or gaskets.
- F. Caulk joints within and at perimeter of system.

3.03 CLEANING AND PROTECTION

- A. Protection:
 - 1. Protect installed product's finish surfaces from damage during construction.
 - 2. Protect units from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants.
- B. Cleaning:
 - 1. Repair or replace damaged installed products.
 - 2. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance.
 - a. Clean promptly after installation.
 - 3. Remove construction debris from project site and legally dispose of debris.
- C. Exercise care to avoid damage to finish, wall members, fastenings, etc., and to protective coating.
- D. Remove excess glazing and sealant compounds and dirt and leave clean.
- E. Protect work and take other precautions required to ensure work not damaged at time of acceptance.

END OF SECTION

SECTION 08 71 00

DOOR HARDWARE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes commercial door hardware for the following:
 - 1. Swinging doors.
 - 2. Sliding doors.
 - 3. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical door hardware.
 - 3. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Division 08 Section "Hollow Metal Doors and Frames".
 - 2. Division 08 Section "Flush Wood Doors".
 - 3. Division 08 Section "Interior Aluminum Storefront".
- D. 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. State Building Codes, Local Amendments.
- E. 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

1.03 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
 2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. 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.

- E. Informational Submittals:
 - 1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.04 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. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
 - 1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 - 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 - 3. Review sequence of operation narratives for each unique access controlled opening.
 - 4. Review and finalize construction schedule and verify availability of materials.
 - 5. Review the required inspecting, testing, commissioning, and demonstration procedures
- H. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

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 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.
 - 4. Five years for motorized electric latch retraction exit devices.
 - 5. Two years for electromechanical door hardware.

1.08 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.

PART 2 - PRODUCTS

2.01 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
 - 1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

- C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.02 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
 5. Manufacturers:
 - a. Hager Companies (HA) - CB Series.
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - TA Series.
 - c. Stanley Hardware (ST) - CB Series.
- B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.
1. Manufacturers:
 - a. Hager Companies (HA).
 - b. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.03 POWER TRANSFER DEVICES

- A. Electrified Quick Connect Continuous Geared Transfer Hinges: Provide electrified transfer continuous geared hinges with a 12" removable service panel cutout accessible without de-mounting door from the frame. Furnish with Molex™ standardized plug connectors with sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
 - 1. Manufacturers:
 - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - SER-QC (# wires) Option.
 - b. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE) - SER-QC (# wires) Option.
- B. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.
 - 1. Provide one each of the following tools as part of the base bid contract:
 - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Electrical Connecting Kit: QC-R001.
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Connector Hand Tool: QC-R003.
 - 2. Manufacturers:
 - a. Hager Companies (HA) - Quick Connect.
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) – QC-C Series.
 - c. Stanley Hardware (ST) – WH Series.

2.04 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.
 - 1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
 - 2. Furnish dust proof strikes for bottom bolts.
 - 3. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
 - 4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
 - 5. Manufacturers:
 - a. Door Controls International (DC).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

- B. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
 2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
 3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
 4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
 5. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.05 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
- B. Cylinders: Original manufacturer cylinders complying with the following:
1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
 2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
 4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 5. Keyway: Manufacturer's Standard.
- C. Keying System: Each type of lock and cylinders to be factory keyed.
1. Conduct specified "Keying Conference" to define and document keying system instructions and requirements.
 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 3. New System: Key locks to a new key system as directed by the Owner.
- D. Key Quantity: Provide the following minimum number of keys:
1. Change Keys per Cylinder: Two (2)
 2. Master Keys (per Master Key Level/Group): Five (5).
 3. Construction Keys (where required): Ten (10).
- E. Construction Keying: Provide construction master keyed cylinders.

F. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

G. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:
 - a. Lund Equipment (LU).
 - b. MMF Industries (MM).
 - c. Telkee (TK).

H. Key Control Software: Provide one network version of "Key Wizard" branded key management software package that includes one year of technical support and upgrades to software at no charge. Provide factory key system formatted for importing into "Key Wizard" software.

2.06 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) – ML2000 Series.
 - b. Sargent Manufacturing (SA) – 8200 Series.
 - c. Yale Locks and Hardware (YA) – 8800FL Series.

2.07 ELECTROMECHANICAL LOCKING DEVICES

2.08 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.09 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
5. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
6. Electromechanical Options: Subject to same compliance standards and requirements as mechanical exit devices, electrified devices to be of type and design as specified in hardware sets. Include any specific controllers when conventional power supplies are not sufficient to provide the proper inrush current.
7. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
 - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
8. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
9. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
10. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
11. Rail Sizing: Provide exit device rails factory sized for proper door width application.
12. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.

1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
 - b. Sargent Manufacturing (SA) - 80 Series.
 - c. Yale (YA) - 7000 Series.

2.10 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.
4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.
5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

- B. Door Closers, Surface Mounted (Commercial Duty): ANSI/BHMA 156.4, Grade 1 certified surface mounted, institutional grade door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck, closing sweep, and latch speed control valves. Provide non-handed units standard.

1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - DC6000 Series.
 - b. Norton Door Controls (NO) - 8500 Series.
 - c. Sargent Manufacturing (SA) - 1431 Series.
 - d. Yale Locks and Hardware (YA) - 3500 Series.

2.11 SURFACE MOUNTED CLOSER HOLDERS

- C. Electromagnetic Door Holders: Certified ANSI A156.15 electromagnetic door holder/releases with a minimum 20 to 40 pounds holding power and single coil construction able to accommodate 12VDC, 24VAC, 24VDC and 120VAC. Coils to be independently wound, employing an integral fuse and armatures to include a positive release button.
 - 1. Manufacturers:
 - a. Rixson (RF) - 980/990 Series.
 - b. Sargent Manufacturing (SA) - 1560 Series.

2.12 ARCHITECTURAL TRIM

A. Door Protective Trim

- 1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
- 2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
- 3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
- 4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, .050-inch thick.
- 5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
- 6. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.13 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 - 1. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

- C. Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

- 1. Manufacturers:
 - a. Rixson Door Controls (RF).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Sargent Manufacturing (SA).

2.14 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 - 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
 - 1. National Guard Products (NG).
 - 2. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
 - 3. Reese Enterprises, Inc. (RE).

2.15 ELECTRONIC ACCESSORIES

- A. Power Supplies: Provide Nationally Recognized Testing Laboratory Listed 12VDC or 24VDC (field selectable) filtered and regulated power supplies. Include battery backup option with integral battery charging capability in addition to operating the DC load in event of line voltage failure. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw plus 50% for the specified electrified hardware and access control equipment.

- 1. Manufacturers:

- a. Alarm Controls (AK) - APS Series.
 - b. Securitron (SU) - BPS Series.

2.16 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.17 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.02 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.03 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.04 FIELD QUALITY CONTROL

- A. Field Inspection (Punch-Out Report): Reference Division 01 Section "Closeout Procedures". Final inspect installed door hardware and state in report whether work complies with or deviates from specification requirements, including whether door hardware is properly installed, operating and adjusted.

3.05 ADJUSTING

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

3.06 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.07 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.08 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
- B. The supplier is responsible for handing and sizing all products and providing the correct option for the appropriate door type and material where more than one is presented in the hardware sets. Quantities listed are for each pair of doors, or for each single door.
- C. Manufacturer's Abbreviations:
 - 1. MK - McKinney
 - 2. PE - Pemko
 - 3. RO - Rockwood
 - 4. SA - SARGENT
 - 5. AD - Adams Rite
 - 6. RF - Rixson
 - 7. SU - Securitron
 - 8. OT - Other

Hardware Sets**Set: 1.0**

Doors: 328, 348

Description: ENTRY - ALUM - EAC

1 Aluminum Storefront	Hardware by Dr Mfg	OT
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Notes:

Set: 3.0

Doors: 333, 366A, 379

Description: ENTRY - ALUM - EAC

1 Aluminum Storefront	Hardware by Dr Mfg	OT
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Notes: Presenting a valid credential releases the lever to allow free entry, door relocks upon closing. REX (request to exit) switch in the lock allow for free exit at all times

Entry by key override at all times

Door is fail secure

Set: 4.0

Doors: 302, 309

Description: STAIR

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D MK
1 Rim Exit Device, Passage	12 8815 ETMB	US32D SA
1 Surface Closer	1431 CPS	EN SA
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D RO
1 Door Stop	409 / 446 as required	US26D RO
1 Gasketing	S88D	PE

Set: 5.0

Doors: 301A, 301B

Description: LOBBY PR

6 Hinge	TA2714 4-1/2" x 4-1/2"	US26D MK
2 Flush Bolt	555 [12" / 72" AFF]	US26D RO
1 Dust Proof Strike	570	US26D RO
1 Passage Latch	8215 LNMB	US26D SA
2 Surface Closer	1431 CPS	EN SA
2 Electromagnetic Holder	980 / 990 series	689 RF ↘
2 Silencer	608	RO

Set: 6.0

Doors: 303

Description: PR - LOCK - MEP

6 Hinge	TA2714 4-1/2" x 4-1/2"	US26D MK
2 Flush Bolt	555 [12" / 72" AFF]	US26D RO
1 Dust Proof Strike	570	US26D RO
1 Storeroom/Closet Lock	8204 LNMB	US26D SA

2 Surface Closer	1431 CPS	EN	SA
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
2 Door Stop	409 / 446 as required	US26D	RO
1 Astragal	357SP X S88D		PE
2 Silencer	608		RO

Set: 7.0

Doors: 307

Description: PR - LOCK - MEP [OHS]

6 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
2 Flush Bolt	555 [12" / 72" AFF]	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom/Closet Lock	8204 LNMB	US26D	SA
2 Surface Closer	1431 PS	EN	SA
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Astragal	357SP X S88D		PE
2 Silencer	608		RO

Notes: Coordinate hardware requirements with existing door / frame. Verify lock functions and hardware compatibility prior to ordering any hardware

Set: 8.0

Doors: 330

Description: CORR

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Rim Exit Device, Classroom	8813 ETMB	US32D	SA
1 Surface Closer	1431 CPS	EN	SA
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Door Stop	409 / 446 as required	US26D	RO
3 Silencer	608		RO

Notes: Coordinate hardware requirements with existing door / frame. Verify lock functions and hardware compatibility prior to ordering any hardware

Set: 9.0

Doors: 366B, 379A

Description: CORR

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Rim Exit Device, Passage	8815 ETMB	US32D	SA
1 Surface Closer	1431 CPS	EN	SA

1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D RO
1 Door Stop	409 / 446 as required	US26D RO
3 Silencer	608	RO

Set: 10.0

Doors: 304

Description: MEP

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D MK
1 Storeroom/Closet Lock	8204 LNMB	US26D SA
1 Surface Closer	1431 CPS	EN SA
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D RO
1 Door Stop	409 / 446 as required	US26D RO
3 Silencer	608	RO

Notes: Coordinate hardware requirements with existing door / frame. Verify lock functions and hardware compatibility prior to ordering any hardware

Set: 11.0

Doors: 336

Description: ENTRY - ALUM

1 Aluminum Storefront	Hardware by Dr Mfg	OT
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Notes: Coordinate hardware requirements with existing door / frame. Verify lock functions and hardware compatibility prior to ordering any hardware

Set: 12.0

Doors: 376

Description: BREAKROOM

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D MK
1 Passage Latch	8215 LNMB	US26D SA
1 Surface Closer	1431 CPS	EN SA
1 Door Stop	409 / 446 as required	US26D RO
3 Silencer	608	RO

Set: 13.0

Doors: 347

Description: LIBRARY

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D MK
1 Passage Latch	8215 LNMB	US26D SA
1 Surface Closer	1431 CPS	EN SA

1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D RO
1 Door Stop	409 / 446 as required	US26D RO
3 Silencer	608	RO

Set: 14.0

Doors: 305, 306

Description: RESTROOM

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D MK
1 Pull Plate	BF 110 x 70C	US32D RO
1 Push Plate	70C	US32D RO
1 Surface Closer	1431 CPS	EN SA
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D RO
1 Door Stop	409 / 446 as required	US26D RO
1 Gasketing	S88D	PE

Notes: Coordinate hardware requirements with existing door / frame. Verify lock functions and hardware compatibility prior to ordering any hardware

Set: 15.0

Doors: 313, 314, 315, 329, 332, 337A, 357, 368

Description: STOR

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D MK
1 Storeroom/Closet Lock	8204 LNMB	US26D SA
1 Door Stop	409 / 446 as required	US26D RO
3 Silencer	608	RO

Notes: Coordinate hardware requirements with existing door / frame. Verify lock functions and hardware compatibility prior to ordering any hardware

Set: 16.0

Doors: 308

Description: JAN

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D MK
1 Storeroom/Closet Lock	8204 LNMB	US26D SA
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D RO
1 Door Stop	409 / 446 as required	US26D RO
1 Gasketing	S88D	PE

Notes: Coordinate hardware requirements with existing door / frame. Verify lock functions and hardware compatibility prior to ordering any hardware

Set: 17.0

Doors: 310

Description: STOR [OHS]

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D MK
1 Storeroom/Closet Lock	8204 LNMB	US26D SA
1 Surf Overhead Stop	10-X36	689 RF
3 Silencer	608	RO

Notes: Coordinate hardware requirements with existing door / frame. Verify lock functions and hardware compatibility prior to ordering any hardware

Set: 18.0

Doors: 325A, 325B, 353, 365, 380A, 381

Description: OFFICE

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D MK
1 Office/Entry Lock	8205 LNMB	US26D SA
1 Door Stop	409 / 446 as required	US26D RO
3 Silencer	608	RO

Notes: Coordinate hardware requirements with existing door / frame. Verify lock functions and hardware compatibility prior to ordering any hardware

Set: 19.0

Doors: 375

Description: CATERING

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D MK
1 Passage Latch	8215 LNMB	US26D SA
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D RO
1 Door Stop	409 / 446 as required	US26D RO
1 Gasketing	S88D	PE

Set: 20.0

Doors: 311, 316, 317, 318, 319, 320, 321, 322, 323, 324, 326, 327A, 327B, 334, 335, 337, 339, 340, 341, 342, 343, 344, 345, 346, 349, 350, 351, 352, 354, 355, 356, 358, 359, 360, 361, 362, 363, 364, 367, 369, 370, 371, 372, 373, 374, 378, 380B, 382, 383, 384, 385, 386, 387, 388

Description: PASSAGE

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D MK
1 Passage Latch	8215 LNMB	US26D SA
1 Door Stop	409 / 446 as required	US26D RO
3 Silencer	608	RO

END OF SECTION

SECTION 08 81 26

INTERIOR GLASS AND GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Interior Glass and Glazing in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Glass Standards:

- 1. ANSI Z97.1.
 - a. CPSC 16 CFR 1201.
 - b. GANA Glazing Manual.

B. Flat Glass:

- 1. ASTM C1036 Standard Specification for Flat Glass.
- 2. Float glass: Type I, Quality q3 and Class 1 unless otherwise indicated.
- 3. Figured glass: Type II, Quality q7, Form 3 and Class 1, Finish f1 and Pattern p2 unless otherwise indicated.
- 4. Mirror glass and one-way vision glass: Type I, Quality q1 or q2, Class 1 and coated for purpose.

C. Flat Glass, Heat Treated, Coated and Uncoated:

- 1. ASTM C1048 Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
- 2. Heat strengthened glass: Kind HS, Type I, Quality q3, Class 1 and Condition A unless otherwise indicated.
- 3. Tempered glass: Kind FT, Type I, Quality q3, Class 1 and Condition A unless otherwise indicated.
- 4. Heat strengthened - tempered glass: Kind HS-FT, Type 1, Quality q3 and Condition A unless otherwise indicated.

D. Mirror Glass:

- 1. ASTM C1503;
- 2. Quality: Mirror select.
- 3. F.S.DD-M-00411B (1).

E. Fire Rated Assemblies:

- 1. Where glazing products are used in fire-rated assemblies, comply with requirements of specific assembly specified in other sections of these Specifications.
- 2. Underwriters Laboratories, Inc. (UL):
 - a. UL 9 - Fire Tests of Window Assemblies.
 - b. UL 10B - Fire Tests of Door Assemblies.
 - c. UL 10C - Positive Pressure Fire Tests of Door Assemblies.

3. Fire Protective Rated Glass:
 - a. Each lite shall bear permanent, non-removable label of UL certifying use in tested and rated fire protective assemblies.
4. Door Assemblies:
 - a. Comply with NFPA 80 and listed and labeled by testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, tested in accordance to NFPA 252.
 - b. Positive Pressure Compliance: UL 10C.
 - c. Fire Protective Glazing Products for Door Assemblies: Products identical to those tested per UL 10B, labeled and listed by UL.
5. Window Assemblies:
 - a. Complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.
 - b. Positive Pressure Compliance: UL 10C.
6. Laminated Glass:
 - a. ASTM C1172 Standard Specification for Laminated Architectural Flat Glass.
 - b. Laminated Glass Design Guide, by the Glass Association of North America (GANA).
7. Glazing Standards:
 - a. Glazing Manual, by the Glass Association of North America (GANA).

1.3 SUBMITTALS

- A. Samples: Provide one (1) 12 IN x 12 IN example of each specified type of glass.
- B. Contract Closeout Information: Warranties.

1.4 WARRANTY

- A. Written warranty signed by manufacturer or fabricator.
- B. Laminated Glass:
 1. Five (5) years against deterioration including edge separation, delamination that materially obstructs vision through glass, and blemishes exceeding those allowed by referenced laminated glass standard.
- C. Fire-rated Ceramics: Five (5) year manufacturer's standard warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Glass Products:
 1. Base:
 - a. AGC Industries
 2. Optional:
 - a. Guardian Industries
 - b. Pilkington
 - c. Vitro Glass
 - d. Saint-Gobain

B. Fire Rated Glass Ceramic:

1. Base:
 - a. Technical Glass Products.
2. Optional:
 - a. Safli First
 - b. Pilkington
 - c. Vetrotech

C. Etched/ Frosted Glass and Etched Patterned Glass:

1. Base:
 - a. Carvart
2. Optional:
 - a. Skyline
 - b. Goldray.

2.2 MATERIALS

A. Glass Materials:

1. Comply with indicated standards.
2. See Glass Types Schedule for listing of types.
3. Materials specified in Glass Types Schedules are minimum acceptable products.
4. Single manufacturer produce individual glass types used in fabrication of insulating units.
5. Manufacturer or fabricator determine if materials should be heat strengthened or fully tempered at non-hazardous locations that do not require safety glazing and provide accordingly.

B. Glazing Compounds:

1. Nonsag, nonstain type.
2. Pigmented to match frame units not requiring painting.
3. Compatible with adjacent surfaces.
4. For use in setting glass: Neutral-cure Silicone sealant.
5. Sealant tape:
 - a. Butyl rubber sealant tape or ribbon having a continuous neoprene shim.
 - b. Gaskets:
 - 1) Polyvinyl chloride or neoprene.
 - 2) Extruded, flexible, of profile and hardness required to receive glass and provide a watertight installation.

C. Installation Setting Blocks and Spacers:

1. Neoprene, compatible with sealants used.
2. Setting blocks: 80-90 durometer.
3. Spacers: 40-50 durometer.
4. Compressible filler stock: Closed cell jacketed rod stock of synthetic rubber or plastic foam.
5. Shims, clips, springs, angles, beads, attachment screws and other miscellaneous items: As indicated or required.

2.3 GLASS TYPES SCHEDULE

- A. Refer to Interior Glass Types Schedule for basic description of mark numbers indicated on Drawing.

- B. Refer to Drawings for depiction of unit sizes and locations.
- C. Upgrade basic type conditions in accordance with following rules:
 - 1. Heat treatment upgrade based on physical size of unit:
 - 2. Heat strengthened or fully tempered units between 55 and 70 SQFT .
 - 3. Fully temper units exceeding 70 SQFT .
 - a. Strengthen annealed glass where units exceed length or width limitations or both as recommended by glass manufacturer.
 - 4. Heat treatment upgrade based on locations which are potentially hazardous to occupants:
 - a. Upgrade units to fully tempered, Kind FT, glass as required by any one of following:
 - 1) When required by local Codes.
 - 2) When specifically indicated on Drawings.
 - 3) Locations requiring Safety Glass, Kind FT, by 16 CFR 1201 and ANSI Z97.1:
 - (a) Units installed in doors, sash, transom or other operable units.
 - 5. Units where any part of unit is within 18 IN , measured vertically, above a floor line, sidewalk, paver, or other walking surface located within 3 FT of the glass unit, measured horizontally.
 - 6. Units in sidelights and other units located adjacent to and within 48 IN of either jamb of door or other operable units; this includes adjacent lites that are in perpendicular plane to door.
 - 7. Other conditions requiring heat treatment upgrades:
 - a. Units which will be exposed to irregular sun or shade combinations or both shall be Kind HS or better.
 - b. Where glass manufacturer recommends heat treatment coatings or tints specified.
 - c. Where required to resist lateral loads.

2.4 INTERIOR GLASS TYPES SCHEDULE

- A. Glass Type - GL3-A: Annealed. Clear float, 1/4" thick.
- B. Glass Type - GL3-T: Tempered.
 - 1. Clear tempered tongless float.
 - 2. Thickness: 1/4" thick.
- C. Glass Type - GL3-HT: Heat strengthened tempered glass.
 - 1. Clear heat strengthened tempered tongless float.
 - 2. Thickness: 1/4" thick.
- D. Glass Type - GL4: Laminated Fire and Safety Glass:
 - 1. Laminated, wireless, UL labeled for assembly indicated.
 - 2. Impact and safety rated per ANSI Z97.1 and CPSC 16CFR1201.
 - 3. Thickness: 5/16" thick laminated.
 - 4. Surface: Polished.
 - 5. Base Product: FireLite Plus by Technical Glass Products.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine framing or glazing channel surfaces, backing, stop design, and conditions under which glazing is to be installed.

3.2 INSTALLATION

- A. Do not install glass with edge damage.
- B. Contractor is responsible for correct glass size for each opening, within tolerances and dimensions established.
- C. Comply with recommendations of manufacturers, except where more stringent requirements are indicated.
- D. Comply with GANA Glazing Manual.
- E. Install sealants as recommended by sealant manufacturer.
- F. Install setting blocks in adhesive or sealant.
- G. Provide spacers inside and out, of proper size and spacing, for glass size, except where gaskets are used for glazing.
- H. Minimum Bite:
 - 1. Monolithic, 6 MM glass: 10 MM minimum bite.
 - 2. For other sizes: Refer to Table C of AAMA's Aluminum Curtain Wall Design Manual, Volume 6, Glass and Glazing.
- I. Sealant Depth: Equal to sealant width.
- J. Prevent sealant exudation from glazing channels.
 - 1. Leave void at heel or install filler at jambs and head.
 - 2. Do not leave void or install filler at sill.
- K. Miter cut and bond gasket ends together at corners.
- L. Immediately after installation, attach crossed streamers to framing held away from glass.
- M. Do not apply anything to surfaces of glass.
- N. Install spandrel units from exterior of building.
- O. Installation of Mirrors:
 - 1. Mastic Attachment: Install mirrors with mirror adhesive applied to back of mirror and pressed against substrate as recommended by mirror supplier.
- P. Installation of Glass below guard rail glass:
 - 1. Attach using metal standoffs, white. Match the standoffs and glass that is used in guard rail system.

Q. Installation of glass using a cable suspension system:

1. Base: Arakawagrip
2. Floor Tensioner, Midway Grippers, Ceiling Grippers and 1/16" 7x7 weave cable, stainless steel.
3. Contractor to verify with manufacturer that the hardware will work with weight of the glass prior to installation.
4. Manufacturer to pre-drill holes for midway grippers. Provide clear plastic gasket between metal and glass.

R. Remove and replace damaged glass.

3.3 CLEANING AND PROTECTION

- A. Wash and polish glass on both faces not more than 7 days prior to final completion of work in each area.
- B. Comply with glass manufacturer's recommendations and GANA 01-0300.

END OF SECTION

SECTION 09 22 16

NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Non-Structural Metal Framing in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.02 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Member of Certified Steel Stud Association (CSSA), Steel Stud Manufacturers Association (SSMA) or Steel Framing Industry Association (SFIA).
- B. ASTM International (ASTM):
 - 1. ASTM C645 Standard Specification for Nonstructural Steel Framing Members.
 - 2. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - 3. ASTM C754 Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
 - 4. ASTM A1003 Standard Specification for Steel Sheet, Carbon, Metallic and Nonmetallic- Coated for Cold-Formed Framing Members.
- C. Provide studs and accessories of type tested and listed for construction indicated.
- D. Gypsum Association (GA):
 - 1. GA-216 Application and Finishing of Gypsum Panel Products.
 - 2. GA-234 Control Joints for Fire-Resistance Rated Systems.

1.03 SUBMITTALS

- A. Product Data:
 - 1. Provide copies of manufacturer's specifications and installation instructions for each type of material and accessory required.
 - a. Where fire resistance classification is indicated, submit copies of nationally recognized testing laboratory listings of products proposed for use.
 - b. Include data required to show specification compliance.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Non-Structural Metal Framing:
 - 1. Base:
 - a. Telling Industries
 - 2. Optional:
 - a. CEMCO Steel Framing and Metal Lath
 - b. ClarkDietrich Building Systems
 - c. Custom Stud Inc.

- d. Marino/WARE
- e. MBA Metal Framing
- f. MRI Steel Framing LLC.

B. Isolation Strip Material:

- 1. Base:
 - a. Reflectix, Inc.
- 2. Optional:
 - a. Saint-Gobain

C. Knee Wall Brace:

- 1. Base: Pittcon Industries

D. Interlocking Grid Support Systems for Gypsum Board Ceilings:

- 1. Base:
 - a. USG Corporation
- 2. Optional:
 - a. Armstrong
 - b. Chicago Metallic

E. Other manufacturers desiring approval comply with Section 01 25 00.

F. Products proposed for use in fire-rated assemblies: Approved by nationally recognized testing laboratory.

2.02 DESIGN CRITERIA

A. Select steel studs in accordance with manufacturer's standard load tables and following design pressures and maximum deflections:

B. Performance Criteria:

- 1. Footnotes
 - a. Limit deflection to L/360 where wall cladding on either face is any of the following: Ceramic Tile, Stone Tile, Porcelain Tile, Thin Brick, Lath & Plaster, Simulated Masonry, Adhered-stone, Veneer Plaster and similar brittle finishes which are prone to movement-induced cracking.
 - b. Where elements meet multiple conditions; Use most stringent Deflection and Design Pressure values.

2.03 MATERIALS

A. Metal Studs and Floor Tracks:

- 1. C-shaped, roll-formed studs and tracks conforming to ASTM C645.
- 2. Galvanized: G40.
- 3. Stud and track depths: As indicated by wall type.
- 4. Minimum flange width: 1-1/4 IN .
- 5. Minimum thickness: 18 MIL (22 GA), except as follows:
 - a. Increase member thickness to comply with performance criteria.
 - b. Increase member thickness to minimum 30 MIL (20 GA) studs at following conditions:
 - 1) Jambs of openings: Two 30 MIL (20 GA) studs.

- 2) One or both sides of walls faced with any of following:
 - (a) Wall mounted cabinetry and equipment.
 - (b) Tile backing board.
 - (c) Adhered stone.
 - (d) Plaster.
 - (e) Moisture-resistant.
 - (f) Abuse-resistant wallboard.
 - (g) Lead backed gypsum wallboard.
 - (h) Where walls do not extend to overhead structural deck, and without supporting diagonal bracing, or horizontal stiffeners.
6. In lieu of increased member thickness, design may employ diagonal braces above ceiling to reduce overall span.
 - a. Coordinate locations with building services items.
 - b. Do not employ studs with member thickness less than allowed by fire resistance rated assemblies.
7. High strength 50KSI studs shall comply with design criteria of equivalent thickness standard 33KSI studs listed.
8. Base products:
 - a. Drywall Framing System by Telling Industries.
9. Optional products, high strength steel:
 - a. Viper Stud by Telling Industries.

B. Head of Wall Accessories:

1. Configure to accommodate deflection of superstructure without inducing axial loading on partition wall.
2. Maintain structural integrity, fire and smoke-resistance, and sound control as required by each wall.
3. Slotted top deflection track:
 - a. Deep leg, vertically slotted track.
 - b. Cold-formed sheet steel; galvanized; G60.
 - c. Thickness: 30 MIL (20 GA) minimum.
 - d. Width: As required for studs sizes indicated.
 - e. Depth: Minimum 2-1/2 IN down-standing legs with 1/4 IN wide by 1-1/2 IN high slots spaced 1 IN on center.
4. Z-bars, cold formed channels and clips:
 - a. Accommodate thickness of spray-applied fire-resistive materials.
5. UL-listed fire resistant components tested for compliance with requirements indicated.
6. Firestopping Materials:
 - a. Sealants, sprays, intumescent strips and forming materials.
 - b. Coordinate with sealants specified in Section 07 92 16.
 - c. Intumescent applications:
 - 1) Factory or field applied.

C. Shaftwall Framing:

1. C-T or C-H shaped studs with U or J shaped tracks.
2. Material: Galvanized steel; G40.
3. Thickness: 30 MIL (20 GA) minimum.
4. Size: 2-1/2, 4, and 6 IN minimum as indicated.
5. Structural design criteria:
 - a. Select stud with properties necessary to limit deflection to L/240 deflection at load of 10 PSF .
 - b. Use larger size and thickness to satisfy span and deflection criteria.

6. Shaftwall assembly with gypsum wallboard specified in Section 09 29 00:
 - a. Fire resistance tested in accordance with ASTM E119.
 - b. Sound transmission loss: Tested in accordance with ASTM E90.
7. Base product: CT Cavity Shaftwall Studs by Telling Industries.

D. Z-Bar Standoff Clips:

1. 30 MIL (20 GA) galvanized steel.
2. Provide Z-bars for attachment of top track to superstructure elements which are to be protected with sprayed fireproofing.
 - a. Size: 2 IN x 2 IN x 2 IN .
3. Length:
 - a. As required to accommodate beam and deck fireproofing.
 - 1) At structural steel member: Length equal to flange width of structural steel member.
 - 2) At steel deck: Minimum length equal to partition width, or as required to span steel deck flutes.
 - b. Extend length of Z-bar to accommodate partition offset that will not clear fireproofed steel beam.
4. Base product: ZFC by Telling Industries.

E. Furring Channels:

1. Hat shaped sections.
2. Galvanized: G40.
3. Sizes: 7/8 IN and 1-1/2 IN , as indicated.
4. Minimum Thickness: 30 MIL (20 GA) ; Use heavier gauge as dictated by conditions.
5. Base product: DWFC by Telling Industries.

F. Z-Furring:

1. Z-shaped sections, attached to structural parent wall.
2. Galvanized: G40.
3. Sizes: 1, 1-1/2, and 2 IN .
4. Thickness: 18 MIL (25 GA) minimum.; Use heavier gauge as dictated by conditions.
5. Base product: ZFC by Telling Industries.

G. Accessory Items:

1. Wire Ties:
 - a. Minimum thickness: 43 MIL (18 GA) soft annealed, galvanized.
2. Track Fasteners:
 - a. Power driven type, to withstand minimum 190 LBS shear when driven.
3. Closure:
 - a. Continuous 30 MIL (20 GA) galvanized closure angle to receive vapor retarder and vapor retarder tape.
4. Isolation Strip Material:
 - a. Non-absorbent, foam padding to prevent direct contact between metal framing and exterior concrete or masonry.
 - b. Thickness: 0.40 MIL minimum.
 - c. Install continuous strips in widths to match steel framing and furring.
 - d. Base product: Sill Sealer by Reflectix, Inc.

5. Metal Blocking:
 - a. C-shaped modified track runners.
 - b. G40 galvanized.
 - c. Backing height: 6 IN minimum.
 - d. Flange width: 1-1/4 IN minimum.
 - e. Thickness: 30 MIL (20 GA) minimum.
6. Backing - Flat Plate:
 - a. Flat, sheet metal stock per ASTM A1008.
 - b. G40 galvanized.
 - c. Thickness: 50 MIL (18 GA) minimum.
7. Knee Wall Brace:
 - a. Steel tube and baseplate bolted to concrete floor slab with tube projecting vertically; concealed within framed walls to provide structural stability for knee walls.
 - b. Design components compatible with wall type.
 - c. Material: Cold-rolled steel tube and base plate, fully welded.
 - d. Overall height: Wall height less 2 IN .
 - e. Spacing as recommended by manufacturer.
 - f. Base product: SKB by Pittcon Industries.

H. Support Systems for Gypsum Ceilings:

1. Interlocking Grid Systems:
 - a. ASTM C635, direct-hung system composed of T-Shaped framing members designed to carry load of screw-applied gypsum ceiling board.
 - b. Tabs on Cross-Tees to interlock into slots in Main Runners where intersections occur.
 - c. Base Product: Drywall Suspension System by USG Corporation.
2. Track and Channel Systems:
 - a. ASTM C645 roll-formed steel with G40 galvanized coating.
 - b. Thickness: 30 MIL (20 GA) minimum; Use heavier gauge as dictated by conditions.
 - c. Carrying channels: 1) Size: 1-1/2 IN .
 - d. Furring channels:
 - 1) Sizes: 7/8 IN and 1-1/2 IN , as indicated.
3. Stud-Framed Ceiling/Soffit Systems:
 - a. C-shaped studs or joists; roll-formed.
 - b. Galvanized: G40.
 - c. Frame member depth: 3-5/8 IN minimum, unless otherwise indicated.
 - 1) Use wider stud sections if ceiling span and support requires.
 - d. Flange width: 1-1/4 IN minimum.
 - e. Stud thickness: 33 MIL minimum.
4. Tie Wire:
 - a. ASTM A641, Class 1 zinc coating, soft temper.
 - b. Diameter, single-strand: 62 mils (14 GA) minimum.
 - c. Diameter, double-strand: 42 mils (18 GA) minimum.
5. Wire Hangers:
 - a. ASTM A641, Class 1 zinc coating, soft temper.
 - b. Diameter: 97 mils (12 GA) minimum.

6. Anchors in Concrete:
 - a. Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined by testing per ASTM E488 or ASTM E1512 as applicable.
 - b. Acceptable types: Cast-in-place, post-installed expansion anchors and post-installed bonded anchors.
 - c. Material: Carbon-steel components zinc plated to comply with ASTM-B633, Class Fe/Zn 5 for Class SC 1 service condition.
7. Powder-Actuated Fasteners in Concrete:
 - a. Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E1190.
 - b. Comply with seismic design requirements where applicable.
8. Other items including suspension wire, tie wire, attachment devices: As specified and indicated.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine supporting structure and conditions under which system will be installed.
- B. Correct conditions detrimental to proper installation.
- C. Installation constitutes acceptance of responsibility for performance.

3.02 INSTALLATION - GENERAL

- A. Layout and install metal framing accurate to dimensions indicated in drawings.
- B. Installation Standard: ASTM C754, except comply with framing sizes and spacing indicated.
 1. Gypsum Board Assemblies: Comply with additional requirements in ASTM C840 relative to framing installation.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.
- F. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- G. Extend framing full height to structural supports.
 1. Exception: Where partitions are indicated to terminate at, or just above, suspended ceilings.
 2. Continue framing around ducts and similar items which penetrate partitions.

- H. Position studs vertically engaging floor track and head of wall deflection track. Align stud knockouts to facilitate running of wires and conduit.
- I. Space studs maximum 16 IN on center. Stud spacing at Shaftwall: 24 IN on center.
- J. Provide additional studs at corners, partition intersections and terminations of partitions, and at each side of control joints.
- K. Positively anchor studs to floor tracks with self-tapping pan head screws, or stud clinching tool on both flanges of each stud.
- L. Anchor studs to deflection track with wafer head screws on both flanges of each stud.
 - 1. Maintain deflection gap between top of stud and top of slotted track.
 - 2. Install screws at centerline of slot and secure allowing vertical movement.
- M. Anchor fire rated partitions as required by fire resistance design, and firestopping design.
- N. Where partitions abut vertical structural elements, provide perimeter relief per Gypsum Association GA-600 Strain Relief System details.
- O. Head-of-Wall:
 - 1. Provide slotted top track for walls extended to structure.
 - 2. Configure to resist lateral loads while accommodating deflection of overhead building superstructure without inducing axial loading on partition framing.
 - 3. Secure deflection track to structure in accordance with industry standards and regulatory requirements.
 - 4. Secure at corners and at ends.
 - 5. Cut vertical studs 5/8 IN short to create a deflection gap when installed into top track.
 - a. Secure vertical studs to top track with framing screw at each stud flange, screwing through track slots for positive stud connection.
 - 6. Secure Gypsum Wallboard to vertical studs; do not secure Gypsum Wallboard to top track directly.
 - 7. Where partitions attach to structural elements that are scheduled to receive Spray-applied Fire Resistive Materials (SFRM):
 - a. Install Z-bar to underside of steel beams and steel deck before application of sprayed fireproofing.
 - b. Locate Z-bars perpendicular to line of partition, spaced maximum 16 IN on center.
 - c. Attach each Z-bar with two 0.145 IN x 1 IN powder-actuated fasteners located minimum 1 IN from ends of Z-bar.
 - d. After fireproofing, secure top track to Z-bars with No. 8 x 5/8 IN wafer head framing screws spaced maximum 16 IN on center.
 - 8. Where fire-rated partitions are offset and will not clear fireproofed steel beam, extend Z-bar outrigger horizontally from bottom of beam out to minimum 2 IN beyond width of head-of- wall.
 - a. Attach 3/4 IN expanded metal lath continuous, width of top of Z-bar outriggers prior to fireproofing steel beam to accommodate sprayed fireproofing.
 - 9. Prepare wall for installation of seals, firestopping, or both:
 - a. Fire-rated Walls: Prepare for fire-resistive joint assemblies specified in Section 07 84 00.
 - b. Non-fire rated partitions including Smoke Partitions: Prepare for Acoustical Sealant specified in Section 07 92 16.

P. Furring Channels:

1. Attach furring channel systems directly to parent walls.
2. Install channels at maximum 16 IN OC.
3. Provide additional framing at openings, cutouts, corners, and control joints.
4. Space fasteners not more than 24 IN OC, staggered on opposite flanges of furring channels.

3.03 FRAMING AT OPENINGS

A. Control Joints (CJ):

1. Install additional stud, maximum 1/2 IN from jamb studs.
2. Do not fasten extra stud to track or jamb stud.
3. Refer to specification Section 09 29 00 for control joint locations.

B. Prefabricated headers, jambs, and sill framing systems option:

1. Proprietary opening framing systems may be used as an alternative to conventionally fabricated framing.
2. Pre-approved Products:
 - a. HDS Framing System by ClarkDietrich.
 - b. Quick Frame Rough Opening System by Marino/ Ware.

C. Door Openings:

1. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section for cripple studs at head and secure to jamb studs.
2. Unless indicated otherwise, extend jamb studs through suspended ceilings and secure laterally to overhead structure.
3. Jamb Studs:
 - a. Install two studs at each jamb, unless otherwise indicated.
 - b. Minimum thickness of jamb studs: 30 MIL (20 GA) at openings.
 - c. Securely attach jamb studs to door frames.
 - d. Attach drywall to both studs equally.
4. Headers:
 - a. Openings less than 4 FT wide:
 - 1) Cut-to-length section of floor runner above and below wall openings.
 - 2) Split flanges and bend webs at ends.
 - 3) Overlap and screw attach jamb studs to frames.
 - b. Openings over 4 FT wide:
 - 1) Cut-to-length, horizontal box beam studs above and below wall openings.
 - 2) Design for actual span and loading.
 - c. Incorporate miscellaneous steel members and wood blocking where indicated.
5. Control Joints at head of jambs:
 - a. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2 IN clearance from jamb stud to allow for installation of control joint in finished assembly.

D. Other Framed Openings:

1. Frame openings other than door openings the same as required for door openings, unless otherwise indicated.

2. Install framing below sills of openings to match framing required above door heads.
3. Cripple Studs:
 - a. Install cut-to-length intermediate vertical studs above and below openings.
 - b. Spacing: As indicated for typical full-length studs.
4. Incorporate miscellaneous steel members and wood blocking, where indicated.

3.04 WALL BACKING AND BLOCKING

- A. Metal Wall Backing: Provide in-wall metal wall backing reinforcement where following items are mounted to interior walls and interior face of exterior walls:
 1. Crash rails, chair rails, wall bumpers, and similar wall protection devices.
 2. Contractor or Owner-furnished equipment indicated to be wall-mounted.
 3. Toilet accessories that do not include proprietary backing devices.
 4. Toilet partitions and lockers.
 5. Markerboards, tackboards, and chalkboards.
 6. Other wall-mounted items where backing is indicated by details or specification.
- B. Coordinate mounting height, location, and coverage with item to be supported.
- C. Determine material width according to item to be supported.
- D. Provide in-wall metal wall backing material to interior metal stud walls specified herein.
- E. Attachment: Minimum 2 - #10 sheet metal screws at each stud.

3.05 CEILING FRAMING

- A. Install in compliance with manufacturer's recommendations.
- B. Provide required items to support and trim out neatly, flush or recessed mechanical and electrical items.
- C. Frame openings in ceiling support system to accommodate access panels and similar openings and penetrations.
 1. Completely frame openings with closed channel side of stud facing opening for support of recessed mechanical and electrical items.

3.06 CEILING SUPPORT SYSTEMS

- A. Install suspension system components in sizes and spacing indicated on Drawings, but not less than required by referenced installation standards for assembly types and other assembly components indicated.
- B. Isolate suspension systems from building structure where abutting or penetrated by building structure.
- C. Suspend hangers from building structure as follows:
 1. Install hangers plumb and free from contact with insulation or other objects that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and secure fasteners appropriate for substrate.
4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and secure fasteners appropriate for structure and hanger.
5. Do not attach hangers to steel roof deck.
6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Seismic Bracing:

1. Saddle-tie hangars around main runners.
2. Saddle-tie cross-furring to main runners with one strand 97 mils (12 GA) or two strands of 42 mils (18 GA) tie wire.
3. Splice main runners by lapping and interlocking flanges 12 IN minimum and tying near each end with double loops of 53 mils (16 GA) 1.346 MM wire.
4. Splice cross-furring by lapping and interlocking pieces 8 IN minimum and tying near each end with double loops of 16 GA wire.
5. Support recessed or drop-in light fixtures by main runners or supplemental framing supported by main runners.
6. Attach surface mounted fixtures to main runners with positive clamping device made of minimum 14 GA material.
7. Seismic brace ceilings with #12 diagonal wires spaced in a 8 FT x 12 FT grid within 6 FT of walls.
 - a. Locate seismic bracing at intersection of main runners and cross-furring members.
 - b. Provide connection between diagonal wires and main runner to prevent slippage for a 200 LB seismic load.

E. Grid Suspension Systems:

1. Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces.
2. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
3. Install suspension systems that are level to within 1/8 IN in 12 FT measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION

SECTION 09 29 00

GYPSUM WALLBOARD

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Gypsum Wallboard in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):

1. ASTM C475 Joint Compound and Joint Tape for Finishing Gypsum Board.
2. ASTM C840 Application and Finishing of Gypsum Board.
3. ASTM C841 Installation of Interior Lathing and Furring.
4. ASTM C954 Steel Drill Screws for Application of Gypsum Panel Products or Metal Plaster Bases.
5. ASTM C1002 Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases.
6. ASTM C1047 Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
7. ASTM C1396 Standard Specification for Gypsum Board.
8. ASTM C1629 Abuse-Resistant Non-decorated Interior Gypsum Panel Products and Fiber- Reinforced Cement Panels.
9. ASTM D3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
10. ASTM E84 Surface-Burning Characteristics of Building Materials.
11. ASTM E90 Sound Transmission Testing.
12. ASTM E119 Fire Tests of Building Construction.
13. ASTM E413 Classification for Rating Sound Insulation.
14. ASTM F2547 Standard Test Method for Determining the Attenuation Properties in a Primary X-ray Beam of Materials Used to Protect Against Radiation Generated During the Use of X-ray Equipment

B. Gypsum Association (GA):

1. GA-216 Application and Finishing of Gypsum Panel Products.
2. GA-234 Control Joints for Fire-Resistance Rated Systems.
3. GA-238 Guidelines for Prevention of Mold Growth on Gypsum Board.

C. Fire Resistant Rated Assemblies:

1. For fire resistance rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
2. Provide materials listed by UL, or other approved testing laboratory, for construction and rating type indicated.

D. STC Rated Assemblies:

1. Provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
2. American National Standards Institute (ANSI):
 - a. ANSI S1.1 American National Standard Acoustical Terminology.
 - b. ANSI S1.4 American National Standard Specification for Sound Level Meters.
 - c. ANSI S1.4 American National Standard Specification for Sound Level Meters.
 - d. ANSI S1.43 American National Standard Specifications for Integrating-Averaging Sound Level Meters.
3. ASTM International (ASTM):
 - a. ASTM C423 Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - b. ASTM C634 Standard Terminology Relating to Building and Environmental Acoustics.
 - c. ASTM E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - d. ASTM E366 Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings.
 - e. ASTM E413 Classification for Rating Sound Insulation.
 - f. ASTM E966 Standard Guide for Field Measurements of Airborne Sound Insulation of Building Facades and Façade Elements.
4. American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. ASHRAE 2007 Handbook: Chapter 47 - Sound and Vibration Control.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's specifications for each type of material and accessory.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Gypsum Wallboard:

1. Base:
 - a. Georgia Pacific (GP).
2. Optional:
 - a. American Gypsum.
 - b. CertainTeed.
 - c. National Gypsum Company (NGC).
 - d. United States Gypsum (USG).

B. Acoustically Enhanced Gypsum Wallboard Composite:

1. Base:
 - a. National Gypsum Company.
2. Optional:
 - a. CertainTeed.
 - b. Supress Products, LLC.

C. Drywall Trim Accessories:

1. Base:
 - a. United States Gypsum (USG)
2. Optional:
 - a. ClarkDietrich.
 - b. Phillips Manufacturing.
 - c. Structus Building Technologies.

D. Specialty Drywall Trim:

1. Base:
 - a. Pittcon Industries.
2. Optional:
 - a. Fry Reglet Corp.
 - b. Gordon, Inc.

E. Foam Tape:

1. Base:
 - a. As noted.

F. Sound Attenuation Batts (SAB):

1. Base:
 - a. As noted.

G. Preformed Acoustical Seal for Wall Boxes:

1. Base:
 - a. STC Architectural Products.

H. Pressure Sensitive Fire Tape:

1. Base:
 - a. E-Z Taping System.

I. Other manufacturers desiring approval comply with Section 01 25 00.

2.2 MATERIALS

A. Furnish in maximum available lengths, consistent with installation requirements.

1. Long Edge: Tapered.
2. Short Ends: Square.

B. Upgrade listed types to fire rated equivalent products when used in fire rated assemblies.

C. Provide listed GWB products to mold and moisture resistant types, where wallboard is installed in Electrical, Communication Rooms, Mechanical shafts, Stair Shafts and similar locations where wallboard is installed prior to building being weathertight.

D. Interior face of exterior walls and rooms where moisture or high humidity is present:

1. Mold and moisture resistant gypsum panels (MRGWB).
2. Gypsum panels, with glass mat facer per ASTM C1658.
3. Thickness: 5/8 IN .
4. Mold resistance score: 10 per ASTM D3273.
5. Apply continuously to interior face of exterior stud walls prior to framing interior partitions and ceilings.
6. Where MR wallboard is scheduled in fire rated walls, provide approved fire resistive products with comparable moisture resistance.
7. Base product:
 - a. DensArmor Plus Interior Panel and DensArmor Plus Fireguard Interior Panel Fireguard by Georgia Pacific.

E. Interior Partitions and Ceilings:

1. Gypsum panels - Type X:
 - a. ASTM C1396.
 - b. Thickness: 5/8 IN .
 - c. Type X core.
 - d. Base product:
 - 1) ToughRock Fireguard X Gypsum Wallboard by Georgia Pacific.
2. Gypsum panels - Standard:
 - a. ASTM C1396.
 - b. Thickness: 1/2 IN .
 - c. Thickness: 3/8 IN .
 - d. Thickness: 1/4 IN .
 - e. Thickness: as shown in Drawings.
 - f. Base product:
 - 1) ToughRock Gypsum Wallboard by Georgia Pacific.
3. Gypsum panels - Mold and moisture resistant (MRGWB):
 - a. Gypsum panels with paper facer per ASTM C1396.
 - b. Thickness: 5/8 IN
 - c. Mold resistance score: 10 per ASTM D3273.
 - d. Base Product: ToughRock Mold-Guard and ToughRock Mold-Guard Fireguard X by Georgia Pacific.
 - e. Utilize approved fire resistive products where mold and moisture resistant wallboard is scheduled in Fire Rated Walls.
4. Gypsum panels - Mold and moisture resistant (MRGWB):
 - a. Uniform composition, no facer per ASTM C1278.
 - b. Thickness: 5/8 IN .
 - c. Base Product:
 - 1) Fiberock Interior Panel, Aqua-Tough by USG.
 - d. Utilize approved fire resistive products where mold resistant wallboard is scheduled in fire rated walls.
5. Cement Board (CB):
 - a. Application:
 - 1) Provide CB at walls in lobbies, waiting rooms, and similar areas where large format tile and stone tile is scheduled.
 - 2) Finish in accordance with manufacturer's material and recommendation.
 - b. Compliance Standards: ANSI A118.9, ANSI A108.11, and ASTM C1325.
 - c. Thickness: 5/8 IN
 - d. Base Product:
 - 1) Durock Cement Board Next Gen by United States Gypsum (USG).

6. Tile Backer Board (TBB):
 - a. Moisture resistant treated gypsum core, glass mats on both sides, and acrylic water barrier or water resistant gypsum coating on finished side.
 - b. Provide TBB at walls of showers, tub rooms, toilet rooms, decontamination rooms, and similar walls where tile is scheduled.
 - c. Thickness: 1/2 IN .
 - d. Thickness: 5/8 IN type X at rated walls.
 - e. Mold resistance score: 10 per ASTM D3273.
 - f. Base Products:
 - 1) Non-Rated Walls: DensShield Tile Backer by Georgia Pacific.
 - 2) Fire Rated Walls: DensShield Fireguard Tile Backer by Georgia Pacific.
 - g. Include Level 5 finish at non-tiled portions.

F. Trim:

1. Interior Trim:
 - a. Material: Galvanized or aluminum coated steel sheet, rolled zinc, paper faced galvanized steel sheet, or paper faced structural laminate.
 - b. Material for wet areas: Zinc.
 - c. Shapes:
 - 1) Corner bead.
 - 2) LC-Bead: J-shaped; exposed long flange receives joint compound.
 - 3) L-Bead: L-shaped; exposed long flange receives joint compound.
 - 4) U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - 5) Control joint.
 - 6) Curved Edge Corner bead: With notched or flexible flanges.
 - 7) Other items as indicated.

G. Joint Treatment Materials:

1. Use product types recommended by wallboard manufacturer for each condition.
2. Materials compatible with other compounds applied previously or on successive coats.
3. Provide dust control products in occupied areas or adjacent to occupied areas.
4. Joint tape:
 - a. Interior gypsum wallboard: Paper.
 - b. Tile backing panels: As recommended by panel manufacturer.
5. Joint compounds for interior gypsum wallboard:
 - a. Setting type joint compound:
 - 1) Filling open joints and voids.
 - 2) Embedding tape and first coat over joints, fasteners and trim flanges.
 - b. Lightweight setting type joint compound:
 - c. Second coat.
 - d. Final, skim coat on surfaces receiving a Level 5 finish.
 - e. Drying type all purpose joint compound:
 - 1) Second and third coats.
 - 2) Final, skim coat, on surfaces receiving a Level 5 finish.
 - f. Spray applied coating compound:
 - 1) Final, skim coat, on surfaces receiving a Level 5 finish.

6. Joint compounds for moisture resistant gypsum wallboard:
 - a. Setting type joint compound:
 - 1) Filling open joints and voids.
 - 2) Embedding tape and first coat over joints, fasteners and trim flanges.
 - b. Lightweight setting type joint compound:
 - 1) Second and third coats.
 - 2) Final, skim coat on surfaces receiving a Level 5 finish.

H. Acoustical Materials:

1. Provide where indicated.
2. Minimum nominal thickness: As required to achieve STC indicated for wall systems.
3. Density: As required to achieve STC indicated for wall systems.
4. Sound attenuation batts (SAB):
 - a. Glass or mineral fiber.
 - b. Commercial sound blanket, ASTM C665, Type I, unfaced, produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - c. Surface burning characteristics per ASTM E84:
 - 1) Maximum flame spread: 10.
 - 2) Maximum smoke developed: 10.
 - d. Fire rated assemblies: Select SAB materials and thicknesses that are approved for use in assemblies listed.
 - e. Acoustically rated assemblies: Select SAB materials and thicknesses that are approved for use in assemblies listed.
 - f. Base Product: Sound Attenuation Batt Insulation by Owens-Corning.
5. Acoustical insulation:
 - a. Minimum 80 PCT recycled wood based cellulosic fibers.
 - b. Flame spread: Less than 25 when tested in accordance with ASTM E84.
 - c. Density: Not less than 1.6 LB/CF accordance with ASTM C739.
 - d. For sound attenuation comply with requirements of ASTM C423.
 - e. Thickness and density as required achieving STC indicated for wall system sound rating.
6. Preformed acoustical seal for wall boxes:
 - a. Box Seal by STC Sound Control
 - b. Molded neoprene, durometer A-40 complying with ASTM D2000.
 - c. Formed to fit the electrical device, outlet and service boxes.
 - d. STC improvement: 6 db in accordance to ASTM E90.
 - e. Provide at electrical and service box penetrations in sound rated walls.

I. Interior joint sealants, including acoustical sealants: See Section 07 92 16.

J. Fasteners:

1. Bugle head screws: ASTM C1002 for use with maximum 22 GA metal stud framing.
2. Self-tapping bugle head screws: ASTM C954 for use with minimum 20 GA metal framing.
3. Type S for gypsum wallboard to metal; Type G for gypsum wallboard to gypsum wallboard.
4. Screws used with backer boards: As recommended by panel manufacturer.

K. Laminating Adhesive:

1. Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

L. Foam Tape:

1. PVC 1/2 x 1/4 IN : With pressure sensitive adhesive; Norseal.
2. EPDM 1/2 x 1/4 IN : With pressure sensitive adhesive; Cellular rubber by Gasket Dynamics.

M. Backing for Control Joints: Fire rated board.

N. Support straps:

1. Galvanized steel sheet for retaining and bracing in length and width indicated or as required for adequate support of assembly.
2. Minimum Base-Metal Thickness: 20 gauge.

O. Sealer for Moisture Resistant Gypsum Wallboard:

1. Manufacturer's standard compound.
2. Use at joints, cut edges and screw penetrations.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION

- A. Examine supporting structure and conditions prior to wallboard installation.
- B. Correct unsatisfactory conditions.
- C. Start of installation constitutes acceptance of conditions and responsibility for performance.

3.2 INSTALLATION - GENERAL

- A. Comply with ASTM C840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Remove loose materials and vacuum cavity of gypsum dust prior to enclosing stud space.
- C. Install wallboard vertically with edges over metal stud framing members and similar framing support members.
- D. Bring boards into contact but do not force into place.
- E. Stagger edge joints on opposite side of partition so they occur on different framing members.
- F. Stagger joints in multi layer applications not less than one support from previous layer.
- G. Seal ends, cutouts and screw penetrations of moisture resistant boards with sealer.

- H. Install wallboard over metal framing studs and similar framing support members at interior face of exterior walls full height from floor to structure above.
- I. Wallboard installation prior to building being weathertight:
 - 1. Replace scheduled GWB products to their mold-resistant counterparts.
 - a. Products proposed are subject to Architect approval.
 - 2. Exposure time shall be limited by manufacturer requirements.
- J. Sound Insulation:
 - 1. Install sound insulation in walls from floor to structure above, where sound rated walls are indicated.
 - 2. Install in thicknesses and densities necessary to achieve sound rating.
 - 3. Fill cavities where studs are installed nested or toe-to-toe.
 - 4. Pack spaces around electric boxes and other penetrations to maintain full sound rating.
 - a. Fill small voids that remain with Acoustical Sealant.
 - 5. Where walls are not finished on both sides or insulation does not fill the cavity depth, supplementary galvanized steel support straps must be provided to hold product in place at 24 IN on center or at spacing as indicated by the insulation manufacturer's written installation instructions.
- K. Preformed Acoustical Seal for Wall Boxes:
 - 1. Place preformed seal over exposed outlet box flush with wall surface with device protruding through preformed or precut opening in seal.
 - 2. Secure in place with outlet cover plate.
- L. Access Panels and Doors: Locate where required or as indicated.

3.3 INSTALLATION - TRIM ACCESSORIES

- A. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Interior Trim:
 - 1. Install in following locations:
 - a. Cornerbead: Use at outside corners.
 - b. J-Bead or LC-Bead: Use at exposed panel edges.
 - c. L-Bead: Use where wallboard abuts dissimilar surfaces and where indicated.
- C. Specialty Trim: Install in locations indicated.

3.4 INSTALLATION - CEILING

- A. Install in compliance with manufacturer's recommendations.
- B. Stagger abutting end joints of adjacent panels' not less than one framing member.
- C. During cold or damp weather, insulate before installing gypsum board on a ceiling with a vapor barrier.

- D. Install fire rated ceiling assemblies as indicated.
 - 1. Fasten minimum 3 IN wide fire rated board continuous over joints or use firestopping.
- E. Install sound insulation so coverage required for sound rating is achieved; maximum 2.2 PSF .

3.5 CONTROL JOINTS

A. General:

- 1. Install Control Joints in location indicated and as described in this article.
- 2. Install suitable backing material to maintain required rating where Control Joints occur in fire or sound rated assemblies.

B. Partitions:

- 1. Extend control joints continuous full height of partition or wall.
- 2. Provide vertical control joints on both wall faces which align with door frames, window frames, and similar opening as follows:
 - a. Single Doors and Cased Opening:
 - 1) Locate CJ's at both jambs, from head of opening to top of partition.
 - b. Pair doors:
 - 1) Locate CJ's at both jambs, from head of opening to top of partition.
 - 2) Exception: Control Joints are not required where partition forms a cross-corridor condition.
 - c. Doors with adjacent sidelights:
 - 1) Locate CJ's at both jambs from head of opening to top of partition, and, from sill to floor at sidelight jambs.
 - d. Sliding doors:
 - 1) Locate CJ's at both jambs, from head of opening to top of partition.
 - e. Punched windows less than 30 FT in width:
 - 1) Both jambs from head of opening to top of partition, and from sill edge to floor.
- 3. Provide additional vertical Control Joints, spaced no more than 30 FT apart from each other, from opening related CJ's, or from corners.

C. Ceilings:

- 1. Use Control Joints to subdivide ceilings/soffits as indicated, and within the following limits:
 - a. Ceilings with perimeter relief:
 - 1) Subdivide so no area exceeds 2500 SQ FT , and no area has a length which exceeds 50 FT .
 - 2) Exception where ceiling occurs at exterior: Subdivide so that no area exceeds 900 SQ FT , and no area has a length which exceeds 30 FT.
 - b. Ceilings without perimeter relief:
 - 1) Subdivide so that no area exceeds 900 SQ FT, and no area has a length which exceeds 30 FT .
 - c. Locate control joints at transitions between areas of different shapes.

3.6 WALLBOARD FINISHING

- A. Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration.
- B. Pre-fill open joints and voids, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Where bead abuts exterior metal window frames or other metal components, separate from other material by use of foam tape.
- E. Remove residual joint compound from adjacent surfaces.
- F. Apply Joint Compound and Tape in accordance with fire rated design.
 - 1. Apply joint treatment compound in accordance with manufacturer's directions.
 - 2. Fill joints, screw heads, and internal corners with compound.
 - 3. Extend joint system vertically from floor to extent described as follows:
 - a. Fire Walls, Barriers, and Partitions: Extend to full height of wall.
 - b. Smoke Barriers and Partitions: Extend to full height of wall.
 - c. Interior face of exterior wall (non-rated): Extend to full height of wall.
 - d. Other interior partitions (non-rated): Extend to 6 IN 150 MM above ceiling.
 - 4. Refer to Drawings for indication of partition heights.
- G. Level 4 Finish:
 - 1. After drying, sand or otherwise smooth final coat of compound as needed to eliminate high spots or excess compound to leave smooth, even, and level surface.
 - 2. Draw down final coat of compound to a smooth even plane.
 - 3. Locations:
 - a. Wallboard scheduled to be finished with Gloss Level 1 (flat), Level 2 (velvet), or Level 3 (eggshell) paint, glazed coating, textured coating, or wall covering.
 - b. Where above listed surfaces are to be finished with textured decorative treatments, wall covering, paneling, or wall guard.
 - c. Remaining locations, unless noted otherwise.
- H. Level 5 Finish:
 - 1. Trowel skim coat of joint compound leaving a thin film covering the entire surface, in accordance with manufacturer's recommendations.
 - 2. Make surfaces free of tool marks and ridges.
 - 3. Locations:
 - a. Exposed ceiling, soffit, or wall areas abutting window mullions, skylights, or receiving direct indoor lighting.
 - b. Hallways or corridors unbroken by doorways or windows in excess of twenty feet .
 - c. Atriums, Lobbies, Auditoriums and similar large spaces.
 - d. Multi-story spaces.
 - e. Wall board scheduled to be finished with Gloss Level 4 (satin), Level 5 (semi-gloss), Level 6 (gloss), Level 7 (high gloss), paint, glazed coating, textured coating, or wall covering.
 - f. Surfaces using MRB or other wallboard types with a glass mat facer on finished side.

- I. Glass Mat, Water Resistant Backing Panels: Finish according to manufacturer's written instructions.
- J. Cementitious Backer Units: Finish according to manufacturer's written instructions.
- K. Repairs:
 - 1. After painter has applied primer to wallboard surfaces, repair and refinish defective areas.
 - 2. If wallboard is damaged, or surfaces are roughened, repair or replace.

3.7 FIRE AND SMOKE WALL IDENTIFICATION

- A. Identify walls indicated on Drawings as having a required fire or smoke rating.
 - 1. Follow guidelines set in Chapter 7 of International Building Code.
 - 2. Permanently identify rating and type of barrier with stencil and paint in contrasting, 3 IN high letters in a manner acceptable to authority having jurisdiction.
 - 3. Text for fire and smoke barriers: "x HOUR FIRE AND/OR SMOKE BARRIER-PROTECT ALL OPENINGS".

3.8 PROTECTION

- A. Protect installed wallboard from water damage during construction.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. 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.
- D. Prior to finishing, walls shall be inspected for visible mold growth. Replace affected portions.

END OF SECTION

SECTION 09 30 00

TILING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Tile, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum ten (10) years of experience in manufacture of tile, setting and grout materials.
- B. Installer Qualifications: Specializing in tile work having minimum of five (5) years successful documented experience with work comparable to that required for this Project.
- C. Single Source Responsibility:
 - 1. Obtain each type and color tile material required from single source.
 - 2. Provide compatible materials for tile system.
- D. Certifications:
 - 1. Submit Master Grade Certificate for each type of ceramic, quarry, and paver tile in accordance with requirements of ANSI A137.1.
 - 2. Submit manufacturer's certifications that mortars, adhesives, and grouts are suitable for intended use.
- E. Tile Council of North America (TCNA): Handbook for Ceramic, Glass and Stone Tile Installation, latest edition.
- F. Ceramic Tile Institute of America (CTIOA).
- G. ASTM International (ASTM):
 - 1. ASTM C373 Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products.
 - 2. ASTM C623 Young's Modulus, Shear Modulus, and Poisson's Ratio for Glass and Glass- Ceramics by Resonance.
 - 3. ASTM C627 Robinson Floor Test for Tile Service Level.
 - 4. ASTM D4068 Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane.
 - 5. ASTM D4551 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-Containment Membrane.
 - 6. ASTM E90 and ASTM E413 for STC (Sound Transmission Class).
 - 7. ASTM E492 and ASTM E989 for IIC (Impact Insulation Class) - Sound Deadening Underlayments.

H. American National Standards Institute (ANSI):

1. ANSI A108.5 Installation of Ceramic tile with Dry-Set Portland Cement or Latex-Portland Cement.
2. ANSI A108.10 Installation of Grout in Tilework.
3. ANSI A108.13 Installation of Membranes for Thin-Set Ceramic Tile.
4. ANSI A108.17 Installation of Crack Isolation Membranes for Thin-set Ceramic Tile and Dimension Stone.
5. ANSI A118.1 Standard Dry-Set Cement Mortars.
6. ANSI A118.3 Chemical Resistant, Water-Cleanable, Tile-Setting and-Grouting Epoxy and Water-Cleanable Tile-Setting Epoxy Adhesive.
7. ANSI A118.4 Modified Dry-Set Cement Mortar.
8. ANSI A118.7 High Performance Cement Grouts.
9. ANSI A118.10 Load-Bearing, Bonded Waterproofing Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation.
10. ANSI A118.12 Crack Isolation Membranes for Thin-set Ceramic Tile and Dimension Stone Installation.
11. ANSI A118.15 Improved Modified Dry-Set Cement Mortars.
12. ANSI A136.1 Organic Adhesives for Installation of Ceramic Tile.
13. ANSI A137.1 Ceramic Tile.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, movement joints, thresholds, ceramic accessories, and setting methods and details.
- B. Samples:
1. Two full size samples of each tile specified in Finish Legend.
 2. Grout: Submit manufacturer's full range of standard and designated color samples for each type for Architect's selection.
 3. Trim: Submit sample of each type and color.
 4. Transition and Edge Protection Profiles: Submit sample of each type and color.
 5. Edging and Finishing profiles: Submit sample of each type and color.
 6. Prefabricated expansion and movement joints: Submit sample of each type and color.
 7. Threshold: Submit 6 IN full profile sample of each type.
- C. Project Information:
1. Installation methods.
 2. Manufacturer's Certificate: For each shipment, type and composition of tile provide a Master Grade Certificate signed by manufacturer and installer certifying products meet or exceed specified requirements of ANSI A137.1-2012.
- D. Contract Closeout Information:
1. Maintenance Data:
 - a. Include recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.
 - b. See Section 01 78 23.

1.4 EXTRA MATERIAL

- A. Provide 5% of each type, color or size of tile specified.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Ceramic Tile:

1. Base:
 - a. As specified on Interior Drawings and Finish Legend.

B. Porcelain Tile:

1. Base:
 - a. As specified on Interior Drawings and Finish Legend.

C. Quarry tile:

1. Base:
 - a. As specified on Interior Drawings and Finish Legend.

D. Thresholds:

1. Base:
 - a. As specified on Interior Drawings and Finish Legend.

E. Accessories:

1. Base:
 - a. Schluter Systems LP.
2. Optional:
 - a. Custom Building Products.
 - b. Mapei Americas
 - c. Laticrete

2.2 DESIGN CRITERIA

A. Ceramic Tile:

1. Comply with ANSI A137.1 American National Standard Specifications for Ceramic Tile for types, compositions, and grades of tile indicated.
2. Furnish tile complying with Standard Grade requirements unless otherwise indicated.
3. ANSI Standard for Tile Installation Materials: Comply with ANSI standard referenced with products and materials indicated for setting and grouting.

B. Colors, Textures, and Patterns:

1. Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with following requirements:
 - a. Match Architect's sample.

C. Factory Mounting:

1. Provide back face or edge mounted tile assemblies as standard with manufacturer unless another mounting method is indicated.
2. Do not use back mounted or edge mounted tile assemblies for swimming pools, exterior applications or wet areas.

D. Grout Release:

1. Factory applied temporary protective coating.
2. Provide where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by pre-coating with a continuous film of petroleum paraffin wax, applied hot.
3. Do not coat unexposed tile surfaces.

2.3 MATERIALS

A. Ceramic Wall Tile:

1. Grade: ANSI A137.1; 5.0 to 10.0 PCT water absorption.
2. Size: As indicated on Finish Schedule.
3. Edge: Cushioned.
4. Finish: Glazed.
5. Color: To be selected.
6. Base: Matching cove base units, 5 or 6 IN high, bullnose top.
 - a. Acceptable Product: As specified in Drawing I-001 Interior Notes and Finish Legend.

B. Porcelain Tile:

1. Acceptable Manufacturer: As specified in Drawing I-001 Interior Notes and Finish Legend.
2. Porcelain Tile: Porcelain based, impervious unglazed ceramic, through body color.
3. Water Absorption: Less than 0.1 PCT maximum, ASTM C373.
4. Finish: Matte.

C. Trim:

1. Provide necessary caps, stops, returns, trimmers and other shapes to complete installation.
2. Color and finish to match adjacent tile unless shown otherwise.

D. Mortar, Grout, and Adhesive Manufacturer:

1. Setting materials: As required by installation Method, See Part 3.
 - a. Custom Building Products
 - b. Laticrete International, Inc.
 - c. Mapei Corporation

E. Mortar - Thick Set

1. Portland Cement Mortar:
 - a. Description: Site mix of Portland cement, sand and water as specified.
2. Portland Cement Mortar with Latex Additive:
 - a. Portland Cement: ASTM C150, Type I, from one source only, non-staining and non- air-entraining.

- b. Supplemental cementitious materials derived from coal fired power plant wastes shall not have a mercury content >5.5ppb.
- c. Fly ash shall not be a byproduct of municipal solid waste incinerators
- d. Mortar Sand: ASTM C144, free of deleterious materials, well graded.
- e. Setting Bed Sand: ASTM C136, 100 PCT passing No. 4 sieve.
- f. Latex Additive:
 - 1) Description: Latex additive serving as replacement for gaging water, for use with site mixed portland cement mortar.
 - 2) Quantity: As recommended by latex additive manufacturer to produce workable consistency.
 - 3) Acceptable Products:
 - (a) CustomFloat Bedding Mortar mixed with Acrylic Mortar Admix 1:1 water by Custom Building Products.
 - (b) 3701 Mortar Admix by Laticrete.
 - (c) Planicrete 50 by Mapei.

F. Mortar - Thin Set:

- 1. Portland Cement with Latex Additive:
 - a. Latex additive and site mixed Cement mortar.
 - b. Comply with ANSI-A118.4.
 - c. Acceptable Products:
 - 1) CustomCrete Latex Mortar Admix with site mixed mortar by Custom Building Products.
 - 2) Keracrete System consisting of KER 303 Latex mixed with 1:1 sand/cement blend by Mapei.

G. J. Epoxy Adhesive:

- 1. Multi-component, factory prepared, 100 PCT epoxy resin and hardener with sand or mineral filler material.
- 2. Comply with ANSI A118.3 for thin-set applications for chemical resistant, water cleanable quarry tile installations.

H. Latex Modified Grout:

- 1. Description: Latex-modified, factory blended, mildew resistant, sanded, grout consisting of cement, graded quartz and additives; comply with ANSI A118.7.
- 2. Latex Additive: Type as recommended by latex mortar manufacturer.
- 3. Acceptable Products:
 - a. Polyblend Sanded Tile Grout by Custom Building Products.
 - b. Satillo Grout Mix with Acrylic Mortar Admix 1:1 with water by Custom Building Products.
 - c. 500 Series Sanded Grout Mixed with 1776 Grout Admix Plus by Laticrete.
 - d. KER 200 polymer-modified sanded grout by Mapei.

I. Unsanded Latex Modified Grout for Wall Tile (Joints under 1/8IN):

- 1. Description: Latex-modified, factory blended, mildew resistant, non-sanded, grout consisting of cement and additives; comply with ANSI A118.6.
- 2. Latex Additive: Type as recommended by latex mortar manufacturer.
- 3. Color: To be selected.

4. Acceptable Products:
 - a. Polyblend Non-Sanded Tile Grout by Custom Building Products.
 - b. White Dry Tile Grout by Custom Building Products.
 - c. 644 White Dry-Set Grout mixed with 17765 Grout Admix Plus by Laticrete.
 - d. 1600 Series Tri-Poly Fortified Non Sanded Grout by Laticrete.
 - e. KER 800 polymer-modified unsanded grout by Mapei.
- J. Epoxy Grout for Floor Tile and Shower Walls:
1. Multi-component, factory prepared, 100 PCT epoxy resin and hardener with sand or mineral filler material.
 2. Comply with ANSI A118.3.
 3. Color: To be selected.
 4. Color: As specified in Drawing I-001 Interior Notes and Finish Legend..
 5. Acceptable Products:
 - a. 100 PCT Solids Epoxy Grout by Custom Building Products.
 - b. Latapoxy SP-100 Stainless Epoxy Grout by Laticrete.
 - c. Latapoxy SP-100 Vertical Grade Epoxy Grout by Laticrete.
 - d. Kerapoxy Chemical Resistant Grout by Mapei.
- K. Polymer Modified Sanded Grout for walls:
1. Description: Proprietary cement/sand compound
 2. Compressive Strength: 3000 PSI at 24 HRS.
 3. Color: To be selected
 4. Acceptable Products:
 - a. Polyblend Sanded Tile Grout by Custom Building Products.
 - b. 1500 Series Tri-Poly Fortified Sanded Grout by Laticrete.
- L. Waterproofing Membrane:
1. Description: Trowel applied elastomeric compound.
 2. Acceptable Products:
 - a. Mapelastic 315 by Mapei.
 3. Accessories:
 - a. Preformed fiberglass mesh coving, inside and outside corners, and drain fittings.
 - b. Preformed expansion joint flashing.
- M. Crack Isolation Membrane:
1. Description: Trowel applied elastomeric compound.
 2. Acceptable Products:
 - a. PRP 315 by Mapei.
- N. Sound Isolation Membrane:
1. Sound deadening underlayment exceeding IIC, Impact Insulation Class, standard of 50 and Sound Transmission Class (STC) standard of 56.
 2. Acceptable Products:
 - a. No.18 Sound Control Underlayment by Laticrete.
 - b. Mapei Kerafonic two component sound deadening mortar underlayment.
 - c. Mapei Mapelastic SM sheet membrane sound deadening underlayment.
 - d. Nobleseal SIS by The Noble Company, Grand Haven, MI.
 - e. Dal Sound by Dal Tile.

O. Tile Backer Board:

1. Moisture-resistant treated gypsum core, glass mats both sides, and vinyl, water barrier coating on finished side.
 - a. Conventional cement-board and green-board products are not acceptable.
2. Thickness: 1/2 IN .
3. Mold-resistance score: 10 per ASTM D3273.
4. Base Product: DensShield Tile Backer by Georgia Pacific.
 - a. Include Level 5 finish at non-tiled portions.
5. Optional Products:
 - a. Fiberock Interior Panel, Aqua-Tough by USG.
 - b. GlasRoc Tile Backer by Certainteed.
6. TBB wallboard scheduled in Fire Rated Walls:
 - a. Approved fire resistive products with comparable moisture-resistance.
 - b. Base Product: DensShield Fireguard Tile Backer by Georgia Pacific.

P. Accessories:

1. Fasteners: Corrosion resistant type required by board manufacturer for securing units.
2. Joint Reinforcement Tape: As recommended by board manufacturer.
3. Vapor Retarder:
 - a. Comply with ASTM D4397.
 - b. Thickness and maximum permeance rating:
 - 1) 4.0 mils, 0.19 perms .
 - c. Vapor retarder tape:
 - 1) For sealing joints and penetrations in vapor retarder.
 - 2) Pressure-sensitive type recommended by manufacturer.

Q. Reinforcing Mesh:

1. Size: 2 IN x 2 IN weave of 16/16 wire size.
2. Fabric: Welded, galvanized.

R. Joint Sealant:

1. Two component polyurethane sealant, ASTM C920, Type M, self-leveling, for horizontal joints, Type II, non-sag, for vertical joints as specified in Section 07 92 16.
2. Color: Match grout.
3. Sealant:
 - a. Chemically compatible with tile, mortar, and grout.
 - b. Physically and chemically capable to withstand local environmental conditions.

S. Joint Backing: Closed cell foam polyethylene.

T. Prefabricated Sealant Joint:

1. Prefabricated aluminum joint with two part, chemically curing non-sag polyurethane sealant.
2. Height as required by tile by 8 FT lengths.
3. Aluminum: Clear anodized.
4. Sealant: Match grout.
5. PolyBlend Ceramic Tile Caulk by Custom Building Products.

U. Expansion and Control Joints for Thin-set and/or Thickset Applications:

1. Main Material:
 - a. Roll-formed stainless steel
 - b. Extruded aluminum
 - c. Extruded rigid PVC
2. Profiles joined by soft CPE movement joint material, with integral perforated anchoring legs for setting joint into setting bed.
3. Height: As required to suit application.
4. Color: As selected by Architect.
5. Schlüter - DILEX-KS

V. Corner Joints:

1. Extruded rigid coved wall corner, with integral perforated anchoring legs.
2. Floor leg height: As required to suit application.
3. Wall leg height: As required to suit application.
4. Material: Aluminum.
5. Schlüter - DILEX-HK

W. Corner Movement Joints:

1. Roll formed stainless steel inside corner, cove-shaped 2-piece joint profile joined by soft thermoplastic rubber movement zone and with perforated anchoring.
2. Floor leg height: As required to suit application.
3. Wall leg height: As required to suit application.
4. Material: Aluminum.
5. Acceptable Products:
 - a. Schlüter - DILEX-HKW

X. Decorative Wall Corner and Edge Trim:

1. Aluminum wide profile, decorative outside wall corner trim, with integral perforated anchoring leg.
2. Height: As required to suit application.
3. Material:
 - a. Aluminum.
4. Acceptable Products:
 - a. 1) Schlüter - QUADDEC
5. Location:
 - a. Provide at all wall tile locations that have an exposed tile edge at the outside corner or an exposed tile edge on the wall.

Y. Edge and Transition Strips:

1. Solid brass, extruded aluminum, or roll-formed stainless steel edge strips, 1/8 IN wide at top edge; height as indicated.
2. Height: As required to suit application.
3. Finish:
 - a. Clear-satin anodized aluminum.
4. Schlüter - SCHIENE M

Z. Setting Buttons:

1. Plastic buttons of thickness required for joint size indicated to maintain uniform joint width.

AA. Grout Release Agents:

1. Protect exposed surfaces of tile against adherence of mortar and grout.
2. Compatible with tile, mortar and grout.
3. Petroleum-Paraffin Wax:
 - a. Fully refined, tasteless, odorless, containing at least 0.5 PCT oil with a melting point of 120 to 140 DEGF per ASTM D87.
4. Manufacturer's standard proprietary liquid coating specially formulated and recommended for use as temporary protective coating for tile.

AB. Penetrating Sealer:

1. Water-based sealer capable of repelling dirt, oil and stains from tile and grout surfaces.
2. Low odor, pH-neutral and non abrasive.
3. Vapor open, non-film forming.
4. Stain Resistance per Ceramic Tile Institute CTI-072: Excellent.
5. Compatible with tile types scheduled.
6. Aqua Mix Sealer's Choice Gold Penetrating Sealer by Custom Building Products.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Comply with requirements of referenced standards and recommendations of material manufacturers for environmental conditions before, during, and after installation.
- B. Verify concrete floor surfaces are suitable for tile installation.
 1. Firm, dry, clean and free of oily or waxy films, mortar and soil.
 2. Grounds, anchors, plugs, hangers, bucks, electrical and mechanical work in or behind tile installed.
 3. Verify limits of moisture and alkalinity are within levels tolerated by Tile manufacturer and setting materials manufacturer.
 4. Verify areas to receive tile installed by thin bed method have wood float finish, are true within 1/4 IN in 10 FT and are pitched to drains where required.
- C. Correct unsatisfactory conditions and proceed with installation only after substrate deficiencies have been corrected and surfaces are acceptable.
- D. Start of work constitutes acceptance of surfaces, and waiver of claim that surfaces are unsuitable.

3.2 PREPARATION

- A. Prepare surfaces in accordance with manufacturers' instructions for setting materials or additives used.
- B. Acid based cleaners are not permitted.
- C. Completely remove curing compounds or other substances that would interfere with proper bond of setting materials.
- D. Do not seal substrate unless required by manufacturer.
- E. Prime substrate when required by manufacturer.

F. Factory Blending:

1. Blend tile in factory and package accordingly so tile are uniform in color range as those throughout packaging and match approved samples.
2. If not factory blended, return to manufacturer or blend tiles at project site before installing.

G. Field Applied Grout Release product, Temporary Protective Coating:

1. Petroleum paraffin wax or proprietary grout release formulation.
2. Provide where specified or required to prevent adhesion or staining of exposed tile surfaces by grout.
3. Precoat exposed surfaces of tile with continuous film of temporary protective coating.
4. Do not coat unexposed tile surfaces.

3.3 INSTALLATION

A. Tile Backer Board:

1. Place and fasten with galvanized or resin coated gypsum board screws at 8 IN OC in field of panel and 6 IN OC at edges.
2. Provide 1/4 IN gap above floor or fixture lip for installation of flexible calking.
3. Maintain manufacturer's required space between board edges.
4. Fill joints by applying tile setting material and joint reinforcement.

B. Membrane:

1. Install membrane with products or methods approved in writing by membrane manufacturer.
2. Flash membrane to cure prior to setting tile.
3. Do not allow construction traffic on membrane.

C. Waterproofing:

1. Install waterproofing in accordance with manufacturer's instructions.
2. Return waterproofing vertically at adjacent walls in accordance with manufacturer details, to minimum height of 4 IN .
3. Flood test waterproof membranes after fully cured.
4. Field Quality Control water test when required.

D. Tile Installation, General:

1. Install tile materials in accordance with ANSI A137.1-2012, ANSI and TCNA specifications, and TCNA Handbook for Ceramic Tile Installation, with exception of more stringent requirements of manufacturer or these Specifications.
2. Cut and fit tile tight to penetrations, protrusions and vertical interruptions and seal.
 - a. See Section 07 92 16.
3. Form corners and bases neatly.
4. Work tile joints uniform in width, subject to variance in tolerance allowed in tile size.
5. Make joint watertight, without voids, cracks, excess mortar, or grout.
6. Prepare surface, fit, set, bond, grout and clean in accordance with applicable requirements of ANSI standards and Tile Council of North America.
7. Where accent tiles are of a lesser thickness than surrounding field tiles, increase bedding thickness as required to achieve flush alignment between finished faces of accent tiles and adjacent field tiles.

8. Where tile has an exposed edge, provide a metal transition strip.
 - a. Outside corners: Schlüter - QUADDEC
 - b. Top edge of tile when tile is not full height: Schlüter - QUADDEC

E. Layout:

1. Lay out work to pattern indicated so full tile or joint is centered on each wall.
 - a. Lay out tile to minimize cutting and to avoid tile less than half size.
2. Continue pattern through openings.
3. For heights stated in feet and inches, use courses of full tile to produce nearest attainable heights without cutting tile.
4. Align joints in tile in both directions.
5. Align joints between wall, floor and base tile.
6. Make joints between sheets of tile same width as joints within sheet.
7. File edges of cut tile smooth and even.
8. Cut and fit tile at penetrations through tile.
9. Grind edges of tile abutting built-in items.
10. Fit tile at outlets, piping and other penetrations so plates, collars, or covers overlap tile.
11. Extend tile work into recesses and under or behind equipment and fixtures, to form complete covering without interruption, except as otherwise indicated.
12. Accurately form intersections and returns.
13. Form internal corners and external corners square.

F. Thick Bed Method, Horizontal Surfaces

1. Apply slurry bond coat approximately 1/16 IN thick to substrate surface using flat trowel.
2. Place thick bed mortar, 1-1/4 IN thick nominally onto slurry bond coat while coat is still wet and tacky.
3. Spread prepared mortar approximately one-half desired bed thickness and then lay reinforcing mesh.
4. Rod and compact mortar with steel trowel.
5. Before placing tiles on green or wet screed bed, apply slurry bond coat approximately 1/16 IN thick to mortar using flat trowel.
6. Apply mortar skim coat to back of each tile or sheet of tile immediately prior to placing.
7. Place tiles in wet slurry coat before surface dries maintaining uniform joints.
8. After each tile or sheet of tiles is laid, level surface and embed tiles.
9. Pitch surface to drain where required.
10. On hardened screed or mortar bed, install tiles by thin bed method.
11. Sound tiles after setting. Replace hollow sounding tiles.
12. Clean excess mortar or adhesive from surface of tile while mortar is fresh.

G. Thin Set Method, Floors and Walls:

1. Apply mortar or adhesive with notched trowel using scraping motion to work material into contact with surface to be covered.
 - a. Maintain 90 PCT coverage on back of tile and fully bed corners.
2. Apply only as much mortar or adhesive as can be covered within time recommended by mortar or adhesive manufacturer.
3. When installing large tiles, ceramics or mosaics, trowel small quantity of mortar or adhesive onto back of each tile or sheet of tiles.
4. Set tiles in place and level surface of tile.
5. Align tile to show uniform joints and set until firm.
6. Clean excess mortar or adhesive from surface of tile while mortar is fresh.

7. Allow face mounted tile to set until firm before removing paper and before grouting.
8. Sound tile after setting. Replace hollow sounding tiles.

H. Grouting:

1. Allow tiles to set before grouting.
2. Install in accordance with grout manufacturer's recommendations and ANSI A108.10.
3. Clean excess grout from surface as work progresses.
4. Cure after grouting by covering with kraft or construction paper for 72 HRS.
5. Install sealant in vertical wall joints at interior corners.

I. Movement Joints:

1. Comply with TCNA EJ171.
2. Coordinate with Drawings.
3. Locate movement joints where indicated.
4. Where not indicated, locate movement joints directly over following substrate conditions:
 - a. Changes in substrate material.
 - b. Over control joints, expansion joints and seismic joints in substrate.
 - c. Over construction joints in substrate.
 - d. At junctures where floors meet walls and other restraining elements such as curbs, columns, bases, and wall corners.
 - e. At other locations recommended by TCNA EJ171 Movement Joint requirements.
5. Locate additional movement joints per following:
 - a. Exterior: 12 FT .
 - b. Interior: 25 FT .
 - c. Interior, where exposed to direct sunlight or moisture: 12 FT .
6. Joint Width: In accordance with TCNA EJ171.
7. Rake or cut control joints through setting bed to supporting slab or structure.
8. Maintain joints free of mortar.
9. Fill joints with self-leveling polyurethane sealant and backing material.
 - a. See Section 07 92 16.
10. Provide sealant material at items penetrating tile work, unless otherwise indicated.
11. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes.
 - a. Seal tile to outlets, piping and other penetrations.
12. Fill joints around water closets with white silicone sealant.
 - a. See Section 07 92 16.
13. Use manufacturer's expansion joint flashing when covering expansion joints with waterproof or crack isolation membranes.

J. Penetrating Sealer:

1. Surface Preparation:
 - a. Verify tile and grout are fully cured.
 - b. Verify surfaces are dry, clean and free of waxes, sealers and finishes.
 - c. Test product in obscure area to produce desirable results.
2. Apply Penetrating Sealer to tiled surfaces, unless otherwise noted.
 - a. Application of penetrating sealer is not necessary where epoxy grouts are used.
 - b. Apply in accordance with Manufacturer's instructions.

3. Test after 2 HRS by applying drops of water on surface.
 - a. If water penetrates, apply an additional coat of sealer.
4. Remove visible residue within 60 minutes after application.

3.4 CLEANING

- A. Perform cleaning while mortar is fresh before hardening on surfaces.
- B. Wash tile diagonally across joints.
- C. Polish with clean dry cloth.
- D. Remove grout haze following recommendation of mortar additive manufacturer.
- E. Remove residual waxes or grout release agent, temporary protective coatings, by method recommended by coating manufacturer.
 1. Confirm acceptability with brick and grout manufacturer.
 2. Trap and remove coating to prevent it from clogging floor drains.

3.5 PROTECTION AND REPAIR

- A. Prohibit traffic on floor finish for 72 HRS after installation.
- B. Where temporary use of new floors is unavoidable, supply large, flat boards or plywood panels for walkways over kraft paper.
- C. Replace broken, cracked, chipped, stained, or damaged tile.

END OF SECTION

SECTION 09 51 00

ACOUSTICAL CEILING MATERIALS (AM)

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Acoustical Ceiling Systems (ACT) in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.02 QUALITY ASSURANCE

- A. ASTM International (ASTM):
 - 1. ASTM A641/A641M Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - 2. ASTM B633 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
 - 3. ASTM C635/C635M Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panels Ceilings.
 - 4. ASTM C636/C636M Standard Specification for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
 - 5. ASTM E488/E488M Standard Test Methods for Strength of Anchors in Concrete Elements.
 - 6. ASTM E580/E580M Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions
 - 7. ASTM E1190 Standard Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members
- B. Site Classification and Seismic Design Categories as defined in the International Building Code: Class C

1.03 SUBMITTALS

- A. Product Data: Manufacturer's product data that products comply with acoustical properties indicated on Drawing I-001 Interior Notes and Finish Legend.
- B. Samples: One sample of each type of tile listed in Drawing I-001 Interior Notes and Finish Legend.
- C. Contract Closeout Information:
 - 1. Maintenance data.
 - a. See Section 01 78 23 - Operation and Maintenance Data.
 - 2. Interior finish fire performance data:
 - a. Provide for each finish material and type specified:
 - 1) Manufacturer's printed information including:
 - 2) Fire class.
 - 3) NFPA test number.
 - 3. Submit certification from manufacturer of ceiling system attesting that products comply with specified requirements including finish as specified.

D. Shop Drawings for types ACT1 and ACT2:

1. Shop drawings shall show dimensions, sizes, thickness, alloys, tempers, finishes, joining, attachments and relationship of adjoining work.
2. Shop drawings that show access panel details and locations for ACT5.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Steel Suspension Systems:

1. Base:
 - a. Armstrong World Industries.
2. Optional:
 - a. USG Corporation
 - b. Rockfon

B. Acoustical Ceiling Tile:

1. Base:
 - a. Armstrong
2. Optional
 - a. USG Corporation
 - b. Rockfon

2.02 MATERIALS

A. Acoustic Suspension Systems:

1. All suspension systems must meet seismic requirements.
2. Heavy duty systems, ASTM C635.
3. Main runner jointing by spliced, interlocking ends, tab locks, pin locks, or other suitable connections.
4. Cross runners interlocking with main runners.
5. Include components and accessories necessary resist seismic loads and dead loads of items such as light fixtures and air diffusers.
6. Hanger Wire:
 - a. Pre-stretched, with a yield stress load of at least 5 times design load, but not less than
 - 1) 0.106 IN (12 GA) .
 - b. Utilize continuous lengths, without kinks and splices.
 - c. Galvanized Steel:
 - 1) Galvanized, soft annealed steel wire conforming to ASTM A641/A641m.
 - d. Stainless Steel:
 - 1) Type 304, soft annealed steel wire conforming to ASTM A641/A641M.
 - 2) Use where aluminum ceiling grid is specified.
 - 3) Use in the following magnetic sensitive areas: MRI.
7. Attachment Devices:
 - a. Anchors in Concrete:
 - 1) Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined by testing per ASTM E488/A488M or ASTM E1512.

- 2) Acceptable types: Cast-in-place, post-installed expansion anchors and post-installed bonded anchors.
- 3) Material: Carbon-steel components zinc plated to comply with ASTM B633, Class Fe/Zn 5 for Class SC 1 service condition.
- 4) Material: Stainless-steel components complying with ASTM-F593 and ASTM-F594, Group 1 Alloy 304 or 316.
 - (a) Use in wet/ corrosive conditions
- b. Power-Actuated Fasteners in Concrete:
 - 1) Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E1190.
 - 2) Verify with Structural engineer prior to using power-actuated fasteners.
8. Suspension System Types:
 - a. CG-1: Exposed grid, non-rated:
 - 1) Description: Galvanized, double web steel, main and cross runners.
 - 2) Face width: 15/16 IN .
 - 3) Base Product:
 - (a) Prelude XL, by Armstrong.
 - 4) Color: White
 - 5) Finish on exposed surfaces: Smooth, flat white.
 - 6) Standards Grid
 - b. Framing and suspension systems for Gypsum Board Ceilings:
 - 1) Specified in Section 09 22 16.

B. Acoustical Ceiling Tile:

1. Scheduled finishes to be factory applied.
2. Class A incombustible units.
3. Fire rated units (when used): UL labeled.
4. Edges uniformly fabricated, true, square.
5. Sizes as required to fit scheduled suspension system.
6. Standard tile size:
 - a. ACT1: 24" x 24"
 - b. ACT2: 24" x 72"
7. Concealed spline style: Edges kerfed for splines.
8. Fiberglass Ceiling Tile (ACT1):
 - a. Base:
 - 1) Optima by Armstrong.
 - b. Color: White
 - c. Surface Texture: Smooth.
 - d. Surface Finish: Factory applied acrylic latex paint
 - e. Light Reflectance (LR): ASTM E 1477; White Panel: Light Reflectance: 0.90.
 - f. Noise Reduction Coefficient (NRC): 0.90.
 - g. Lay-in style: Square Tegular 15/16 IN
 - h. Thickness: Minimum 1 IN thick.
9. Fiberglass Ceiling Tile (ACT2):
 - a. Base:
 - 1) Ultima by Armstrong
 - b. Color: White
 - c. Surface Texture: Smooth.
 - d. Surface Finish: Factory applied acrylic latex paint
 - e. Light Reflectance (LR):
 - f. Noise Reduction Coefficient (NRC): 0.75.
 - g. Lay-in style: Beveled Tegular 15/16 IN
 - h. Thickness: Minimum 1 IN thick.

- C. Diffusers and Grilles: See Section 23 38 90 - Ductwork and Section 23 39 10 - Ductwork and Accessories.
- D. Light Fixtures: See Section 26 51 00 - Interior Lighting

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify suitability of substrate to accept installation.
- B. Examine installation site for irregularities having affect on quality and execution of work.
- C. Consult other trades involved before start of ceiling work, to determine areas of potential interference
- D. Do not start installation until interferences have been resolved.
- E. Installation constitutes acceptance of responsibility for performance.

3.02 PREPARATION

- A. Coordinate ceiling layout with sprinkler head spacing and work penetrating acoustical ceiling systems.
- B. Tolerances:
 - 1. Comply with ASTM C635/C635M Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
 - 2. Deviation from level plane: 1/8 IN in 10 FT with no load applied maximum.
 - 3. Bow: 1/32 IN in 2 FT maximum.
 - 4. Camber: 1/32 IN in 2 FT maximum.
 - 5. Twist: 1 degree in 2 FT maximum.

3.03 INSTALLATION

- A. Suspension System:
 - 1. Install suspension system in accordance with manufacturers' instructions.
 - 2. Install in accordance with seismic requirements
 - 3. Grid layout:
 - a. See Reflected Ceiling Plans.
 - b. Install grid based on electrical lighting fixture layout indicated in Electrical Drawings, unless otherwise indicated,
 - c. Acoustical panel dimension at perimeter walls: Not less than 6 IN .
 - d. In case of conflict notify Architect.
 - 4. Install grid square with room and with grid or acoustical panel center lines coinciding with center lines of room, each direction.
 - 5. Intersections between main tees and cross tees:
 - a. Butt cut and notch as required.
 - 6. Wall angles:
 - a. Install wall angles or moldings where ceilings meet walls, partitions, vertical elements, and other types of ceilings or ceiling fixtures.
 - 1) Secure angles to wall construction at stud locations.
 - 2) Maximum spacing from terminal ends: 3 IN.

- 3) Draw fasteners tight against vertical surfaces.
- 4) Level tolerance: not more than 1 IN 1000.
- 5) Miter cut inside and outside corners.
- 6) Install with leg supporting bottom flange of runners.
7. Hanger wires:
 - a. Provide hangers and inserts necessary to support ceiling suspension systems and ceiling dead loads.
 - b. Coordinate location and alignment with work of other trades.
 - c. Install hanger wires plumb to main tees and cross tees.
 - 1) Do not suspend any part of suspension system from ducts, pipes, conduit, cable tray or equipment.
 - 2) Provide supplementary rough suspension system where necessary to support ceilings beneath pipes, ducts, equipment, cable trays.
 - 3) Splay hangers no greater than 30 DEG from vertical to avoid obstructions or other conditions that prevent plumb, vertical installation.
 - 4) Offset horizontal forces by bracing or counter-splaying.
 - d. Space hangers to prevent eccentric deflection and rotation due to loads from items in or on ceiling
 - 1) Provide supplemental hangers to support lighting fixtures and within 6 IN from end of main runners and fixtures which exceed manufacturer's published load data.
 - 2) Do not bear runners on walls or partitions.
8. Main runners:
 - a. Utilize wall angles to align and receive terminal ends of main tees without transferring load to wall angle.
 - b. Space main tees as indicated to receive lay-in panels and fixtures.
 - c. Support terminal ends of main tees by wires located within 6 IN from boundary walls.
9. Cross runners:
 - a. Space cross tees as indicated to receive lay-in panels and fixtures.
 - 1) Install cross runners with positive interlock.
 - b. Utilize wall angles to align and receive terminal ends of cross tees without transferring load to wall angle.
 - c. Support terminal ends of cross tees by wires located within 6 IN from boundary walls.
10. Leave suspension system ready to accept installation of acoustic materials.

B. Lay-In Items:

1. Install acoustic materials in accordance with manufacturer's instructions.
2. Place lay-in panels, fixtures, diffusers, grilles, and similar items in manner not compromising suspension system performance.
3. Field cut materials to fit grid.
4. Tegular and similar tiles with articulated edges:
 - a. Cut edges to match profile of factory edges and paint to match.
5. Ceiling paint:
 - a. Touch-up minor surface scratches and blemishes.
 - b. Cover field cut edges exposed to view.
 - c. Armstrong SuperCoat Ceiling Panel Touch-up Paint.

3.04 CLEANING AND REPAIR

- A. Perform cleaning of soiled units and replacement of defective or damaged units.

END OF SECTION

SECTION 09 65 13

RESILIENT BASE (RB)

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Resilient Base (RB), as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.02 QUALITY ASSURANCE

- A. ASTM International (ASTM):
 - 1. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
 - 2. ASTM E648 Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
 - 3. ASTM E662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
 - 4. ASTM F1861 Standard Specification for Resilient Wall Base
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 253 Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source
 - 2. NFPA 258 Recommended Practice for Determining Smoke Generation of Solid Materials
- C. Thermoplastic Rubber: Type TP.
- D. Critical Radiant Flux: Class I, not less than 0.45 W/cm².
- E. Flame Spread: Maximum, 75.
- F. Smoke Developed: Maximum, 250.

1.03 SUBMITTALS

- A. Samples:
 - 1. Resilient Base:
 - a. Two samples of material and color as specified in Drawing I-001 Interior Notes and Finish Legend.
 - 2. Field fabricated corners: Construct sample base inside and outside corner:
 - a. Include minimum 4 FT straight base each direction from corner.
 - b. If not acceptable construct additional corners.
 - 1) Stress whitening and cracking will not be acceptable.
 - 2) Color and height variation will not be acceptable.
 - c. Sample corners constitute standard of quality for actual construction.
 - d. Maintain sample corners during construction.
 - e. Remove when directed.

- f. Sample corners may be built into permanent construction provided sample area is readily identifiable during construction.
- g. Do not proceed with base installation until sample corners are approved by Architect.

B. Contract Closeout Information:

- 1. Warranty.
- 2. Maintenance data:
- 3. Interior finish fire performance data:
 - a. Provide for each finish material and type specified:
 - 1) Manufacturer's printed information including:
 - (a) Fire class.
 - (b) NFPA test number.
 - (c) Photograph.
 - 2) Proof of purchase.

1.4 WARRANTY

- A. Manufacturer's standard warranty.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Resilient Base (RB):

- 1. Base:
 - a. Johnsonite.
- 2. Optional:
 - a. Tarkett
 - b. Roppe.

2.02 MATERIALS

A. Resilient Base (RB):

- 1. Rubber top set, coved type.
- 2. 1/8 x 6 IN, 1/4 IN wide at bottom.
- 3. Field formed external and internal corners.
- 4. Provide continuous rolls, minimum 95 FT long

- B. Leveling compound: As recommended by manufacturer, compatible with adhesives.

- C. Adhesives and primers: As recommended by manufacturer.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine surfaces for defects and irregularities.
- B. Verify substrates are free of materials that may affect adhesion.
- C. Do not proceed with installation until unsatisfactory conditions have been corrected.

- D. Installation indicates acceptance of substrates and responsibility for performance.

3.02 PREPARATION

- A. Fill cracks, joints, etc., with water resistant non-crumbling patching compound.
- B. Trowel to smooth and proper level.

3.03 INSTALLATION

- A. Install after wall finishes.
- B. Install prior to carpet and acoustical material.
- C. Prepare substrate in accordance with manufacturer's instructions.
- D. Protect adjacent work from damage.
- E. Schedule installation to minimize accumulation of air contaminants that cannot be removed prior to occupancy.
- F. Install base after wall material has dried out thoroughly.
 - 1. Provide base at intersections of floor and vertical surfaces in areas scheduled to receive base, where intersection is exposed to view.
 - 2. Apply primer and adhesive as recommended by manufacturer.
 - 3. Set base straight and true.
 - 4. Fit base neatly into breaks and recesses.
 - 5. Install corners as recommended by manufacturer.
 - 6. Scribe to trim at door frames.
 - 7. Make joints tight.
 - 8. Install with top and bottom edges in firm contact with wall and floor.

3.04 CLEANING

- A. Remove surplus adhesive immediately after application and rolling.
- B. Clean in accordance with manufacturer's recommendations after materials have sufficiently seated.

END OF SECTION

SECTION 09 65 19

RESILIENT TILE FLOORING (RT)

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Resilient Tile Flooring (LVT) in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.02 QUALITY ASSURANCE

- A. ASTM International (ASTM):
 - 1. ASTM F1700 Standard Specification for Solid Vinyl Tile.
 - a. ASTM D2047 Measuring Static Coefficient of Friction of Flooring Finishes

1.03 SUBMITTALS

- A. Samples: Two samples of each material specified in Drawing I-001 Interior Notes and Finish Legend.
- B. Contract Closeout Information:
 - 1. Maintenance data.
 - 2. Warranty.

1.04 EXTRA MATERIAL

- A. Quantities of Extra Material Required:
 - 1. Resilient Tiles: One full carton of each type, color and pattern of material for maintenance.

1.05 WARRANTY

- A. Provide written warranty that material will be free from manufacturing defects for a period of five (5) years from date of purchase.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Luxury Vinyl Tile (LVT):
 - 1. Base:
 - a. Tarkett
 - 2. Optional:
 - a. Johnsonite
 - b. Amtico
 - c. Armstrong World Industries.

2.02 MATERIAL

A. Luxury Vinyl Tile (LVT):

1. Clear, unfilled, polyurethane-coated, 0.020 IN thick PVC wear layer over printed film on an intermediate layer over filled vinyl backing.
2. ASTM F1700 Class III, Type B - Embossed Surface.
3. Critical Radiant Flux, per ASTM E648 / NFPA 253: Class I, not less than 0.45 W/cm².
4. Smoke Developed: 450 or less per ASTM E662 / NFPA 258.
5. Minimum Static Load Limit: 250 PSI.
6. Nominal Total Thickness: 0.125 IN gauge.
7. No wax no finish for life of product.
8. Base Product:: See Finish Schedule
9. Color and Pattern: Refer to Interior Drawings and Finish Legend.

B. Leveling Compound:

1. As recommended by manufacturer:
 - a. Compatible with adhesives.
 - b. Moisture resistant.
 - c. Non-crumbling.

C. Primers and Adhesive:

1. For general use.
2. As recommended by flooring manufacturer.
3. Primers and adhesives shall have a VOC content no greater than 50 g/L.

D. Hard-Set Adhesive:

1. Hard-setting polyurethane or epoxy product recommended by flooring manufacturer.
2. LVT: s recommended by flooring manufacturer.

E. Transition Strip:

1. Nominal Size: 1/8 x 1 IN plain color homogeneous vinyl with backing.
2. Use tapered profiles where abutting material is of different thickness.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine surfaces for defects, irregularities and conditions under which flooring and base are to be installed.
- B. Verify substrates are free of materials that may affect adhesion.
- C. Identify cracks and other surface defects which need repair prior to application of floor system.
- D. Inspect substrate for markers, paint and similar materials used for layout by others and take remedial action as necessary to remove layout line work to prevent bleed-through.
- E. Verify floors are level or meet indicated slope.

- F. Do not proceed with installation until unsatisfactory conditions have been corrected.
- G. Installation indicates acceptance of substrates and responsibility for performance.

3.02 PREPARATION

- A. Prepare substrate in accordance with manufacturer's instructions.
- B. Fill construction joints and other non-moving joints with product approved by manufacturer of flooring system.
- C. Coordinate leveling with vapor emission control system provider.

3.03 INSTALLATION

- A. Utilize hard-set adhesive in the following rooms:
 - 1. Areas with heavy movable equipment
 - 2. Utilize conventional adhesive in remaining locations.
- B. Install flooring in accordance with manufacturer's recommendations.
- C. Install flooring wall to wall before the installation of equipment, movable partitions, etc.
 - 1. Extend flooring into toe spaces, door recesses, closets, and similar openings.
- D. If required, install flooring on pan-type floor access covers.
 - 1. Maintain continuity of color and pattern within pieces of flooring installed on covers.
 - 2. Adhere flooring to the subfloor around covers and to covers.
- E. Scribe, cut, and fit to permanent fixtures, columns, walls, partitions, pipes, outlets, and built-in furniture and cabinets.
- F. Lay tile in patterns indicated.
 - 1. Alternate tile 90 DEG if pattern is directional.
 - 2. Layout resilient flooring to provide equal size at perimeter.
 - 3. Adjust layout as necessary to reduce the amount of resilient flooring which is cut to less than half full width.
- G. Bond tile to floor, flush, tight accurate seams, and in true alignment with adjacent tiles and with finished surface.
- H. Provide tiles in one room or area from one production run.
- I. Minimize accumulation of air contaminants that cannot be removed prior to occupancy.
- J. Transitions:
 - 1. Where Resilient Tile Flooring abuts thicker finish flooring materials, feather leveling compound for approximately 12 IN for each 1/8 IN of rise so finished surfaces align.
 - 2. Install reducer strips at exposed edges.

3. Install accent transition strip where tile color changes or floor finish material changes to sheet vinyl or sheet rubber:
4. Locate transition strip directly under closed door position where seam occurs in door openings.

K. Roll each row when finished and roll total floor when completed.

1. Roll floor in both directions.
2. Roll with device and weight recommended by maker of tiles to ensure that the underside mat surface is fully bonded to the glue and sub-floor.
3. Avoid over-rolling.

3.04 ADJUST AND CLEAN

- A. Immediately after application and rolling, remove surplus adhesive.
- B. Clean floors in accordance with manufacturer's recommendations.
- C. Protect with non-staining building paper to prevent dirt and damage.
- D. Protect traffic areas with fiberboard or plywood.
- E. NO WAX.

END OF SECTION

SECTION 09 68 13

TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Carpet tile, fully adhered.

1.02 REFERENCE STANDARDS

- A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2016.
- B. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2017.
- C. CRI 104 - Standard for Installation of Commercial Carpet; 2015.

1.03 SUBMITTALS

- A. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- B. Shop Drawings: Indicate layout of joints.
- C. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
- D. Submit two, 12 inch long samples of edge strip, base cap, and stair nosing.
- E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- F. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

1.05 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Base: Bentley
- B. Optional:
 - 1. Tandus
 - 2. Interface

2.02 MATERIALS

- A. See Interior Drawings and Finish Schedule for product selection, and patterns.

2.03 ACCESSORIES

- A. Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive carpet tile.

3.02 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- B. Remove subfloor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with subfloor filler.
- C. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.
- D. Vacuum clean substrate.

3.03 INSTALLATION

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions.
- C. Blend carpet from different cartons to ensure minimal variation in color match.
- D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.
- F. Locate change of color or pattern between rooms under door centerline.
- G. Fully adhere carpet tile to substrate.

- H. Trim carpet tile neatly at walls and around interruptions.
- I. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

- A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- B. Clean and vacuum carpet surfaces.

END OF SECTION

SECTION 09 91 23

INTERIOR PAINTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Interior Painting, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.02 QUALITY ASSURANCE

A. Definitions:

- 1. Finished room or space: Room or space indicated to receive a finish on Interior Drawings & Finish Legend.
- 2. Mechanical work: Work included in Mechanical Specification Divisions.
- 3. Electrical work: Work included in Electrical Specification Divisions.

B. Work Included:

- 1. Interior surfaces in finished rooms or spaces, unless indicated not to be painted or indicated to be painted under other sections.
- 2. Mechanical and electrical work:
 - a. In finished rooms and spaces: Exposed ductwork, piping, insulated piping, conduit, busways, raceways, and associated accessories.
 - b. Where duct surfaces are visible through grilles or diffusers, paint visible surfaces of ducts flat black.

C. Surfaces Not to be Painted:

- 1. Anodized aluminum, stainless steel, chromium plate, glass, copper, bronze or similar materials.
- 2. Moving parts of valves, operating units, motor and fan shafts, sending devices or mechanical and electrical parts such as valve and damper operators.
- 3. Code labels, such as UL, FM that are mylar or flat, non-embossed plates.
 - a. Embossed plates and labels stamped into frames are to be painted.
 - b. Information shall be readily visible and convenient for identification by authority having jurisdiction.
- 4. Equipment identification or rating plates.

D. Factory Finishing of Wood Items Specified Elsewhere: Flush Wood Doors: See Section 08 14 16.

E. ASTM International (ASTM):

- 1. ASTM D2486 Standard Test Method for Scrub Resistance of Interior Latex Flat Wall Paints.
- 2. ASTM D2805 Standard Test Method for Hiding Power of Paints by Reflectometry.

1.03 SUBMITTALS

- A. Product Data: Manufacturer's data for each paint system specified.

- B. Samples: Two 8-1/2 IN by 11 IN samples of each color and finish as noted in Drawing I-001 Interior Notes and Finish Legend.
- C. Contract Closeout Information:
- D. Maintenance data:

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Paints:
 - 1. Base: Sherwin-Williams
 - 2. Optional:
 - a. Benjamin Moore
 - b. Farrell-Calhoun Paint
 - c. PPG Paints
 - d. Pratt & Lambert

2.02 MATERIALS

- A. Manufacturers listed as noted in Drawing I-001 Interior Notes and Finish Legend are for color reference only.
- B. Provide paint products from one manufacturer as far as possible.
- C. Paints and Stain Systems: Paint, stain, and coating systems are by Benjamin Moore unless noted otherwise.
- D. Accent Paint:
 - 1. Architect reserves right to require that one or more walls in a room or space be painted a contrasting accent color, except in janitor's and electrical closets.
 - 2. Primer color:
 - a. Standard: White.
 - b. Bold, deep, vivid, and transparent topcoats: Gray tint.
 - c. Coordinate with topcoat color.
- E. Gloss range: As indicated for paint systems when measured in accordance with ASTM D523:
 - 1. Flat: Below 15, at 85-degrees.
 - 2. Eggshell: Between 5 and 20, at 60-degrees.
 - 3. Satin: Between 15 and 35, at 60-degrees.
 - 4. Semi-gloss: Between 30 and 65, at 60-degrees.
 - 5. Gloss: More than 65, at 60-degrees.
- F. Colors: As noted on Interior Drawings and Finish Legend.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine surfaces for defects and correct to prevent unsatisfactory results.

- B. Verify compatibility of intermediate and topcoat finishes applied over surfaces primed by others.
- C. Commencement of work constitutes acceptance of surfaces and responsibility for performance.
- D. Do not paint items having complete factory finish with exception of items noted in Interior Drawings and Finish Legend.

3.02 PREPARATION

- A. Verify surfaces are clean, dry and free of foreign materials which will affect adhesion or appearance.
- B. Remove mildew and neutralize surface.
- C. Eliminate efflorescence before painting.
- D. Prior to painting, test surfaces with moisture meter. Paint when moisture is within paint manufacturer's acceptable limits.
- E. Ferrous Metal and Hollow Metal:
 - 1. Follow requirements of SSPC SP1 and SP3 except where higher preparation levels are indicated.
 - 2. Wire brush, or grind as necessary to remove shoulders at edge of sound paint to prevent telegraphing.
 - 3. Touch up damaged shop coats.
 - 4. Caulk hollow metal frame joints, corner seams, intersections of rabbets, stops, and soffit joints prior to painting.
- F. Galvanized Metal and Non-anodized Aluminum:
 - 1. Follow requirements of SSPC SP1 except where higher preparation levels are indicated.
 - 2. Treat surfaces with galvanized surface cleaner as recommended by primer and topcoat manufacturer.
- G. Gypsum Wallboard:
 - 1. Repair minor irregularities.
 - 2. Avoid raising nap of paper.
 - 3. Apply prime coat.
 - 4. Correct areas showing defects after application of primer.
 - 5. Re-prime refinished areas.

3.03 APPLICATION

- A. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items, or provide ample in place protection.
- B. Touch up abraded areas of shop prime coats, suction or hot spots in plaster, gypsum wallboard, concrete block, and concrete before painting.

- C. Provide coverage to hide.
 - 1. Evenly spread and smoothly flow on for full, smooth cover.
 - 2. Apply additional coats where undercoats show until paint film is of uniform finish and color.
- D. Back prime wood trim with penetrating sealer.
- E. Apply additional coats in accordance with manufacturer's instructions.
- F. Finish closets and semi-exposed surfaces to match nearest adjoining surfaces. Include surfaces behind grills.
- G. Upon completion of painting, replace removed items and remove protection.

3.04 PROTECTION AND CLEANUP

- A. Provide WET PAINT signs.
- B. Protect adjacent work from damage by painting and finishing work.
- C. Remove temporary protective wrappings, after completion of operations.
- D. Clean, repair or replace, and repaint damaged work.

3.05 INTERIOR PAINT SYSTEMS

A. Gypsum Wallboard and Plaster Surfaces, Walls:

- 1. Latex (PTL), Gloss Level 3, Eggshell:
 - a. Sherwin Williams
 - 1) Prime coat: Fresh Start Latex Primer N023
 - 2) Intermediate coat: Ultraspec 500 N538 500 Eg-Shel.
 - 3) Topcoat: Ultraspec 500 N538 Eg-Shel.
- 2. Epoxy (PTE), Semigloss:
 - a. Sherwin Williams
 - 1) Prime coat: Recommended by topcoat manufacturer for substrate.
 - 2) Intermediate coat: Corotech V341 PreCatalyzed Waterborne Epoxy, SemiGloss.
 - 3) Topcoat: Corotech V341 PreCatalyzed Waterborne Epoxy, SemiGloss.

B. Gypsum Wallboard - Ceilings and Soffits:

- 1. Latex (PTL), Eggshell: Soffits, continuation of accent wall paint
 - a. Sherwin-Williams:
 - 1) Prime coat: Fresh Start Latex Primer N023
 - 2) Intermediate coat: Ultraspec 500 N538 500 Eg-Shel.
 - 3) Topcoat: Ultraspec 500 N538 Eg-Shel.
- 2. Latex (PTL), Flat: Ceilings
 - a. Sherwin-Williams:
 - 1) Prime coat: Fresh Start Latex Primer N023
 - 2) Intermediate coat: Ultraspec 500 N536 500 Eg-Shel.
 - 3) Topcoat: Ultraspec 500 N536 Eg-Shel. 4)

3. Epoxy (PTE), Gloss Level 3, Eggshell:
 - a. Sherwin-Williams:
 - 1) Prime coat: Recommended by topcoat manufacturer for substrate.
 - 2) Intermediate coat: Corotech V342 PreCatalyzed Waterborne Epoxy, SemiGloss.
 - 3) Topcoat: Corotech V342 PreCatalyzed Waterborne Epoxy, SemiGloss.
- C. Duct Surfaces Visible Through Grilles or Diffusers:
 1. Interior Latex Gloss Level 1 Flat:
 - a. Sherwin-Williams:
 - 1) Prime coat: Recommended by topcoat manufacturer for substrate.
 - 2) Topcoat: Ultra Spec 500 (536), Flat.
 - 3) Color: Black.
- D. Metal Doors and Frames:
 1. Waterborne epoxy, Gloss Level 5 Semi-gloss:
 - a. Sherwin-Williams:
 - 1) Prime coat: Recommended by topcoat manufacturer for substrate.
 - 2) Intermediate coat: Corotech Waterborne Acrylic Epoxy, Semi-Gloss.
 - 3) Topcoat: Corotech Waterborne Acrylic Epoxy, Semi-Gloss.

END OF SECTION

SECTION 10 21 13

SOLID PLASTIC TOILET COMPARTMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Solid plastic toilet compartments including the following: (ARIA)
 - 1. Floor mounted toilet compartments.

1.2 RELATED WORK

- A. Section 06 10 00 - Rough Carpentry.

1.3 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM A 666 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - 2. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 3. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative 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: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Include coordinated dimensions for equipment and furnishings specified in other Sections.
- D. Verification Samples: For each finish product specified, two samples, representing actual product, color, and finish.
- E. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- F. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for periodic checking and adjustment, cleaning and maintenance.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Five years or more experience in manufacture of laboratory casework and equipment of type specified.
- B. Installer: Five years or more experience with installation of similar products, and acceptable to the manufacturer.

- C. Mock-Up: Provide a mock-up for evaluation of fabrication techniques and application workmanship.
 - 1. Install in areas designated by Architect.
 - 2. Do not proceed with remaining work until installation is approved by Architect.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in the manufacturer's unopened packaging until ready for installation.
- B. Protect finished surfaces from soiling or damage during handling and installation.

1.7 COORDINATION AND SCHEDULING

- A. Schedule delivery of access flooring so that spaces are sufficiently complete and access flooring materials can be installed immediately following delivery.

1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.9 WARRANTY

- A. Manufacturer's Warranty: Provide manufacturer's standard 25 year limited warranty for against breakage, corrosion, and delamination under normal conditions.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Acceptable Manufacturer: Scranton Products, which is located at: 801 E. Corey St.; Scranton, PA 18505; Toll Free Tel: 800-445-5148; Fax: 855-376-6161; Email: [request info \(info@scrantonproducts.com\)](mailto:requestinfo@scrantonproducts.com); Web: www.scrantonproducts.com
- B. Equivalent products by the following manufacturers are acceptable:
 - 1. Bradley Corp / Mills Partitions, Menomonee Falls, WI. Tel (414) 354-0100.
 - 2. General Partitions Mfg. Corp., Erie, PA. (814) 833-1154.
 - 3. Knickerbocker Partition Corp, Freeport, NY. Tel. (516) 546-0550
- C. Substitution requests WILL NOT be considered PRIOR to Contract Award. Substitutions that fully meet or exceed the specified requirements may be considered under provisions of Section 01 25 00- Substitution Procedures and Section 01 60 00-Product Requirements.

2.2 MATERIALS

- A. Doors, Panels and Pilasters:
 - 1. High density polyethylene (HDPE), fabricated from polymer resins compounded under high pressure, forming single thickness panel.
 - 2. Waterproof and nonabsorbent, with self-lubricating surface, resistant to marks by pens, pencils, markers, and other writing instruments.
 - 3. Thickness: 1 inch (25 mm) with 1/4 inch (6 mm) radiused edges. One edge of pilaster and transom panels to be ship lapped.
 - 4. Recycled Content (Post Industrial): 25 %.
 - 5. Fire Rating: Tested per ASTM E 84: Class A flame spread/smoke developed rating.

- B. Aluminum and Aluminum Extrusions: ASTM B221, 6463-T5 alloy and temper.
- C. Stainless Steel: ASTM A167, Type 304.

2.3 TOILET COMPARTMENT SYSTEM

- A. Basis of Design: ARIA Toilet Partitions as manufactured by and supplied by Scranton Products.
- B. System Construction:
 - 1. System Specified Height (inches / mm): 86 inches.
 - 2. Doors: 79 inches (2007 mm) high. Mounted 1 inch (25 mm) above finished floor.
 - 3. Dividing Panels: Two panels stacked and secured with 3 dowels ensuring proper alignment totaling the system specified height
 - 4. Trim: Application to hide seam gap between dividing panels.
 - 5. Pilasters: System specified height, shoeless system secured with 3/4 inch (19 mm) long stainless steel tamper resistant Torx head screws and angled wall brackets.
 - 6. Transom Panel: Height required to accommodate specified system height with ship lap on one edge. Mounted with four mending plates using 3/4 inch (19 mm) long stainless steel tamper resistant Torx head screws.
 - 7. Wall Brackets: 82 inches long, heavy-duty aluminum. Mounts to pilasters, panels and walls with 3/4 inch (19 mm) long stainless steel tamper resistant Torx head screws.
- C. System Design:
 - 1. Door Design: Traditional Series; Model 1000.
 - 2. Side Panel Design: Plain (standard).
 - 3. Color: Traditional; As determined by the Architect from Manufacturer's full spectrum of color selection.
 - 4. Trim: As determined by the Architect from Manufacturer's selection.
 - 5. Trim Color: As determined by the Architect from Manufacturer's full spectrum of color selection..

2.4 HARDWARE:

- A. Hinges: Helix style 78 inches (1981 mm) edge mounted continuous hinge.
 - 1. Stainless steel: 0.09 inch (1.88 mm) thick 304-2B stainless steel using a stainless-steel pin in 0.25 inch (5.94 mm) diameter.
- B. Occupancy Indicator Latch and Housing: Satin stainless-steel showing green and red occupancy indicators.
 - 1. Latch housing: Satin stainless steel.
 - 2. Slide bolt and button: Satin stainless steel.
 - 3. Door Pulls: Satin stainless steel.
- C. Coat Hook and Bumper:
 - 1. Combination type, chrome plated Zamak.
 - 2. Equip outswing handicapped doors with second door pull and door stop.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas receiving toilet partitions, panels and pilasters for correct height and spacing of anchorage, blocking and plumbing fixtures that affect installation of partitions. Report discrepancies to the Architect.

- B. Do not begin installation until substrates have been properly prepared.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 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.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install partitions rigid, straight, plumb, and level manor, with items laid out as shown on shop drawings.
- C. Clearance at vertical edges of doors shall be uniform top to bottom.
- D. No evidence of cutting, drilling, and/or patching shall be visible on the finished work.
- E. Finished surfaces shall be cleaned after installation and be left free of imperfections.

3.4 PROTECTION

- A. Take protective measures to prevent exposure to other construction activity.
- B. Protect installed products until completion of project.

3.5 CLEANING

- A. Clean surfaces to remove soiling, stains, dust, and dirt using materials acceptable to manufacturer.
- B. Touch-up, repair or replace damaged products and defective work, as directed by Architect.
- C. Leave installation area clean, free of residue and debris resulting from work of this Section.

END OF SECTION

SECTION 10 28 00

TOILET ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Commercial toilet accessories.

1.2 RELATED REQUIREMENTS

- A. Section 10 21 13 Solid Plastic Toilet Compartments

1.3 REFERENCE STANDARDS

- A. ASTM C1036 - Standard Specification for Flat Glass; 2016.
- B. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror; 2018.

1.4 SUBMITTALS

- A. Product Data: Manufacturer's product and technical data indicating compliance with these specifications and shop drawings for the fabrication and installation of all toilet accessories. Show all anchorage and other necessary items including mounting heights.
- B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.
 - 2. Identify products using designations indicated.
- C. Warranty: Sample of special warranty.
- D. Closeout Submittals: Maintenance Data.
- E. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

1.5 QUALITY ASSURANCE

- A. Provide products of the same manufacturer for each type of accessory unit and for units exposed in the same areas, unless otherwise acceptable to the MDOT Architect. Stamped names or labels on exposed faces of units will not be permitted, except where otherwise indicated.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Upon receipt of toilet accessories and other materials, examine the shipment for damage and completeness. Materials shall be stored in a clean, dry place. Stack all materials to prevent damage.

1.7 WARRANTY

- A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 15 years from date of Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings (Bradley Washroom Accessories Division, P.O. Box 309, Menomonee Falls, WI 53051. Tel. (414) 354-0100) or comparable product by one of the following:
- B. Commercial Toilet, Shower, and Bath Accessories:
 - 1. AJW Architectural Products; www.ajw.com
 - 2. American Specialties, Inc; www.americanspecialties.com

2.2 COMMERCIAL TOILET ACCESSORIES

- A. Toilet Paper Dispenser: Double roll, surface mounted bracket type, stainless steel.
 - 1. Products:
 - a. Bradley model 5263
- B. Paper Towel Dispenser: Folded paper type, stainless steel, semi-recessed, with viewing slots on sides as refill indicator and tumbler lock.
 - 1. Capacity: 400 multifold minimum.
 - 2. Products:
 - a. Bradley Corporations; Model 2442-10
- C. Robe Hook: Heavy-duty aluminum, single-prong, rectangular-shaped bracket and backplate for concealed attachment, satin finish
 - 1. Peter Pepper; Model 2140
- D. Mirrors: Stainless steel framed, 1/4 inch thick annealed float glass; ASTM C1036.
 - 1. Annealed Float Glass: Silvering, protective and physical characteristics in compliance with ASTM C1503.
 - 2. Size: 16" x 36".
 - 3. Products:
 - a. Bradley Corporations; 781 Series
- E. Seat Cover Dispenser: Stainless steel, surface-mounted, reloading by concealed opening at base, tumbler lock.
 - 1. Minimum capacity: 250 seat covers.
 - 2. Products:
 - a. Bradley Corporation; Model 5831
- F. Grab Bars: Stainless steel, smooth surface.
 - 1. Standard Duty Grab Bars:
 - a. Push/Pull Point Load: 250 pound-force, minimum.
 - b. Dimensions: 1-1/4 inch outside diameter, minimum 0.05 inch wall thickness, exposed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
 - c. Finish: Satin.
 - d. Length and Configuration: As indicated on drawings.
 - e. Products:
 - 1) Bradley Corporation
- G. Purse Shelf: Fixed; 0.05 inch thick satin-finished stainless steel, with rolled or hemmed edge at shelf front. 1' x 5" x 3/4".

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.
- C. Verify that field measurements are as indicated on drawings.

3.2 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.3 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.
 - 1. Grab Bars: As indicated on drawings.
 - 2. Other Accessories: As indicated on drawings.

3.4 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION

SECTION 12 36 63

SOLID SURFACE FABRICATIONS (SSF)

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Solid Surface Fabrications, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.02 QUALITY ASSURANCE

- A. Applicable standards:
 - 1. International Association of Plumbing and Mechanical Officials (IAPMO)
 - a. IAPMO Z124 Plastic Plumbing Fixtures.
 - 2. ASTM International:
 - 3. National Electrical Manufacturers Association (NEMA).
 - a. NSF International.
 - 1) NSF/ANSI Standard 51 for food zone - all food types.
 - 4. Manufacturer's certification of fabricator and installer.
- B. Installer Qualifications:
 - 1. Successfully installed at least five projects within the past four years, utilizing systems, materials and techniques as specified or required by product manufacturer.
- C. Manufacturer Certification of Fabricator and Installer:
 - 1. Certified by manufacturer.
 - 2. Submit prior to Shop Drawings.

1.03 SUBMITTALS

- A. Shop Drawings:
 - 1. Show location of each item, dimensioned plans and elevations, large scale details, attachment devices and other components.
 - 2. Show full size details, edge details, thermoforming requirements, attachments, etc.
 - 3. Show locations and sizes of furring, blocking, including concealed blocking and reinforcement.
 - 4. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers, waste receptacle and other items installed in surface.
 - 5. Indicate dimensions, component sizes, fabrication details, attachment provisions and coordination requirements with adjacent work.
- B. Product Data:
 - 1. Manufacturer's product data sheets, details and installation instructions for Solid Surface Fabrications, components and accessories.

C. Samples:

1. For each SSF color selected:
 - a. Minimum 6 IN x 6 IN sample in specified gloss.
 - b. Cut sample and seam together for representation of inconspicuous seam.
 - c. Indicate full range of color and pattern variation.
2. Sealant colors for selection.
3. Approved samples will be retained as a standard for work.

D. Project Information:

1. Manufacturer's current certification of Fabricator and Installer prior to submittal of Shop Drawings.

E. Contract Closeout Information:

1. Warranty.
2. Maintenance data.

1.04 WARRANTY

A. Manufacturer's ten (10) year warranty including colorfastness and material defects.

1. Warranty shall provide material and labor to repair or replace defective materials.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Solid Surface Fabrications (SSF):

1. Base: Corian by DuPont.
2. Optional:
 - a. Wilsonart.
 - b. Formica Solid Surfaces

B. Sealant:

1. Base: Color Rite.
2. Optional: As approved by SSF manufacturer.

2.02 MATERIALS

A. Solid Surface Materials:

1. Cast, non-porous, homogeneous, acrylic polymer composition with additional fire retardant fillers and pigments.
 - a. Prime product may not be coated, laminated or of composite construction.
2. Defects with depth < 0.010 IN shall be considered superficial.
 - a. Repair superficial damage by sanding and/or polishing.
 - b. Components with more severe defects shall be rejected.
3. Physical properties: See Chart Below

Minimum Physical Properties		
Property	Method	Value
Tensile Strength	ASTM D638	5500 PSI
Flexural Strength	ASTM D790	10 KSI
Hardness	Rockwell M Scale ASTM D785	Greater than 85
	Barcol Impressor ASTM D2583	55
Thermal Expansion	ASTM D696	1.8 x 10 ⁻⁵ IN/IN/DegF
Gloss (60 –degree Gardner)	IAPMO Z124	Matte = 5; Highly Polished = 75
Light Resistance	NEMA LD 3-2000 Method 3.3	No Effect (Xenon Arc)
Wear and Cleanability	IAPMO Z124	Pass
Stain Resistance	IAPMO Z124	Pass
Fungal Resistance	ASTM G21	Does not support growth
High Temperature Resistance	NEMA LD 3-2000 Method 3.6	No change
Boiling Water Resistance	NEMA LD 3-2000 Method 3.5	No visible change
Ball Impact Resistance; 1/2 LBS Ball	NEMA LD 3-2000	36 IN drop 1/4 IN sheet
	Method 3.5	144 IN drop 1/2 IN sheet
Water Absorption	ASTM D570	0.8 PCT for 1/4 IN sheet
		0.6 PCT for 1/2 IN sheet
Flammability	ASTM E84 and NFPA 255	Class I / Class A
Flame Spread Index		Less than 25
Smoked Developed Index		Less than 450

B. Backing materials (build down):

1. Finished or exposed edges: SSF material.
 - a. Profiles as indicated.
2. Concealed spaces and non exposed edges:
 - a. Moisture resistant, medium density fiberboard (MDF) panels or moisture resistant plywood.
 - 1) Use at countertops with sinks
 - 2) No added formaldehyde (NAF)
 - 3) Particleboard is not acceptable.
 - 4) Base Product: Medex by Roseburg.
 - b. Physical Properties, Based on 3/4 IN Thickness, ASTM D1037, Part A:
 - 1) Density: 48 LBS/FT³.
 - 2) Modulus of Rupture: 4,000 PSI.
 - 3) Screw Holding: Required to pull 1 IN #10 sheet metal screw:
 - (a) Face: 225 LBS.
 - (b) Edge: 200 LBS.
 - c. Panel Thickness:
 - 1) As required for application, use a single thickness to achieve build down to cross sectional thickness.
3. Backer Sheets for knee spaces:
 - a. Plastic laminate in coordinating color
 - b. Grade 20 (VGP)
 - c. Apply to bottom side of backing material
4. Backing materials adhesive:
 - a. Construction grade adhesive recommended by SSF manufacturer for backing materials with VOC content no greater than 70 g/L.

C. Joint Adhesive:

1. Manufacturer's standard one- or two-part adhesive as required for inconspicuous, non- porous joint with VOC content no greater than 80 g/L.

D. Sealant:

1. Mildew resistant silicone sealant in colors matching components.
2. Specifically formulated for applications indicated, including wet areas.
3. Shore A Hardness: 25.
4. Compatible with SSF specified.
5. Compatible with gypsum wallboard, paint, laminates and other materials being sealed.
6. Sealant VOC content shall be no greater than 250g/L.
7. Colors:
 - a. Colors to match specified SSF colors from no less than 400 standard color choices.
 - b. Number of different colors required for project shall not be limited.
8. Base Products:
 - a. At solid colored SSF: Color-Sil by Color Rite; 100 PCT silicone.
 - b. Where speckle colored SSF is specified: Poly-Sil by Color Rite; 100 PCT silicone with suspended accent color particles.
 - c. Architect to select final colors and locations during submittals phase.

E. Conductive Foil Tape:

1. Manufacturer's standard aluminum foil tape, with required thickness, for use with cutouts near heat sources.
2. Insulating Felt Tape:
 - a. Manufacturer's standard for use with conductive tape in insulating solid surface material from adjacent heat source.

2.03 SHOP FABRICATION

A. Shop Assembly

1. Fabricate components to greatest extent practical to sizes and shapes indicated, in accordance with approved shop drawings and manufacturer's instructions.
2. Form joints between components using color matched Joint Adhesive in an inconspicuous manner.
 - a. Reinforce with 4 IN wide strip of SSF material.
3. Provide factory cutouts for plumbing fittings and bath accessories as indicated.
 - a. Radius inside corners of cutouts as large as but not less than 1/4 IN.
 - b. Reinforce with SSF corner blocks to avoid stress cracking.
 - c. Sand edges and corners smooth and free of chips or nicks.
 - d. Utilize heat conductive aluminum tape around drop-in stoves and other heat sources to protect SSF from thermal stress.
4. Rout and finish component edges with clean, sharp returns.
 - a. Rout cutouts, radii and contours to template.
 - b. Smooth edges.
 - c. Repair or reject defective and inaccurate work.
5. Fabricate coved splashes where indicated.
6. Reinforce inside corners, narrow pieces, cantilevered overhangs, and stress points against breakage by laminating an additional thickness of SSF on concealed face.

7. Laminate additional thicknesses of SSF and tool edge profiles indicated.
8. Uniformly finish completed pieces according to SSF schedule.

2.04 FABRICATIONS

A. SSF Countertops:

1. Configurations as indicated on the Drawings.
2. Composite thickness of countertop assemblies: 1-1/4 IN unless otherwise indicated.
 - a. Nominal Thickness of SSF material: Minimum 1/2 IN unless otherwise indicated.
3. Radius exposed outside corners: Minimum 1-1/2 IN.
4. Join multiple pieces, where required, with Joint Adhesive to create inconspicuous seam.
5. Backer:
 - a. Configure backing material as required for application:
 - b. Ladder frame at SSF countertops supported by base cabinets:
 - 1) Form ladders from approved backing material ripped into 3- 4 IN wide strips.
 - 2) Locate main runner strips (rails) along front and back edges of countertops.
 - (a) Provide clearance for shrinkage and normal expansion and contraction.
 - 3) Space front-to-back supports (stiles) to align with line where base cabinet units adjoin. Locate stiles over other wall brackets and supports.
 - 4) Where base cabinets and supports exceed in 24 IN width: Include additional intermediate stiles so that maximum spacing does not exceed 24 IN.
 - 5) Provide additional intermediate stiles at seams in SSF countertop material.
 - 6) Join the stiles to rails using screwed or glued wooden biscuit seams, serrated dowels or rabbeted seams.
 - 7) Overhangs: Configure backer material per SSF manufacturer's guidelines according to distance overhang projects past its support.
 - c. Countertops which span between supports 30 IN and wider:
 - 1) Fabricate backer from solid backing material (not stile and rail construction).
 - 2) Extend one piece, solid backer material, across entire span. Extend load bearing edges not less than 4 IN over edge of supporting cabinets (or similar support).
 - d. Portions of Countertops schedule to support countertop equipment:
 - 1) Provide full backing for the entire countertop cross section for the full width of the equipment.
 - 2) Extend 4 IN (min) beyond equipment width and as required for mounting.
6. Backsplashes and Sidesplashes:
 - a. Provide where indicated.
 - b. Thickness: Minimum 1/2 IN (unless otherwise indicated).
 - c. Height: As indicated.
 - d. Fabricate from same material and color as top.
 - e. Backsplash Style: Integrally coved.
 - f. Sidesplash Style: Applied.
7. Front overhang of Tops: 1-1/2 IN, unless otherwise indicated.
8. Edge Treatments: As indicated on the drawings.

9. Polish exposed faces.
10. SSF color / pattern / finish: Refer to Finish Schedule

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with fabricator present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 1. Verify measurements, dimensions and drawing details before proceeding.
 2. Coordinate location of furring, nailers, blocking, grounds and similar supports for attached work.
 3. Examine conditions under which work is to be installed.
 4. Correct unsatisfactory conditions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Installation constitutes acceptance of responsibility for performance.

3.02 INSTALLATION

- A. General:
 1. Install components plumb, level and rigid, scribed to adjacent finishes, in accordance with approved shop drawings and product data.
 2. Provide product in the largest pieces available.
 3. Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work.
 - a. Exposed joints/seams will not be allowed.
 4. Reinforce field joints with SSF strips extending a minimum of 1 to 2 IN on either side of the seam with the strip being the same thickness as the top.
 5. Cut and finish component edges with clean, sharp returns.
 6. Rout radii and contours to template.
 7. Anchor securely to base cabinets or other supports.
 8. Align adjacent countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop.
 9. Carefully dress joints smooth, remove surface scratches and clean entire surface.
 10. Install countertops with no more than 1/8 IN sag, bow or other variation from a straight line.
 11. Units with sinks or lavatories shall withstand an applied vertical load of not less than 250 LBS on front edge of countertop.
- B. Countertops:
 1. Install plumb, level, true and straight.
 - a. Shim as necessary using concealed shims.
 2. Adhere tops to base cabinets with dabs of a clear silicone sealant at 10 to 12 IN apart.
 3. Attach top securely to base unit or support brackets in accordance with manufacturer's instructions.
 - a. Supply additional wood supports, spaced no more than 18 IN apart or as otherwise required for adequate strength.

4. Attach top securely to base unit or support brackets in accordance with manufacturer's instructions.
 - a. Ensure full contact with support brackets and backing for entire support length with mechanical fastening into backing material.
 - b. Provide fasteners of appropriate length. Do not allow screws to penetrate into SSF material.
 - c. Supply additional supports or solid backing as required for adequate strength.
5. Where tops are abutted by walls at both ends:
 - a. Include 1/8 IN expansion gaps at both ends for every of 10 FT countertop.
 - b. Seal gaps with elastomeric sealant.

C. Backsplashes and Sidesplashes:

1. Integrally Coved Splashes:
 - a. Join coved items to countertops using color matched Joint Adhesive.
 - b. Adhere to walls and other substrates with clear silicone sealant.
 - c. Seal to walls and adjacent cabinets with color matched, elastomeric sealant.
2. Applied Splashes:
 - a. Join adhered items to substrate using color matched, elastomeric sealant.
 - b. Adhere to walls and other substrates with clear silicone sealant.
 - c. Seal to walls and adjacent cabinets with color matched, elastomeric sealant.

D. Sinks:

1. Install sinks per Division 22.
2. Seal to Countertop with elastomeric sealant and mounting hardware provided.
3. Drain and overflow connections: Specified in Division 22.

3.03 CLEANING AND PROTECTION

- A. Keep components clean during installation.
- B. Protect finished surfaces from damage.
- C. Remove adhesives, sealants and other stains.
- D. Replace damaged work which cannot be repaired.

END OF SECTION

SECTION 21 00 10

FIRE PROTECTION GENERAL PROVISIONS

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material, equipment and labor, etc., required to complete installation specified herein and/or shown or scheduled on Contract Drawings.

1.02 MECHANICAL SPECIFICATION SECTION INDEX

- A. Division 21 - Fire Protection
 - 1. Section 21 00 10 - Fire Protection General Provisions
 - 2. Section 21 00 30 - Basic Fire Protection Requirements
 - 3. Section 21 00 50 - Fire Protection Materials and Methods
 - 4. Section 21 13 30 - Wet Pipe Sprinkler System

1.03 ABBREVIATIONS

- | | | |
|----|----------|--|
| A. | A/E | ARCHITECT; ENGINEER AND OTHER PROFESSIONALS OF RECORD for this project |
| B. | A.S.A.P. | As Soon As Possible |
| C. | FT | Foot or Feet |
| D. | HP | Horsepower |
| E. | i.e | That is |
| F. | N.C. | Normally closed |
| G. | N.O. | Normally open |
| H. | U.L. | Underwriters Laboratories |
| I. | vs. | Versus |
| J. | W.P.D. | Water Pressure Drop |

1.04 DEFINITIONS

- A. ARCHITECT: Architectural Design firm or ARCHITECT OF RECORD, meaning general building designer whose professional seal appears on the majority of general construction Contract Documents, or their authorized representative.
- B. ENGINEER (ENGINEER-OF-RECORD): ENGINEER whose professional stamp appears on Contract Drawings, etc. In general, unless specifically denoted otherwise, ENGINEER-OF-RECORD in 21 Specification Sections denotes MECHANICAL ENGINEER-OF-RECORD.
- C. Exposed, or exposed to view: Those installations which can be seen, in whole or part.

- D. Finished Spaces: Inside the building extents.
- E. Inspect and/or Inspection: Utilized for the PROFESSIONAL'S construction period services and defines as "visits by the PROFESSIONAL to the Project at appropriate intervals during construction to become generally familiar with the progress and quality of the CONTRACTOR'S work and to determine if the work is proceeding in accordance with the Contract Documents."
- F. Outside: Synonymous with outdoors, outside of building, exposed to weather, etc.
- G. Plans: Denotes general Construction Drawings prepared by the A/E.
- H. PROFESSIONAL: Authorized representative of ENGINEER-OF-RECORD'S firm.
- I. Provide: Unless specifically denoted otherwise, the CONTRACTOR referred to shall be responsible for furnishing, providing, installing, connecting, and making item or system fully functional in a safe manner as recommended by the manufacturer and by Industry Standards.

1.05 APPLICABLE STANDARDS

- A. The intent is that the complete installation shall comply with applicable laws and ordinances, utility company regulations, and applicable requirements from the latest edition of the following:
 - 1. ANSI - American National Standard Institute
 - 2. ASME - American Society of Mechanical Engineers
 - 3. ASTM - American Society of Testing Materials
 - 4. ICC - International Code Congress
 - 5. NFPA - National Fire Protection Association
 - 6. OSHA - Occupational Safety and Health Administration
 - 7. UL - Underwriters Laboratories
 - 8. City of Jackson, Mississippi, Fire, Building, Gas, Plumbing and Mechanical Codes and Regulations, and governing authority having jurisdiction.
- B. Other applicable building, safety or fire codes having jurisdiction over equipment, materials or methods. The decision of the ENGINEER will be final in event of dispute over Code to use or its interpretation.

1.06 GENERAL CONDITIONS

- A. The General Conditions, Information to Bidders, Special Conditions, and other pertinent documents issued by the ARCHITECT are a part of these Specifications and shall be complied with in every respect.
- B. By the act of submitting a bid, this CONTRACTOR agrees that all of the Contract Documents and each of the divisions of the complete Specifications have been reviewed and studied, and all requirements and coordination resulting there from are included.
- C. This CONTRACTOR shall conform to standards prescribed by City, County, and State regulations or ordinances having jurisdiction. Any changes that may be necessary to conform to such regulations or ordinances shall be made by this CONTRACTOR without extra costs to the OWNER. Where code requirements are less than those shown on the Plans or in the Specifications, the Plans and Specifications shall be followed. Where applicable, NFPA requirements shall be met.

- D. The CONTRACTOR shall comply with all applicable provisions of the William-Steiger Occupational Safety and Health Act (O.S.H.A.).
- E. Permits required for the installation of the work, as well as all authorized code inspections, including all fees and assessments, shall be borne by and arranged for by the CONTRACTOR. The CONTRACTOR shall verify specific mechanical related provisions for permitting in advance, especially where additional design/installation documentation may be required, and include provisions and/or cost of same in this bid.
- F. This 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, required or implied, for the completion of the various systems.

1.07 EXPLANATION AND PRECEDENCE OF DRAWINGS

- A. For purposes of clearness and legibility, Drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale whenever possible, the CONTRACTOR shall make use of all data in the contract documents and shall verify this information at building site.
- B. Do not scale drawings having 1/4" or smaller scale. The Drawings indicate required size and points of termination of pipes and ducts, and suggest proper routes of pipe to conform to structure, avoid obstructions and preserve clearances. Because of small scale, it is not intended that Drawings indicate all necessary offsets, and it shall be the work of this Section to install work in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear without further instruction or cost to the OWNER.
- C. It is intended that all apparatus be located symmetrically with architectural elements, and shall be installed at exact height and locations as shown on the Architectural Drawings.
- D. The CONTRACTOR shall be solely responsible for taking his own measurements and installing his work to suit conditions encountered.

1.08 SPECIAL CONDITIONS, FIRE PROTECTION

- A. The right is reserved to move any element as much as ten (10') feet at no increase in cost provided CONTRACTOR is notified before work in question is fabricated or installed.
- B. The CONTRACTOR shall fully inform himself regarding any and all peculiarities and limitations of spaces available for the installation of all work and materials furnished and installed under the contract. He shall exercise due and particular caution to determine that all parts of his work are made quickly and easily accessible. The CONTRACTOR shall be guided by the architectural details and conditions existing at the job, correlating this work with that of the other trades, and report to the OWNER any discrepancies or interferences that are discovered. Failure to report such discrepancies and interferences shall result in the correcting of these errors or omissions by the CONTRACTOR at his own expense. All work which deviates from the Drawings and Specifications without prior approval of the OWNER, shall be altered by the CONTRACTOR at his own expense to comply with the Drawings and Specifications as directed.

- C. If equipment or fixtures to be furnished by OWNER and/or OWNER'S vendor are not delivered prior to final acceptance, services shall be capped or plugged at walls or floor as directed by ARCHITECT, ready for future connection.
- D. The CONTRACTOR shall coordinate his work with that of the OWNER, in order that there will be no delay in the proper installation and completion of the work. If, in the opinion of the OWNER, any piping, equipment, etc., has been improperly placed or installed due to lack of coordination with the other trades, such piping and equipment shall be relocated as directed by the OWNER at the CONTRACTOR'S expense.

1.09 SITE SAFETY

- A. CONSULTANT'S site responsibilities are limited solely to the activities of CONSULTANT and CONSULTANT'S employees on site. These responsibilities shall not be inferred by any party to mean that CONSULTANT has responsibility for site safety. Safety in, on, or about the site is the sole and exclusive responsibility of the CONTRACTOR alone. The CONTRACTOR'S methods of work performance, superintendence of the CONTRACTOR'S employees and sequencing of construction are also the sole and exclusive responsibilities of the CONTRACTOR alone. The CONTRACTOR shall, to the fullest extent permitted by law, waive any claim against CONSULTANT and his employees and indemnify, defend, and hold CONSULTANT harmless from any claim or liability for injury or loss arising from CONSULTANT'S alleged failure to exercise site safety responsibility. The CONTRACTOR also shall compensate CONSULTANT for any time spent or expenses incurred by CONSULTANT in defense of any such claim. Such compensation shall be based upon CONSULTANT'S prevailing fee schedule and expense reimbursement policy. The term "any claim" used in this provision means "any claim in contract, tort or statute alleging negligence, errors, omissions, strict liability, statutory liability, breach of contract, breach of warranty, negligent misrepresentation, or other acts giving rise to liability.

1.10 TESTS

- A. This CONTRACTOR shall conduct such tests as required to determine that systems and equipment, which he installs, conform to Specifications. CONTRACTOR shall supply all labor, materials, instruments, operations, etc., required to facilitate testing.
- B. Gauges, thermostats, and instruments used in testing shall be accurate, recently calibrated and approved by the PROFESSIONAL prior to test. Instruments installed permanently in systems as specified herein may be used in testing when approved by the ENGINEER.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 WORKMANSHIP, MATERIALS AND EQUIPMENT

- A. All work shall be performed in a workmanlike manner and shall present a neat and mechanical appearance when completed. All materials shall be of type, quality and minimum rating prescribed herein or indicated on the Contract Drawings.
- B. If equipment or fixtures to be furnished by OWNER and/or OWNER'S vendor are not delivered prior to final acceptance, services shall be capped or plugged at walls or floor as directed by ARCHITECT, ready for future connection.

3.02 CLEAN-UP

- A. Do not allow mechanical related waste material or rubbish to accumulate in or about job site.
- B. At completion of work, remove all rubbish, tools, scaffolding and surplus materials from and about building, leaving work clean and ready for use without further cleaning required. Clean all equipment, piping, valves, fixtures, and fittings of grease, metal cuttings, insulation cement, dust, dirt, paper labels, etc.
- C. Any discoloration or other damage to parts of building, its finish or furnishings due to failure to properly clean or keep clean mechanical systems shall be repaired without additional cost to OWNER.
- D. All equipment, fixtures and installations, especially where installations are exposed to view, shall be thoroughly cleaned, polished, seams smoothed and/or sealed for a neat appearance.

3.03 INSPECTION OF PROPOSED CONSTRUCTION

- A. Prior to submitting his bid, the CONTRACTOR shall visit the site of the proposed construction and shall thoroughly acquaint himself with existing utilities, working conditions to be encountered, etc. No additional compensation shall be allowed for conditions increasing the CONTRACTOR'S cost which were not known or appreciated by him when submitting his proposal if the condition was obvious and could have been discovered by him if he had visited the project site and thoroughly informed himself of all existing conditions which would affect his work, including requirements of local authorities to meet their procedures, special requirements, codes, etc.

3.04 MISCELLANEOUS WORK REQUIRED

- A. The CONTRACTOR shall bring adequate power to and make final connections to all equipment furnished under this Contract.
- B. All items of labor, materials and equipment not specifically stated herein or on Contract Drawings to be by others are required to make the systems complete and operative, shall be by this CONTRACTOR.

3.05 PROTECTION OF EQUIPMENT AND MATERIALS

- A. Responsibility for care and protection of equipment and materials under this Contract rests with this CONTRACTOR until equipment or materials have been tested and accepted.
- B. All pipe ends, valves, and parts of equipment left unconnected, permanently or temporary, shall be capped, plugged or properly protected at the end of each working day to prevent entry of foreign matter.
- C. Damaged equipment shall be repaired or replaced at the option of the PROFESSIONAL. Finishes and/or scratched paint on equipment, etc., shall be repaired and repainted to match new condition(s).
- D. This CONTRACTOR shall protect his work at all times from danger by freezing, breakage, dirt, foreign materials, etc., and shall replace all work so damaged. The CONTRACTOR shall use every precaution to protect the work of others, and he will be held responsible for all damage to other work caused by his work or through the neglect of his workmen.

3.06 INSTALLATION COORDINATION

- A. The fire protection plans do not give exact elevations or locations of lines or other installation details. The CONTRACTOR shall carefully lay out his work at the site to conform to the structural conditions to avoid all obstructions, to conform to details of installation supplied by the manufacturers of the equipment to be installed, and to thereby provide an integrated, coordinated and satisfactory operating installation.
- B. If the CONTRACTOR proposes to install equipment, including piping requiring space conditions other than those shown, or to rearrange the equipment, he shall assume full responsibility for the rearrangement of the space and shall have the ARCHITECT review the change before proceeding with the work. The request for such changes shall be accomplished by Shop Drawings of the space in question.
- C. The CONTRACTOR shall so coordinate the work of the several various trades that it may be installed in the most direct and workmanlike manner without hindering the other trades. Piping interferences shall be handled by giving precedence to pipe lines, which require a stated grade for proper operation. For example sewer lines and condensate piping shall take precedence over water lines in determination of elevations. Where there is interference between sewer lines and condensate lines, the sewer lines shall have precedence and provisions shall be made in the condensate lines for looping them around the sewer lines.
- D. Piping or equipment shall not be installed in electrical equipment rooms or elevator machine rooms except as serving only those rooms. Outside of electrical equipment rooms, do not run piping, or locate equipment, with respect to switchboards, panel boards, power panels, motor control centers or dry type transformers:
 - 1. Within 42 inches in front (and rear if free standing) of equipment; or
 - 2. Within 36 inches of sides of equipment.
 - 3. Clearances apply vertically from floor to structure/ceiling.

3.07 INSTALLATION DIRECTIONS

- A. Obtain manufacturer's printed installation directions to aid in properly executing work on equipment requiring such directions. Submit such directions and installation details to PROFESSIONAL for approval prior to time of installation for use in supervising work. If the manufacturer's installation instructions or details conflict with the Contract Document requirements, CONTRACTOR shall promptly make PROFESSIONAL aware in writing and request clarification.

END OF SECTION

SECTION 21 00 30

BASIC FIRE PROTECTION REQUIREMENTS

PART 1 - GENERAL

1.01 SUBMITTALS AND SHOP DRAWINGS

- A. The submittal data to be furnished for this project shall comply with the Specifications and Contract Documents in their entirety.
- B. CONTRACTOR shall submit to the ARCHITECT/ENGINEER list of materials, fixtures and equipment to be utilized for this project.
- C. Failure to submit data for approval within specified time limits will result in the CONTRACTOR being required to furnish equipment as called for by name.
- D. Reproduction of design documents in any portion for use in a submittal is not acceptable.
- E. Whether or not the CONTRACTOR is utilizing the equipment as called for by name or not, does not relieve the CONTRACTOR of providing submittals. Submittals shall be required for all equipment as directed herein and as directed by the PROFESSIONAL.
- F. CONTRACTOR shall not delegate the authority to material supply houses to present data for approval. This shall be done by the CONTRACTOR.
- G. Materials/equipment not initially submitted, incomplete, or rejected shall be revised and re-submitted within twenty (20) days. The same format is required for all resubmitted data.
- H. All Submittals and Shop Drawings shall be thoroughly reviewed for general conformance with Contract Documents and with other crafts/trades.
- I. The CONTRACTOR shall verify with local governing authority and provide all additional documentation required to obtain permanent permit for this project. This shall include, but not limited to, plumbing, HVAC and fire protection risers, details, calculations, etc. Should an ENGINEER'S stamp or specific designer's credentials also be required on this supplemental design and/or installation documentation, the CONTRACTOR shall comply. The cost of all such extended documentation shall be considered a normal part of the shop drawing for installation coordination documentation, and the full cost of same shall be included in the CONTRACTOR'S base bid.
- J. CONTRACTOR's Selection of Materials and Equipment:
 - 1. Where a definite material or brand name is specified, it is not the intent to discriminate against any product of another manufacturer. Reference to a specific manufacturer's product by name, make or catalog number is intended to establish standards of quality, design, dimensions and appearance.
 - 2. Open competition is expected, but in all cases, complete data must be submitted on all proposed substitutions and samples shall be submitted for comparison and test when requested by the PROFESSIONAL. Burden of "proof of equality" lies solely with the CONTRACTOR.
 - 3. 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 ascertain if the submitted materials and equipment will fit into the space allotted as conveniently as the materials and equipment utilized as the basis of design. Furthermore, the CONTRACTOR 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 PROFESSIONAL, the CONTRACTOR shall install items specified even though materials and equipment had been previously approved. PROFESSIONAL'S approval of materials and equipment other than the basis of design is for performance only.

4. When submitting materials and equipment other than the basis of design, the CONTRACTOR should note the following minimum considerations: (1) capacities shown are absolute minimum and must be equaled, (2) physical size limitation for space allotted, (3) static and dynamic weight limitation, (4) structural properties, (5) noise level, (6) vibration generation, (7) interchangeability, (8) accessibility for maintenance and replacement, (9) compatibility with other materials, assemblies, and (10) similar items shall be same manufacture and style whenever possible.
5. The availability of service is of prime importance to the OWNER and was a major consideration in selecting the materials and equipment that are listed as the basis for design. The CONTRACTOR is advised, therefore, to exercise caution in accepting prices in the "or equal" clause in this specification. Competent service must not only be available, but must, in the case of specialty HVAC equipment and control systems, be a direct arm of the manufacturer. Further, the service agency, as a representative of this manufacturer, must have been in continuous operation in this area sufficient time to indicate a degree of permanence as required by the PROFESSIONAL.
6. All material and equipment, for which a U.L. Standard, and AGA approval, or an ASME requirement is established, shall be so approved and labeled or stamped.
7. Substitution requests WILL NOT be considered PRIOR to Contract Award. Substitutions that fully meet or exceed the specified requirements may be considered under provisions of Section 01 25 00- Substitution Procedures and Section 01 60 00-Product Requirements.

K. Submittal format and information shall be provided as follows:

1. Submittals for fire protection data shall be bound, with each volume containing one copy of all specified submittals. Complete submittals may also be submitted electronically. **FAILURE TO BIND AND IDENTIFY SUBMITTALS WILL RESULT IN THE AUTOMATIC REJECTION OF THE SUBMITTAL DATA WITH NO EXCEPTION. ANY PARTIAL SUBMITTALS WILL BE RETURNED TO THE CONTRACTOR FOR RE-SUBMITTAL. ONLY COMPLETE SUBMITTALS WILL BE ACCEPTABLE.**
2. All submitted equipment must be identified with same "Mark Numbers" as identified on Drawings or in Specifications.
3. Reference to all pertinent data such as electrical characteristics and horse power, capacities, construction material of equipment, UL labels where required, accessories specified, manufacturer, make and model number, weights where specified, size and characteristics of the equipment, name of the project and a space large enough to accept an approval stamp.
4. The bound submittals shall be provided with an identification tab for each and every Specification Section that requires submittals. Each item in each tabbed section

shall be identified with the paragraph number relating to the item submitted by the use of a cover sheet or by high lighting the paragraph on the first page concerning the item.

5. Any deviation from any part of the Contract Documents shall be clearly and completely highlighted.
6. Each and every submittal shall be stamped by the CONTRACTOR confirming that the submittals have been checked for compliance with the Contract Documents.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 SUBMITTALS AND SHOP DRAWINGS

- A. The following list of materials and equipment shall be submitted to PROFESSIONAL for approval:
- B. SUBMITTALS ARE REQUIRED FOR THE FOLLOWING WITHIN 30 DAYS AFTER PROJECT "NOTICE TO PROCEED":
 1. SECTION 21 13 30 - WET PIPE SPRINKLER SYSTEM
 - a. Sprinkler Hydraulic Calculations
 - b. Sprinkler Shop Drawing(s)
 - c. Copy of State Rating Board of Certification (Letter)
 - d. Sprinkler Heads
 - e. Spare Sprinkler Head Cabinet
 - f. Pipe Labels (Section Mechanical Identification)
 - g. Hangers (Section Supports and Anchors)
 - h. Copy of Local Fire Marshall Approval Letter
 - i. Copy of Installation and Material Certificate (End of Project)

3.02 AS-BUILT DRAWINGS

- A. Project Record Documents and As-Built Drawings:
- B. 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.
- C. 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.
- D. At the completion of the project, furnish the OWNER three (3) set(s) of plans and three (3) 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.

3.03 OPERATION AND MAINTENANCE MANUALS

- A. Submit three (3) complete sets of bound brochures in 8-1/2 inches by 11 inches spring post binders, indexed and tabled by equipment type.
- B. Include in these brochures written submittal data, manufacturers operating and maintenance procedures and recommendations, spare parts lists and suppliers and any

interlocking control or wiring diagrams for all equipment. The information listed herein is to be bound in the following order:

1. First sheet to list ARCHITECT, ENGINEER, CONTRACTOR and Sub-Contractors with addresses for each.
 2. Second sheet to list type of equipment with sequential number, the manufacturer, make, model and serial number of the actual equipment nameplate data rated horsepower, full load rated amps, voltage and phase.
 3. Next, actual copy of approved submittal data including all manufacturers published information on capacities, capacity curves or tables, accessory and control item lists, and other pertinent information as requested by ENGINEER. Cross-reference all equipment to Contract Documents.
 4. Next, copy of all spare parts list and suppliers' contact information.
 5. Next, include the manufacturer's published operating and maintenance procedures.
 - a. Include instructions to stop and start each piece of equipment including reference to controls and interlocks and an itemized maintenance schedule detailing procedure and interval of periodic maintenance items. Start this log of the maintenance list(s) by accomplishing the initial required maintenance procedure(s) for each and every maintenance item.
 - b. Operating instructions shall also include recommended periodic maintenance, seasonal changeover procedures, and suggested procedures in operation of all systems. These instructions must be written expressly for this project and shall refer to equipment, valves, etc., by mark number from project schedules. Operating instructions and procedures shall be submitted in draft form, for approval prior to final issue of complete brochures. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions. Bulletins shall be clearly marked for the equipment furnished. Where a bulletin contains more information than that for the installed equipment, such extended information shall be deleted by crossing it out or by stripping it from the bulletin.
 6. All system operating instructions that were earlier approved by PROFESSIONAL and utilized for OWNER personnel training shall also be inserted herein.
- C. This bound information will require the PROFESSIONAL'S signed approval before this contract is complete. No exceptions will be granted.
- D. A copy of sprinkler system operation and maintenance (O & M) Manufacturer's recommended brochures shall be transmitted to the TAB Agent within ninety (90) days after Notice To Proceed such that TAB Agent shall utilize same in preparation of Owner's Personnel Training/Agenda.
- E. The manuals shall be previously approved by the PROFESSIONAL and transmitted to the OWNER at least one week prior to the final inspection.

3.04 OWNER TRAINING

- A. OWNER Representative Training and Operating and Maintenance instructions
1. During the last phase of the project, the CONTRACTOR, in conjunction with the Fire Alarm, Controls, Sprinkler and MECHANICAL (Sub) CONTRACTORS shall coordinate and facilitate the start-up and subsequent OWNER'S representatives training and instructions.
 2. The OWNER Training shall be administered by the CONTRACTOR, with special training/instructions from equipment technical representatives, CONTRACTOR qualified representatives, etc.

- a. The training and instructions for the OWNER will include a complete walk-through of the facility, review of all fire protection systems, and comprehensive training of the pertinent operating and maintenance requirements.
 - b. This shall include an overview of system components and descriptions, seasonal provisions/changes required, major valve location/function, safety provisions and concerns, actions to be taken with system failure or malfunction, reaction to fire and safety alarm annunciation, normal operating parameters, etc.
 - c. The training/data shall include all pertinent data from industry standards, minimal recommendations indicated herein and further as recommended by each manufacturer's O&M manuals.
 - d. All equipment and material suppliers will also be expected to participate. The CONTRACTOR shall coordinate and schedule the OWNER'S training with the A/E and designated OWNER'S Representative(s).
 - e. Additional instruction and training sessions shall be provided subsequent to the initial session to provide additional training as required to fully train the OWNER'S operators.
3. The CONTRACTOR shall submit to the PROFESSIONAL in draft form, an outline of the contents of this training, with agenda and list of pertinent training personnel, a minimum of thirty (30) days prior to project completion date and scheduling said training with the OWNER and PROFESSIONAL.
4. When the seminar and subsequent instruction periods are completed, CONTRACTOR shall furnish ARCHITECT a letter signed by the OWNER certifying that his representative(s) has received adequate instruction in operation of installed equipment and systems. This letter shall be furnished prior to final acceptance of this project.
- B. Some suggestions for pertinent subject matter to include in the administration of the training of OWNER'S operation and maintenance personnel, is as follows:
- 1. Fire Protection Sprinkler:
 - a. Replacement heads and tools
 - b. Alarm and annunciation with fire alarm panel
 - c. Periodic maintenance
 - d. Go thru procedures for alarm and false alarm, water turn-off in case of problem, etc.
 - e. Annual certification of system

3.05 CLOSEOUT DOCUMENTATION

- A. Seven (7) days prior to requesting a final inspection, the CONTRACTOR shall submit all O&M and closeout documentation to the ARCHITECT, to be turned over to the OWNER at the end of the project.
- B. The following checklist 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 fax or email copy of the completed checklist to the PROFESSIONAL prior to final inspection request.

CLOSEOUT DOCUMENTATION CHECKLIST		
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. SEE SECTION <i>PLUMBING IDENTIFICATION</i> .
		PROVIDE COPY OF INSTALLATION AND MATERIAL CERTIFICATE PER NFPA 13.

END OF SECTION

SECTION 21 00 50

FIRE PROTECTION MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material, equipment and labor, etc., required to complete installation specified herein and/or shown or scheduled on Contract Drawings.
- B. The requirements of this section apply to all Sections of Division 21.
- C. Definitions:
 - 1. Exposed: Piping and equipment exposed to view in finished rooms, including mechanical and/or equipment rooms.
 - 2. Option or Optional: CONTRACTOR'S choice of an alternate material or method.

1.02 PRODUCTS CRITERIA

- A. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
- B. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
- C. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or otherwise permanently marked on each item of equipment.

1.03 FLAME SPREAD AND SMOKE DEVELOPED PROPERTIES OF MATERIALS

- A. Materials and adhesives used throughout the fire protection and electrical systems for insulation, and jackets or coverings of any kind, or for piping or conduit system components, shall have a flame spread rating not over 25 without evidence of continued combustion and with a smoke developed rating not higher than 50. If such materials are to be applied with adhesives, they shall be tested as applied with such adhesives, or the adhesives used shall have a flame spread rating not over 25 and a smoke developed rating not higher than 50. (Note: Materials need not meet these requirements where they are entirely located outside of a building and do not penetrate a wall or roof, and do not create an exposure hazard.)
- B. "Flame-Spread Rating" and "Smoke Developed Rating" shall be as determined by the "Method of Test of Surface Burning Characteristics of Building materials," NFPA No. 255, ASTM E84, Underwriter's Laboratories, Inc., Standard". Such materials are listed in the Underwriters' Laboratories, Inc., "Building Materials List" under the heading "Hazard Classification (Fire)".

1.04 HAZARDOUS MATERIALS

- A. No products shall be used that contain any known hazardous or carcinogenic materials. Products with asbestos or radioactive content shall not be used.
- B. Handling of any hazardous material is not covered in this Specification Division.

PART 2 - PRODUCTS

2.01 EQUIPMENT ACCESSORIES

- A. Provide removable guards to enclose all rotating or moving elements. Construct of galvanized steel to withstand 250 lbs. static load.
- B. Wall/Ceiling Access Doors (Required for Fire Protection Equipment)
 - 1. Panels in non-rated applications shall be galvanized steel, 18 gage frame, 16 gage door with mounting accessories, continuous concealed hinge, screwdriver operated lock, and prime coat paint.
 - a. Equal to Acudor Model UF-5000 for acoustic tile or exposed masonry
 - b. Equal to Acudor Model PS-5030 for plaster finishes
 - c. Equal to Acudor Model UF-5000 (stainless steel) for ceramic or glazed structural tile.
 - 2. Panels in fire rated applications shall be painted steel type, 1 hour rated, piano hinged, exterior key lock, nominal size 24 inches by 36 inches at equipment installations as approved, equal to Air Balance, Inc. - Model "F".
 - 3. Do not duplicate. Coordinate with Section 22 00 50-Basic Plumbing Materials and Methods.

2.02 FIRE, SMOKE AND SOUND STOPPING

- A. UL listed penetration sleeve assembly and/or firestop that meets ASTM E-814 E119, and E84, as equal to "3M" systems for the intended applications.
- B. All fire, smoke and sound stopping to be done by a separate licensed and certified Subcontractor as approved by Professional.
- C. Do not duplicate. Coordinate with Section 22 00 50-Basic Plumbing Materials and Methods.

2.03 PIPE SLEEVES

- A. Galvanized sheet metal sleeves shall have lock seam joints and comply with the following minimum thickness:
 - 1. 24 Gage for 3 inches and smaller.
 - 2. 22 Gage for 4 inches to 6 inches inclusive.
 - 3. 20 Gage for sizes over 6 inches.
- B. Galvanized steel sleeves shall be constructed from schedule 40 grade A53 pipe.
- C. Water tight sleeves/seals shall be equal to "Link-Seal".

2.04 WALL, FLOOR, AND CEILING PLATES

- A. Chrome plated brass, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve.
- B. The thickness shall conform to the following requirements:
 - 1. Not less than 3/32-inch for floor plates.
 - 2. For wall and ceiling plates, not less than 0.025 inch for up to 3-inch pipe and 0.035 inch for larger pipe.

- C. All escutcheons shall be equal to Beacon, Caldwell or approved equal.

2.05 PAINTING OF FIRE PROTECTION WORK

- A. Painting of Fire Protection shall be by Division 09. See Division 09 for more information.
- B. See Section Plumbing Identification for color-coding of piping, etc. All other metal structure and hangers to be color of adjacent finish.

2.06 PIPING MATERIALS

- A. All piping installed on this project shall be new and of full weight and size indicated and of proper specification for service intended. Only domestic pipe may be used. Pipe and pipe fittings for the various systems shall be as follows:
- B. Fire Protection Piping
 - 1. Wet Pipe: Piping from fire protection riser to new wet pipe sprinkler distribution system shall be black steel, with joints and connections either welded, screwed, or by mechanical gasketed grooved couplings, as per NFPA 13.
 - a. Sprinkler piping shall have antibacterial coating on inside of piping to resist microbial colonization of pipe/fitting wall(s) preventing the onset of microbiological influenced corrosion (MIC), as equal to "Dynathread" by Allied Tube and Conduit.
 - 2. All screwed piping shall be minimum schedule 40 and all rolled groove piping shall be a minimum of schedule 10 piping. No piping less than schedule 10 shall be allowed anywhere in the Project.

2.07 PIPE FITTINGS, UNIONS, FLANGES, AND GASKETS

- A. All fittings shall conform to pipe as to black steel, galvanized steel, copper, PVC or cast iron, etc. or as indicated. Fittings and accessories shall have equal or greater pressure rating than piping specified for particular application.
- B. Malleable steel fittings shall be minimum 150 psi class.
- C. Steel pipe unions shall be malleable iron having bronze-to-iron ground joints.
- D. Steel nipples shall be extra heavy type. All thread nipples prohibited. Provide a minimum of 1 inch of bare pipe between threaded ends of nipples.
- E. E. Flange bolts: Galvanized Alloy steel, ASTM #A 196, Galvanized GR. B 7; nuts' ASTM #S 194, GR. 2 H; both hex head style.
- F. Flange gaskets serving piping below 250 degrees F shall be synthetic composition type; serving above 250 degrees F gaskets shall be corrugated metallic type. Utilize gasket suitable for service intended.
- G. Couplings, steel pipe malleable iron, Grade II.
- H. Provide factory made reducers and increasers, and nipples of comparable materials as the piping. The use of bushings is not acceptable to obtain reduction or increase in sizes.
- I. Galvanized steel pipe shall be assembled with galvanized screw fittings unless specifically indicated otherwise.

2.08 HANGERS & SUPPORTS

- A. All hangers, fasteners and accessories exposed to view indoors shall be galvanized or zinc plated. Similar installations outdoors shall be hot dipped galvanized materials and fasteners.
- B. Supports, hangers, anchors and guides shall be provided for all horizontal and vertical piping. Selection and application shall be in accordance with ANSI/MSS SP-69.
- C. All pipe supports shall be so arranged as to prevent excessive bending stresses between supports. Specifically designed hangers shall be fabricated and installed in accordance with ANSI/MSS SP-69.
- D. All piping routed on trapeze hangers shall be attached rigidly to same unistrut hanger bar with clamps designed by unistrut manufacturer as approved by PROFESSIONAL.

PART 3 - EXECUTION

3.01 EQUIPMENT ACCESSORIES

- A. Provide access panels, or doors, at concealed dampers, valves, vents, equipment, inspection points, etc., and where noted. Where ceiling is "lift out" construction, ceiling access panels are not required. Panels shall be 15" square, or larger as approved for service intended.
- B. CONTRACTOR shall provide substantial metal angle frame and support at all ceiling access doors.

3.02 FIRE, SMOKE AND SOUND STOPPING

- A. Fire and smoke stopping shall be provided and installed at all locations where mechanical Work passes thru rated assemblies. This includes all ductwork, piping and controls related conduit.
- B. Penetrations in "sound" 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.

3.03 PIPE SLEEVES

- A. Pipe sleeves shall be constructed of galvanized sheet steel except where noted below or in individual work sections.
- B. Pipe sleeves shall be constructed of galvanized steel pipe when pipes are located within or passing through the following:
 - 1. concrete beams
 - 2. outside walls
 - 3. foundations
 - 4. footings
 - 5. waterproofed floors
 - 6. In locations where sleeve is extended above finished floor
- C. Where pipe motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe.

- D. Where pipes are insulated, make sleeves of sufficient diameter to pass pipe insulations.
- E. Check floor and wall construction and finish to determine proper length of sleeves for various locations, make actual length to suit following:
 - 1. Terminate sleeve flush with walls, partitions, and ceilings.
 - 2. In areas where pipes are concealed as in chases, terminate sleeves flush with floor.
 - 3. In finished areas where pipes are exposed, extend sleeves 1/4" above finished floor except in kitchen, toilets, equipment rooms, and other areas where water may accumulate on floor, extend 1-1/2 inch.
- F. 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.
- G. For drilled penetrations in existing floors provide one inch angle rings set in silicone sealant and bolted to the floor in lieu of pipe sleeves with one inch extension above floor.
- H. Below grade exterior wall penetrations into habitable spaces, including crawlspaces shall include sleeves with water tight seals as "Link-Seal".

3.04 WALL, FLOOR, AND CEILING PLATES

- A. Exposed piping passing through walls, floors and ceilings, shall be fitted with escutcheons.
- B. Inside diameter shall fit around insulation or around pipe when not insulated; outside diameter shall cover sleeve.
- 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.

3.05 PAINTING OF FIRE PROTECTION WORK

- A. All equipment shall present a clean painted appearance; touch-up or repair as required.
- B. All surfaces shall be properly prepared prior to painting. CONTRACTOR must contact PROFESSIONAL, such that all tests, installations etc., are approved prior to painting.
- C. The CONTRACTOR shall prime (where applicable) and paint the following fire protection related Work:
 - 1. New and modified piping outside and indoor exposed to view, including mechanical rooms, of the following type(s):
 - a. Fire Protection Piping
 - 2. All exposed ferrous metal non-galvanized hangers, auxiliary supports, braces, etc., in all locations.
 - 3. All new or modified fire hydrants, metal valve and metal box covers, post indicator valves, and the like. This includes items provided and installed by others, and existing on site installations.

3.06 IDENTIFICATION OF PIPING ABOVE GRADE

- A. All piping exposed to view or concealed shall include manufactured labels on pipe in a visible location. Label shall be attached to pipe every twenty feet (20'-0").

B. Labels to be utilized as follows.

1. In exposed applications, CONTRACTOR shall utilize pre-coiled, snap in place type markers as equal to Seton "Setmark". On 6 inches and larger pipe, CONTRACTOR shall utilize nylon ties to secure marker to piping.
2. In concealed applications, CONTRACTOR shall utilize a pressure-sensitive tape manufactured legend on all installations. Tape shall be tamper resistant vinyl tape for indoor as equal to Seton "Opti-Code" and outdoor installations as equal to Seton "Ultra-mark."
3. Tape legend colors shall meet ANSI recommendations.
4. On piping where markers do not include directional arrows, CONTRACTOR shall include similar manufactured stick-on flow arrows on all pumped circulating systems as equal to Seton "Arrows On A Roll" with colors to match pipe legend tape identification.

3.07 PIPING INSTALLATION

A. General

1. Arrange and install piping approximately as indicated, straight, plumb and as direct as possible; form right angles or parallel lines with building walls. Keep pipes close to walls, partitions, ceilings, offset only where necessary to follow walls as directed. Locate groups of pipes parallel to each other; space them at distance to permit applying full insulation and to permit access for servicing valves. The PROFESSIONAL reserves the right to require this CONTRACTOR to make minor changes in pipe locations where conflicts occur with other trades or equipment. Such changes shall be made without extra cost to OWNER.
2. Install horizontal piping as high as possible without sags or humps. Grade drainage piping at uniform slope of 1/8 inch per foot minimum and maximum 1/4 inch per foot, or as noted. Where this is impossible, maintain slope as directed, but in no case less than 1/16 inch per foot. Pitch piping in direction of flow.
3. When piping is cut, it shall be reamed with pipe reamer and all burrs, scale, trash and foreign matter removed. If any piping is found installed without being reamed, cleaned, deburred, etc., or in any way contrary to above, it shall be sufficient reason for related erected piping to be removed, inspected by the PROFESSIONAL, corrected and reinstalled, all at CONTRACTOR'S expense.
4. Sufficient space shall be allowed in erecting piping for proper application of thermal installations including fittings. In no case shall any insulation be cut or reduced thickness because of inadequate space.
5. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping.
6. Locate valves for easy access and operation. Concealed valves shall be provided access doors. Do not locate any valves with stems below horizontal.
7. Install gauges, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gauges to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
8. Furnish and install unions or mating flanges at all connections to each piece of equipment conveniently located to facilitate quick and easy disconnecting of equipment. Flanges or union connections shall be used on both sides of traps, control valves, pressure reducing valves and meters and the like.

B. Steel Piping

1. Where piping is threaded, dies shall be clean and sharp. Threads shall conform to ANSI B2.1; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads or steel pipe with joint compound and red lead paint for corrosion protection. The caulking of these joints will not be tolerated. Pipe joint compound must be approved by the PROFESSIONAL.
2. Where welding is specified or done, it shall be by electric arc by mechanics skilled in operation and holding a test certificate acceptable to the ENGINEER. All scale and flux shall be removed from piping after welding. Welding, beveling, spacing and other details shall conform to ANSI B31.1.

3.08 PIPE EXPANSION

- A. In the installation of all pipe runs where shown or where necessary, install swing joints, flexible couplings, turns, expansion loop or long offsets to allow for expansion. Broken pipe or fittings due to rigid connections must be removed and replaced at no additional cost to the OWNER.
- B. All lines shall be securely anchored where required. Where such anchors occur, they shall be securely fastened to the steel or concrete structure of the building in a manner approved by the PROFESSIONAL. Drawings shall be submitted before installation.

3.09 TESTS

- A. Cooperation/Scheduling:
 1. The ARCHITECT shall be notified no less than ninety-six (96) hours prior to any pipe test. The ARCHITECT shall also be notified in adequate time for an inspection of the test before the test is completed. The PRIME CONTRACTOR'S Superintendent shall be responsible for administering and witnessing all tests, log it for permanent record and transmit to ARCHITECT at completion of project. The PRIME CONTRACTOR'S Superintendent shall keep this on-going log on jobsite and shall include the following:
 - a. Date of Test
 - b. Piping Description (EX: "Wet Pipe Sprinkler")
 - c. Location (EX: "Northwest Quadrant First Level")
 - d. Results (EX: "Held 10 ft. of head for eight hours without leakage", etc.)
 - e. Contractor's/Superintendent's Witness Initials
- B. Tests shall be as follows: (New and Existing Modified Piping shall be tested and all leaks repaired)
 1. Wet Pipe Fire Protection Sprinkler System: Fire Protection System Test: Test fire lines hydrostatically for two (2) hours at 200 psi. Obtain certificate of approval from local Fire Marshal.

END OF SECTION

SECTION 21 13 30

WET PIPE SPRINKLER SYSTEM

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material, equipment and labor, etc., required to complete installation specified herein and/or shown or scheduled on Contract Drawings.
- B. The CONTRACTOR shall (modify and extend existing sprinkler system) (provide a new fire sprinkler arrangement) including piping and heads, and other appurtenances as shown on Contract Drawings or as specified, to provide wet (and dry) pipe system coverage to the entire facility, including (modification of existing) riser, piping and heads, with new as required to suit (renovated and) new areas, as shown on Contract Drawings.
- C. The system shall include all piping, valves, fittings, fire alarm interface, and heads required for the type of construction and as required by OWNER'S insurance and local fire authority requirements.
- D. Standard Products:
 - 1. Equipment furnished under this Specification is essentially the standard product of the manufacturer. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the products of the same manufacturer.
- E. System shall include general wet (and dry) pipe area sprinkler piped arrangement, including new heads of type indicated hereinafter, per NFPA-13 (latest edition) requirements for all new interior (and exterior covered) space(s), and interstitial spaces, attics, etc., as required for comprehensive fire sprinkler protection.
- F. It is the CONTRACTOR's responsibility to review the plans, available as-builts, and visit the site to familiarize themselves with the conditions for installation.
- G. The CONTRACTOR shall be responsible for verifying static and residual and flow of existing water distribution system and design requirements of the local governing authority which vary from the minimum code standards imposed by these Specifications, and include same in his bid and install same in this project. Should an ENGINEER's stamp be required, same will be coordinated and cost for same included in his bid.

1.02 APPLICABLE STANDARDS

- A. All equipment used must meet the requirements of the National Board of Fire Underwriters for the service intended.
- B. The CONTRACTOR shall conform to standards prescribed by City, County and State regulations or ordinances having jurisdiction and be approved by the OWNER'S insurance company. Any changes that may be necessary to conform to such regulations or ordinances shall be made by the CONTRACTOR without extra cost to the OWNER.
- C. The interior sprinkler system shall be designed for type occupancy and hazard protection per NFPA 13, newest edition, or as applicable.

- D. It is the CONTRACTOR'S sole responsibility to ascertain and verify the specifics of the characteristics (pressure and flow) of the water service available and include same in the hydraulic calculations for design and installation. The review of the sprinkler Shop Drawings by the A/E does not relieve the CONTRACTOR of this responsibility.

1.03 GENERAL REQUIREMENTS

- A. The entire work must be executed in a neat, substantial, and workman-like manner, according to the true intent and meaning of the plans and specifications, which are intended to include everything dependent upon them and required for the completion of the work with materials best adapted to the purpose.
- B. Unless otherwise shown, specified, or approved by the ENGINEER, use materials and equipment in the installation of the sprinkler system listed as approved by the Underwriters' Laboratories Inc. List of Inspected Fire Protection Equipment and Materials, or approved by any other appropriate nationally known and recognized testing laboratory for use in sprinkler systems, and of the latest design of the manufacturer.
- C. In general, ductwork and other graded piping drainage systems have the right-of-way. The CONTRACTOR shall provide, install, and arrange his piping layout to avoid conflicts with other installations.
- D. Seismic restraints:
 - 1. Submit shop drawings for all devices specified herein and as indicated and scheduled on the drawings. Submittals shall indicate full compliance NFPA 13 requirements. Any deviation shall be specifically noted and subject to engineer approval. Submittals shall include device dimensions, placement, attachment and anchorage requirements.
 - 2. Provide calculations for selection of seismic restraints, certified by a qualified professional engineer, licensed in the state of the project.

PART 2 - PRODUCTS

2.01 SPRINKLER HEADS

- A. Unless otherwise specified or shown, provide and install sprinkler heads of regular automatic closed-type, or new spray-type heads, for ordinary degree temperature rating except that type and temperature ratings of sprinkler heads installed in the vicinity of heating equipment shall be as required for such locations by NFPA 13, where, in the opinion of the OWNER's insurance company, special occupancies and installations indicate the need for special heads, high-temperature rating, etc., for such heads by actual tests at the site. Provide quick response heads in all applications.
- B. Utilize chrome plated semi-recessed pendant-type heads in areas with lay-in ceilings.
- C. Utilize concealed pendent-type heads with flush mounted covers in areas with hard ceilings.
- D. Utilize chrome plated upright heads, with the deflectors parallel to ceiling or roof slope, in areas without ceilings. Clearances between the deflectors and the ceilings, roof decking, or roof joists to be in accordance with NFPA 13, unless otherwise shown on Drawings.
- E. Utilize flush mounted lever sprinklers with tamper resistant construction and solder link in institutional applications.

- F. All heads in lay-in acoustical tile ceiling areas shall be installed with swing joints so as to be able to center same in ceiling tile. (No exceptions). An accepted alternative to swing joints are flexible stainless steel hoses and lay-in or sheetrock mounting brackets equal to those manufactured by FlexHead®.

2.02 DRAINS

- A. Install main drains on main risers and auxiliary drains at low points in the system. Install inspector's test drains on each sprinkler system as near the outer end of system as possible. Drain valves to be of the angle type. Install in accordance with NFPA 13. Pipe drain valves to a safe place of discharge; discharge to be visible either by open-end drain pipe or sight drain fitting. Provide permanent metal signage at each test valve installation.

2.03 WATER PIPING ACCESSORIES:

- A. GATE VALVES: Shall be manufactured in accordance with AWWA C500 and shall have a rated water working pressure of 200 PSI. Gate valves shall be iron body, bronze mounted, double disc, parallel seat, non-rising stem type. Each valve shall have "O" ring type stem seal, standard 2 inches AWWA square operating nut, and shall be opened by COUNTER-CLOCKWISE stem rotation. Valves shall connect directly with PVC Pipe using elastomeric gaskets. Valve weight shall not be carried by PVC pipe. Weight shall be supported by a concrete cradle or concrete block with anchors.

2.04 TAMPER SWITCHES

- A. Provide tamper switches for all above grade and interior building shut-off valves and coordinate fire alarm connections for all switches.

2.05 WATER FLOW INDICATOR SWITCHES

- A. Provide water flow indication switches for all zones and systems of the sprinkler installations. Coordinate all fire alarm connections and zones.

2.06 FIRE ALARM (PANEL)

- A. The CONTRACTOR shall provide all wiring and interlocks as required for connection to the building fire alarm system for new and existing replaced tamper and flow switches.

2.07 MISCELLANEOUS EQUIPMENT AND ACCESSORIES

- A. Piping and fittings: Refer to Section Pipes and Pipe Fittings.
- B. Pipe Hangers and Seismic Restraints: Use types indicated as acceptable in NFPA 13 and Section Supports and Anchors. Galvanized hangers materials and fasteners shall be utilized in outdoor and exposed to view indoor applications.
- C. Provide separate NEMA 1 box with two (2) spare sprinkler heads of each type utilized, wrench(es) to install same, and wall mount in a location adjacent to main building riser.
- D. Piping Identification: See Section Mechanical Identification. All piping exposed to view and concealed everywhere shall be properly labeled.
- E. Fire Stopping: Section Basic Mechanical Materials and Methods
- F. Coordination: Section Basic Mechanical Requirements and Basic Mechanical Materials and Methods

- G. Insulation: Section Mechanical Insulation
- H. Fire Alarm Interactions: Division 28 Specifications and NFPA requirements.
- I. Seismic Restraint: See Section Mechanical Seismic and Wind Restraints

PART 3 - EXECUTION

3.01 GENERAL PIPING INSTALLATION:

- A. Install pipe, fittings, and hangers where shown on drawings in accordance with NFPA No. 13 and NFPA 231C.
- B. Cutting Structural Members: Cutting of structural members for the passage of sprinkler piping or for pipe-hanger fastenings will not be permitted unless approved by metal building vendor and/or STRUCTURAL ENGINEER.
- C. Holes through Walls, Floors, and Ceilings: Where sprinkler pipes pass through walls, floors, and ceilings, the holes shall be large enough to accommodate pipe expansion. Provide chrome plated escutcheon at each hole to ensure the effectiveness of the floor or wall as a fire stop. Provide fireproof material around pipes to maintain fire integrity as per Section Basic Mechanical Materials and Methods. Expansion and Contraction: Provide long runs of pipe with means to permit free movement resulting from expansion and contraction.
- D. Reducers: Make reductions in pipe sizes with one-piece reducing fittings. Bushings not acceptable, except that when one-piece reducing fittings of proper size are not obtainable, single bushings of the face type will be permitted up to 5 percent of total number of reducing fittings in the system. Where face bushings are used, install with outer face flush with the face of fitting opening being reduced.
- E. Couplings: Couplings not to be used except where length of pipe between fittings exceeds 20 feet.
- F. Flanged Fittings: Use flanged fittings in the control valve and drain assembly at base of risers of multiple-story sprinkler systems at each floor-system connection. Where part of a sprinkler system is on the opposite side of a wall or partition, a flanged connection may be used.
- G. Unions and Companion Flanges: Use ground-joint malleable iron unions in looped sprinkler systems where pipe is 2 inches in diameter or smaller. Where loops are larger than 7 inches are used, install companion flanges.

3.02 SEISMIC RESTRAINTS

- A. All piping associated with Life Safety systems, including fire protection sprinkler systems: $I_p=1.5$.
- B. Install seismic restraint devices per the manufacturer's submittals and per NFPA 13 requirements. Any deviation from the manufacturer's instructions shall be reviewed and approved by the Engineer whose stamp appears on the calculations and shop drawings.
- C. Attachment to structure for suspended equipment and pipe: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

- D. Wall penetrations may be used as bracing locations provided the wall can provide adequate resistance without significant damage.
- E. Coordinate sizes and locations of cast-in-place inserts for post-tensioned slabs.
- F. Provide hanger rod stiffeners where indicated or as required to prevent buckling of rods due to seismic forces.
- G. Where rigid restraints are used on equipment, piping, or support rods for the equipment, ductwork or piping at restraint locations they must be supported by anchors rated for seismic use. Post-installed concrete anchors must be in accordance with ACI 355.2.

3.03 TESTS

- A. Upon completion and prior to the acceptance of the installation, subject the system to the tests required by Fire Department Authorities and the OWNER'S insurance company and NFPA 13, and subsequently furnish the OWNER with a certificate as acceptable by same, indicating the CONTRACTOR certifies the sprinkler system is completely operable and conforms to local and national code requirements, specifically NFPA 13 (Material and Test Certificates).

3.04 SYSTEM TESTING:

- A. The CONTRACTOR shall test the system and controls, relief valves, etc., as it pertains to proper operation in conjunction with a new or existing system fire pump, fire alarm, system, dry pipe or anti-freeze loop, etc. CONTRACTOR shall provide any and all equipment and installations necessary to provide a fully operable system conforming to the latest codes and standards. CONTRACTOR to report all discrepancies and concerns to ENGINEER-OF-RECORD.

3.05 OWNER'S TRAINING:

- A. The CONTRACTOR in conjunction with the Owner Training requirements of Section *Basic Fire Protection Requirements*, shall train the OWNER'S personnel in the proper use, testing, operation and maintenance of all new and renovated fire protection sprinkler systems. These training session(s) shall be coordinated through the TAB Agency, designated OWNER'S representative and A/E.
- B. The CONTRACTOR shall furnish to the ARCHITECT, a letter from the OWNER indicating his staff has received adequate training in the proper use and maintenance of the fire protection sprinkler systems.

END OF SECTION

SECTION 22 00 10

PLUMBING GENERAL PROVISIONS

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material, equipment and labor, etc., required to complete installation specified herein and/or shown or scheduled on Contract Drawings.

1.02 PLUMBING SPECIFICATION SECTION INDEX

- A. Division 22 - Plumbing
 - 1. Section 22 00 10 - Plumbing General Provisions
 - 2. Section 22 00 20 - Basic Plumbing Requirements
 - 3. Section 22 00 30 - Plumbing Submittals and Shop Drawings
 - 4. Section 22 00 40 - Plumbing Close-out Requirements
 - 5. Section 22 00 50 - Basic Plumbing Materials and Methods
 - 6. Section 22 01 40 - Plumbing Supports and Anchors
 - 7. Section 22 01 90 - Plumbing Identification
 - 8. Section 22 02 50 - Plumbing Insulation
 - 9. Section 22 10 60 - Plumbing Pipes and Pipe Fittings
 - 10. Section 22 11 00 - Plumbing Valves
 - 11. Section 22 11 20 - Plumbing Piping Specialties
 - 12. Section 22 44 30 - Plumbing Specialties
 - 13. Section 22 44 40 - Plumbing Fixtures, Trim and Accessories

1.03 ABBREVIATIONS

- A. A/E ARCHITECT; ENGINEER AND OTHER PROFESSIONALS OF RECORD for this project
- B. A.S.A.P. As Soon As Possible
- C. CFH Cubic Feet Per Hour
- D. ft. Foot or Feet
- E. F.F.E.C. Food Facilities Equipment Contractor
- F. HP Horsepower
- G. i.e. That is
- H. in. w.g. Inches Water Gauge
- I. N.C. Normally closed
- J. N.O. Normally open
- K. p.p.m. Parts per Million
- L. PVC Poly Vinyl Chloride
- M. s/s Stainless Steel

- N. TAB Testing, Adjusting and Balancing
- O. UL Underwriters Laboratories
- P. vs. Versus
- Q. W.P.D. Water Pressure Drop

1.04 DEFINITIONS

- A. ARCHITECT: Architectural Design firm or ARCHITECT OF RECORD, meaning general building designer whose professional seal appears on the majority of general construction Contract Documents, or their authorized representative.
- B. ENGINEER (ENGINEER-OF-RECORD): ENGINEER whose professional stamp appears on Contract Drawings, etc. In general, unless specifically denoted otherwise, ENGINEER-OF-RECORD Plumbing Specification Sections denotes MECHANICAL ENGINEER-OF-RECORD.
- C. Exposed, or exposed to view: Those installations which can be seen, in whole or part.
- D. Finished Spaces: Inside the building extents.
- E. Inspect and/or Inspection: Utilized for the PROFESSIONAL'S construction period services and defines as "visits by the PROFESSIONAL to the Project at appropriate intervals during construction to become generally familiar with the progress and quality of the CONTRACTOR'S work and to determine if the work is proceeding in accordance with the Contract Documents."
- F. Outside: Synonymous with outdoors, outside of building, exposed to weather, etc.
- G. Plans: Denotes general Construction Drawings prepared by the A/E.
- H. PROFESSIONAL: Authorized representative of ENGINEER-OF-RECORD'S firm.
- I. Provide: Unless specifically denoted otherwise, the CONTRACTOR referred to shall be responsible for furnishing, providing, installing, connecting, and making item or system fully functional in a safe manner as recommended by the manufacturer and by Industry Standards.

1.05 APPLICABLE STANDARDS

- A. The intent is that the complete installation shall comply with applicable laws and ordinances, utility company regulations, and applicable requirements from the latest edition of the following:
 - 1. ANSI - American National Standard Institute
 - 2. ASME - American Society of Mechanical Engineers
 - 3. ASTM - American Society of Testing Materials
 - 4. ICC - International Code Congress
 - 5. NFPA - National Fire Protection Association
 - 6. OSHA - Occupational Safety and Health Administration
 - 7. UL - Underwriters Laboratories

8. City of Jackson, Mississippi, Fire, Building, Gas, Plumbing and Mechanical Codes and Regulations, and governing authority having jurisdiction.
9. Other applicable building, safety or fire codes having jurisdiction over equipment, materials or methods. The decision of the ENGINEER will be final in event of dispute over Code to use or its interpretation.

1.06 GENERAL CONDITIONS

- A. The General Conditions, Information to Bidders, and other pertinent documents issued by the ARCHITECT are a part of these Specifications and shall be complied with in every respect. Comply with Division 00 "Procurement and Contracting Requirements" Documents and Division 01 "General Requirements" Sections.
- B. By the act of submitting a bid, this CONTRACTOR agrees that all of the Contract Documents and each of the divisions of the complete Specifications have been reviewed and studied, and all requirements and coordination resulting there from are included.
- C. This CONTRACTOR shall conform to standards prescribed by City, County, and State regulations or ordinances having jurisdiction. Any changes that may be necessary to conform to such regulations or ordinances shall be made by this CONTRACTOR without extra costs to the OWNER. Where code requirements are less than those shown on the Plans or in the Specifications, the Plans and Specifications shall be followed. Where applicable, NFPA requirements shall be met.
- D. The CONTRACTOR shall comply with all applicable provisions of the William-Steiger Occupational Safety and Health Act (O.S.H.A.).
- E. Permits required for the installation of the work, as well as all authorized code inspections, including all fees and assessments, shall be borne by and arranged for by the CONTRACTOR. The CONTRACTOR shall verify specific mechanical related provisions for permitting in advance, especially where additional design/installation documentation may be required, and include provisions and/or cost of same in this bid.
- F. This 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, required or implied, for the completion of the various systems.

1.07 EXPLANATION AND PRECEDENCE OF DRAWINGS

- A. For purposes of clearness and legibility, Drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale whenever possible, the CONTRACTOR shall make use of all data in the Contract Documents and shall verify this information at building site.
- B. Do not scale drawings having 1/4 inch or smaller scale. The Drawings indicate required size and points of termination of pipes, and suggest proper routes of pipe to conform to structure, avoid obstructions and preserve clearances. Because of small scale, it is not intended that Drawings indicate all necessary offsets, and it shall be the work of this Section to install work in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear without further instruction or cost to the OWNER.
- C. It is intended that all apparatus be located symmetrically with architectural elements, and shall be installed at exact height and locations as shown on the Architectural Drawings.

- D. The CONTRACTOR shall be solely responsible for taking his own measurements and installing his work to suit conditions encountered.

1.08 SPECIAL CONDITIONS, PLUMBING

- A. The right is reserved to move any element as much as ten (10) feet at no increase in cost provided CONTRACTOR is notified before work in question is fabricated or installed.
- B. The CONTRACTOR shall fully inform himself regarding any and all peculiarities and limitations of spaces available for the installation of all work and materials furnished and installed under the Contract. He shall exercise due and particular caution to determine that all parts of his work are made quickly and easily accessible. The CONTRACTOR shall be guided by the architectural details and conditions existing at the job, correlating this work with that of the other trades, and report to the OWNER any discrepancies or interferences that are discovered. Failure to report such discrepancies and interferences shall result in the correcting of these errors or omissions by the CONTRACTOR at his own expense. All work which deviates from the Drawings and Specifications without prior approval of the OWNER, shall be altered by the CONTRACTOR at his own expense to comply with the Drawings and Specifications as directed.
- C. If equipment or fixtures to be furnished by OWNER and/or OWNER'S vendor are not delivered prior to final acceptance, services shall be capped or plugged at walls or floor as directed by ARCHITECT, ready for future connection.
- D. The CONTRACTOR shall coordinate his work with that of the OWNER, in order that there will be no delay in the proper installation and completion of the work. If, in the opinion of the OWNER, any piping, equipment, etc., has been improperly placed or installed due to lack of coordination with the other trades, such piping and equipment shall be relocated as directed by the OWNER at the CONTRACTOR'S expense.

1.09 SITE SAFETY

- A. CONSULTANT'S site responsibilities are limited solely to the activities of CONSULTANT and CONSULTANT'S employees on site. These responsibilities shall not be inferred by any party to mean that CONSULTANT has responsibility for site safety. Safety in, on, or about the site is the sole and exclusive responsibility of the CONTRACTOR alone. The CONTRACTOR'S methods of work performance, superintendence of the CONTRACTOR'S employees and sequencing of construction are also the sole and exclusive responsibilities of the CONTRACTOR alone. The CONTRACTOR shall, to the fullest extent permitted by law, waive any claim against CONSULTANT and his employees and indemnify, defend, and hold CONSULTANT harmless from any claim or liability for injury or loss arising from CONSULTANT'S alleged failure to exercise site safety responsibility. The CONTRACTOR also shall compensate CONSULTANT for any time spent or expenses incurred by CONSULTANT in defense of any such claim. Such compensation shall be based upon CONSULTANT'S prevailing fee schedule and expense reimbursement policy. The term "any claim" used in this provision means "any claim in contract, tort or statute alleging negligence, errors, omissions, strict liability, statutory liability, breach of contract, breach of warranty, negligent misrepresentation, or other acts giving rise to liability."

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 WORKMANSHIP, MATERIALS AND EQUIPMENT

- A. All work shall be performed in a workmanlike manner and shall present a neat and mechanical appearance when completed. All materials shall be of type, quality and minimum rating prescribed herein or indicated on the Contract Drawings.
- B. If equipment or fixtures to be furnished by OWNER and/or OWNER'S vendor are not delivered prior to final acceptance, services shall be capped or plugged at walls or floor as directed by ARCHITECT, ready for future connection.

3.02 CLEAN-UP

- A. Do not allow mechanical related waste material or rubbish to accumulate in or about job site.
- B. At completion of work, remove all rubbish, tools, scaffolding and surplus materials from and about building, leaving work clean and ready for use without further cleaning required. Clean all equipment, piping, valves, fixtures, and fittings of grease, metal cuttings, insulation cement, dust, dirt, paper labels, etc.
- C. Any discoloration or other damage to parts of building, its finish or furnishings due to failure to properly clean or keep clean mechanical systems shall be repaired without additional cost to OWNER.
- D. All equipment, fixtures and installations, especially where installations are exposed to view, shall be thoroughly cleaned, polished, seams smoothed and/or sealed for a neat appearance.

3.03 INSPECTION OF PROPOSED CONSTRUCTION

- A. Prior to submitting his bid, the CONTRACTOR shall visit the site of the proposed construction and shall thoroughly acquaint himself with existing utilities, working conditions to be encountered, etc. No additional compensation shall be allowed for conditions increasing the CONTRACTOR'S cost which were not known or appreciated by him when submitting his proposal if the condition was obvious and could have been discovered by him if he had visited the project site and thoroughly informed himself of all existing conditions which would affect his work, including requirements of local authorities to meet their procedures, special requirements, codes, etc.
- B. Refer to Document 00 21 13 "Instruction to Bidder", Article 1.05 "Examination of Proposal and Site"; Paragraphs A. through C.

3.04 EXISTING UTILITIES AND SERVICES

- A. When encountered in work, protect existing active sewer, water, gas, electric, other utility services, structures; where required for proper execution of work, relocate them as directed. If existing active services are not indicated, contact PROFESSIONAL for instructions.

- B. When encountered in work area, whether or not indicated, cap or plug or otherwise discontinue existing inactive sewer, water, gas, electric, other utility service structures, of which action should be taken. If removal is required, request instructions from PROFESSIONAL.
- C. While work is in progress, except for designated short intervals during which connections are to be made, continuity of service shall be maintained to all existing utilities and systems. Interruptions shall be scheduled and coordinated with ARCHITECT and OWNER and approved in advance with the OWNER and serving utilities. If requested, downtime shall be limited to weekends and/or night periods to least disrupt normal use of these utilities. The CONTRACTOR shall be responsible for any interruptions to service and shall promptly repair any damages to existing systems caused by his operations.
- D. The accuracy of the location of existing underground, and otherwise concealed, domestic, sanitary and storm drainage utilities is not guaranteed. The CONTRACTOR shall, early in the project, prior to demolition of existing work and layout of new work, verify all underground and concealed work in the proximity of connections to existing services and routings.
- E. Immediately upon commencing construction, and prior to construction of any part of the facility involved in any way with utilities, the CONTRACTOR shall investigate thoroughly the size, capacity, arrangement and location of all mechanically related utilities. The CONTRACTOR shall immediately report any discrepancies or apparent problem involving the project that pertains to utilities. This applies to private as well as public utilities. This CONTRACTOR shall coordinate and utilize the services of public and private "locators" to ascertain the whereabouts of all underground utilities in the area where work is to be performed.

END OF SECTION

SECTION 22 00 20

BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE

- A. Furnish all labor, materials, services, and equipment required to complete the installation of complete and acceptable mechanical systems in accordance with these specifications and the Contract Drawings.

1.02 TESTS

- A. This CONTRACTOR shall conduct such tests as required to determine that systems and equipment, which he installs, conform to Specifications. CONTRACTOR shall supply all labor, materials, instruments, operations, etc., required to facilitate testing.
- B. Gages, thermostats, and instruments used in testing shall be accurate, recently calibrated and approved by the PROFESSIONAL prior to test. Instruments installed permanently in systems as specified herein may be used in testing when approved by the ENGINEER.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 MISCELLANEOUS WORK REQUIRED

- A. The CONTRACTOR shall bring adequate power to and make final connections to all equipment furnished under this Contract.
- B. All items of labor, materials and equipment not specifically stated herein or on Contract Drawings to be by others are required to make the systems complete and operative, shall be by this CONTRACTOR.

3.02 PROTECTION OF EQUIPMENT AND MATERIALS

- A. Responsibility for care and protection of equipment and materials under this Contract rests with this CONTRACTOR until equipment or materials have been tested and accepted.
- B. All pipe ends, valves, and parts of equipment left unconnected, permanently or temporary, shall be capped, plugged or properly protected at the end of each working day to prevent entry of foreign matter.
- C. Damaged equipment shall be repaired or replaced at the option of the PROFESSIONAL. Finishes and/or scratched paint on equipment, etc., shall be repaired and repainted to match new condition(s).
- D. This CONTRACTOR shall protect his work at all times from danger by freezing, breakage, dirt, foreign materials, etc., and shall replace all work so damaged. The CONTRACTOR shall use every precaution to protect the work of others, and he will be held responsible for all damage to other work caused by his work or through the neglect of his workmen.

3.03 INSTALLATION COORDINATION

- A. The plumbing plans do not give exact elevations or locations of lines, nor do they show all the offsets, control lines, or other installation details. The CONTRACTOR shall carefully lay out his work at the site to conform to the structural conditions, to provide proper grading of lines, to avoid all obstructions, to conform to details of installation supplied by the manufacturers of the equipment to be installed, and to thereby provide an integrated, coordinated and satisfactory operating installation.
- B. If the CONTRACTOR proposes to install equipment, including piping requiring space conditions other than those shown, or to rearrange the equipment, he shall assume full responsibility for the rearrangement of the space and shall have the ARCHITECT review the change before proceeding with the work. The request for such changes shall be accomplished by shop drawings of the space in question.
- C. The CONTRACTOR shall so coordinate the work of the several various trades that it may be installed in the most direct and workmanlike manner without hindering the other trades. Piping interferences shall be handled by giving precedence to pipe lines, which require a stated grade for proper operation. For example sewer lines and condensate piping shall take precedence over water lines in determination of elevations. Where there is interference between sewer lines and condensate lines, the sewer lines shall have precedence and provisions shall be made in the condensate lines for looping them around the sewer lines. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork.
- D. Piping or equipment shall not be installed in electrical equipment rooms or elevator machine rooms except as serving only those rooms. Outside of electrical equipment rooms, do not run piping, or locate equipment, with respect to switchboards, panel boards, power panels, motor control centers or dry type transformers:
 - 1. Within 42 inches in front (and rear if free standing) of equipment; or
 - 2. Within 36 inches of sides of equipment.
 - 3. Clearances apply vertically from floor to structure/ceiling.

3.04 INSTALLATION DIRECTIONS

- A. Obtain manufacturer's printed installation directions to aid in properly executing work on equipment requiring such directions. Submit such directions and installation details to PROFESSIONAL for approval prior to time of installation for use in supervising work. If the manufacturer's installation instructions or details conflict with the Contract Document requirements, CONTRACTOR shall promptly make PROFESSIONAL aware in writing and request clarification.

3.05 PLUMBING VERIFICATION AND INSPECTIONS

- A. The CONTRACTOR shall coordinate, with the A/E with a minimum ten (10) days advance notice, the inspection of mechanical sub-systems for the following:
 - 1. in-wall piping
 - 2. above ceiling piping
 - 3. in-attic ceiling piping

These inspections shall be coordinated prior to wall and/or ceiling/attic insulation installation, (concealment) etc., such that these mechanical installations can be easily visually inspected by A/E for general conformance with Contract requirements. These installations shall not be concealed until such time the A/E indicates these mechanical installations are acceptable. If a re-inspection is required, an A/E revisit and a follow-up inspection shall be similarly coordinated with sufficient advance notice as approved by the A/E. Therefore, it is pertinent for the CONTRACTOR to inspect these type installations himself and verify that these installations are complete and in conformance with specified standards to minimize any time delays and/or coordination of construction sequencing, etc.

- B. The CONTRACTOR should note the following requirement for administering the punch list(s) and mechanical closeout documents associated with a substantial completion and/or final, etc. In general, the punch list(s) will be furnished with blanks for the CONTRACTOR and/or his Sub-Contractor(s) to initial and date, adjacent to each item, for coordination and verification efforts. The completed punch list shall be transmitted to A/E to allow them to thereafter schedule a follow-up visit for re-inspection and verification. It is, therefore, prudent for the CONTRACTOR, to administer the overall process, and verify that all punch list items are complete and in compliance with Contract requirements, prior to requesting a follow-up A/E inspection effort.
- C. The CONTRACTOR shall be liable for inspections and further administrative involvement required of the A/E after 30 days of the original scheduled completion date, and for re-inspections and involvement by the A/E caused by the CONTRACTOR'S negligence and failure to fully complete punch lists and Closeout Documents when required and/or requested.

END OF SECTION

SECTION 22 00 30

PLUMBING SUBMITTALS AND SHOP DRAWINGS

PART 1 - GENERAL

1.01 SUBMITTALS AND SHOP DRAWINGS

- A. The submittal data to be furnished for this project shall comply with the Specifications and Contract Documents in their entirety.
- B. CONTRACTOR shall submit to the ARCHITECT/ENGINEER list of materials, fixtures and equipment to be utilized for this project.
- C. Failure to submit data for approval within specified time limits will result in the CONTRACTOR being required to furnish equipment as called for by name.
- D. Reproduction of design documents in any portion for use in a submittal is not acceptable.
- E. Whether or not the CONTRACTOR is utilizing the equipment as called for by name or not, does not relieve the CONTRACTOR of providing submittals. Submittals shall be required for all equipment as directed herein and as directed by the PROFESSIONAL.
- F. CONTRACTOR shall not delegate the authority to material supply houses to present data for approval. This shall be done by the CONTRACTOR.
- G. Materials/equipment not initially submitted, incomplete, or rejected shall be revised and re-submitted within twenty (20) days. The same format is required for all resubmitted data.
- H. All Submittals and Shop Drawings shall be thoroughly reviewed for general conformance with Contract Documents and with other crafts/trades.
- I. The CONTRACTOR shall verify with local governing authority and provide all additional documentation required to obtain permanent permit for this project. This shall include, but not limited to, plumbing, HVAC and fire protection risers, details, calculations, etc. Should an ENGINEER'S stamp or specific designer's credentials also be required on this supplemental design and/or installation documentation, the CONTRACTOR shall comply. The cost of all such extended documentation shall be considered a normal part of the shop drawing for installation coordination documentation, and the full cost of same shall be included in the CONTRACTOR'S base bid.
- J. CONTRACTOR's Selection of Materials and Equipment:
 - 1. Where a definite material or brand name is specified, it is not the intent to discriminate against any product of another manufacturer. Reference to a specific manufacturer's product by name, make or catalog number is intended to establish standards of quality, design, dimensions and appearance.
 - 2. Open competition is expected, but in all cases, complete data must be submitted on all proposed substitutions and samples shall be submitted for comparison and test when requested by the PROFESSIONAL. Burden of "proof of equality" lies solely with the CONTRACTOR.

3. 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 ascertain if the submitted materials and equipment will fit into the space allotted as conveniently as the materials and equipment utilized as the basis of design. Furthermore, the CONTRACTOR 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 PROFESSIONAL, the CONTRACTOR shall install items specified even though materials and equipment had been previously approved. PROFESSIONAL'S approval of materials and equipment other than the basis of design is for performance only.
 4. When submitting materials and equipment other than the basis of design, the CONTRACTOR should note the following minimum considerations: (1) capacities shown are absolute minimum and must be equaled, (2) physical size limitation for space allotted, (3) static and dynamic weight limitation, (4) structural properties, (5) noise level, (6) vibration generation, (7) interchangeability, (8) accessibility for maintenance and replacement, (9) compatibility with other materials, assemblies, and (10) similar items shall be same manufacture and style whenever possible.
 5. The availability of service is of prime importance to the OWNER and was a major consideration in selecting the materials and equipment that are listed as the basis for design. The CONTRACTOR is advised, therefore, to exercise caution in accepting prices in the "or equal" clause in this specification. Competent service must be available.
 6. All material and equipment, for which a U.L. Standard, and AGA approval, or an ASME requirement is established, shall be so approved and labeled or stamped.
- K. Submittal format and information shall be provided as follows:
1. Submittals for and plumbing data shall be bound containing one copy of all specified submittals. Complete submittals may also be submitted electronically. **FAILURE TO BIND AND IDENTIFY SUBMITTALS WILL RESULT IN THE AUTOMATIC REJECTION OF THE SUBMITTAL DATA WITH NO EXCEPTION. ANY PARTIAL SUBMITTALS WILL BE RETURNED TO THE CONTRACTOR FOR RE-SUBMITTAL. ONLY COMPLETE SUBMITTALS WILL BE ACCEPTABLE.**
 2. All submitted equipment must be identified with same "Mark Numbers" as identified on Drawings or in Specifications.
 3. Reference to all pertinent data such as electrical characteristics and horse power, capacities, construction material of equipment, UL labels where required, accessories specified, manufacturer, make and model number, weights where specified, size and characteristics of the equipment, name of the project and a space large enough to accept an approval stamp.
 4. The bound submittals shall be provided with an identification tab for each and every Specification Section that requires submittals. Each item in each tabbed section shall be identified with the paragraph number relating to the item submitted by the use of a cover sheet or by high lighting the paragraph on the first page concerning the item.
 5. Any deviation from any part of the Contract Documents shall be clearly and completely highlighted.
 6. Each and every submittal shall be stamped by the CONTRACTOR confirming that the submittals have been checked for compliance with the Contract Documents.

1.02 SAMPLES AND MOCK-UPS OF PROPOSED INSTALLATION

A. Samples:

1. The CONTRACTOR shall furnish samples of equipment, components, control devices, etc. as requested by the PROFESSIONAL.
2. These samples are intended to demonstrate quality of construction of proposed installation materials and/or equipment.
3. In general, each substitution request made by the CONTRACTOR will likely require a sample be furnished for review. However, in some cases, samples will be requested of specified equipment, components, control devices, etc. in order to demonstrate to the Owner the particular installations proposed.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 SUBMITTALS AND SHOP DRAWINGS

- A. The following list of materials and equipment shall be submitted to PROFESSIONAL for approval:

- B. SUBMITTALS ARE REQUIRED FOR THE FOLLOWING WITHIN 30 DAYS AFTER PROJECT "NOTICE TO PROCEED":

1. SECTION 22 00 50 - BASIC PLUMBING MATERIALS AND METHODS
 - a. Fire Stopping for Piping and Conduit
 - b. Wall and Plenum Access Doors
 - c. Welders Test and Certification
2. SECTION 22 01 90 - PLUMBING IDENTIFICATION
 - a. List and Size/Color(s) of all Starter, Switch, Disconnect Switch, Time clock and Equipment and Warning Phenolic Labels
 - b. Piping Markers
 - c. Underground Tracer Identification Tape
3. SECTION 22 02 50 - PLUMBING INSULATION
 - a. Insulation for all piping applications
 - b. Piping fitting insulation and cover
 - c. Vinyl cover
4. SECTION 22 10 60 - PIPE AND PIPE FITTINGS
 - a. Sanitary Waste and Vent Piping Fittings and Connections
 - b. Storm Drain Piping (Rain Leader) Fittings and Connections
 - c. Condensate Drain Piping Fittings and Connections
 - d. Domestic Water Piping Fittings and Connections
 - e. Natural Gas Piping Fittings and Connections
 - f. Refrigerant Piping Fittings and Connections
 - g. Equipment Utility and Relief Drain Piping Fittings and Connections
 - h. Grease Waste Piping Fittings and Connections
 - i. Lab Waste and Vent Piping Fittings and Connections
5. SECTION 22 11 00 - VALVES
 - a. Manual "Circuit-Setter" Balancing Valves
 - b. Ball Valves
 - c. Gas Valves
 - d. Check Valves

6. SECTION 22 44 30 - PLUMBING SPECIALTIES
 - a. Cleanouts
 - b. Floor Drains
7. SECTION 22 44 40 - PLUMBING FIXTURES, TRIM & ACCESSORIES
 - a. Plumbing Fixtures and Trim
 - b. Carriers
 - c. Handicapped Drain/Water Supply Insulation Protectors
 - d. Hose Bibbs
 - e. Water Hammer Arrestors
 - f. Ice maker Boxes

END OF SECTION

SECTION 22 00 40

PLUMBING CLOSE-OUT REQUIREMENTS

PART 1 - GENERAL - NOT APPLICABLE

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 AS-BUILT DRAWINGS

- A. Refer to Section 01 78 39 – PROJECT RECORD DOCUMENTS and comply with requirements therein.

3.02 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Section 01 78 23 – OPERATION AND MAINTENANCE DATA and comply with requirements therein.

3.03 OWNER TRAINING

- A. OWNER Representative Training and Operating and Maintenance instructions
 - 1. During the last phase of the project, the CONTRACTOR, in conjunction with the Controls and MECHANICAL (Sub) CONTRACTORS shall coordinate and facilitate the start-up, Testing, Adjusting and Balancing, and subsequent OWNER'S representatives training and instructions.
 - 2. The OWNER Training shall be administered by the CONTRACTOR, with special training/instructions from equipment technical representatives, CONTRACTOR qualified representatives, etc.
 - a. The training and instructions for the OWNER will include a complete walk-through of the facility, review of all mechanically related systems, and comprehensive training of the pertinent operating and maintenance requirements.
 - b. This shall include an overview of system components and descriptions, seasonal provisions/changes required, major valve location/function, safety provisions and concerns, normal operating and energy conservation techniques, actions to be taken with system failure or malfunction, start-up and shut-down instructions, normal operating parameters, etc.
 - c. The training/data shall include all pertinent data from industry standards, minimal recommendations indicated herein and further as recommended by each manufacturer's O&M manuals.
 - d. All equipment and material suppliers will also be expected to participate. The CONTRACTOR shall coordinate and schedule the OWNER'S training with the A/E and designated OWNER'S Representative(s).
 - e. Additional instruction and training sessions shall be provided subsequent to the initial session to provide additional training as required to fully train the OWNER'S operators.
 - 3. The CONTRACTOR shall submit to the PROFESSIONAL in draft form, an outline of the contents of this training, with agenda and list of pertinent training personnel, a minimum of thirty (30) days prior to project completion date and scheduling said training with the OWNER and PROFESSIONAL.
 - 4. When the seminar and subsequent instruction periods are completed, CONTRACTOR shall furnish ARCHITECT a letter signed by the OWNER certifying that his representative(s) has received adequate instruction in operation of installed

equipment and systems. This letter shall be furnished prior to final acceptance of this project.

B. Some suggestions for pertinent subject matter to include in the administration of the training of OWNER'S operation and maintenance personnel, is as follows:

1. Potable Water Heaters and Accessories:
 - a. Normal setpoint and adjustment for water temperature from heater
 - b. Normal setpoint and seasonal adjustment for water temperature from mixing valve, along with safety/use instructions
 - c. Periodic maintenance for mixing valve
 - d. Periodic maintenance for recirculating pumps
 - e. Routine inspection of flue piping and discharge cap for soot build-up on gas fired hoods.
 - f. Function and periodic maintenance of T&P relief valve.
 - g. Function and periodic maintenance of anode rods.
 - h. Cleaning of filters and/or adjusting and maintaining tankless gas water heaters per manufacturer's recommendations.
2. General:
 - a. Warranties: Explain the various warranties. Explain to OWNER his role during the warranty period(s), his limitations who he is to call when a problem tied to a warranty issue occurs, for both the one year standard warranty and extended warranties, etc.
 - b. Special tools and spare parts
 - c. Purpose of O & M Manuals (spare parts, O & M manufacturer's recommendations, trouble-shooting, etc.)
 - d. Purpose of roof mounted hydrant.

3.4 CLOSEOUT DOCUMENTATION

- A. Seven (7) days prior to requesting a final inspection, the CONTRACTOR shall submit all O&M and closeout documentation to the ARCHITECT, to be turned over to the OWNER at the end of the project.
- B. The following checklist 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 fax or email copy of the completed checklist to the PROFESSIONAL prior to final inspection request.

<u>CLOSEOUT DOCUMENTATION CHECKLIST</u>		
<u>PLUMBING</u>		
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)
		MECHANICAL PLUMBING OPERATION & MAINTENANCE MANUALS (3 EACH)
		AS-BUILT DRAWINGS WITH CONTRACTOR'S STAMP (3 EACH)

		EXTENDED WARRANTIES: (SEE SECTION <i>MECHANICAL SYSTEMS AND EQUIPMENT WARRANTIES</i>)
		POTABLE WATER SANITATION REPORT AND CERTIFICATION
		SEISMIC RESTRAINT MANUFACTURER'S REPRESENTATIVE CERTIFICATION THAT ALL INSTALLATIONS HAVE BEEN INSTALLED PER MANUFACTURER'S RECOMMENDATIONS. SEE SECTION <i>MECHANICAL SEISMIC AND WIND RESTRAINTS</i> .
		PIPE TEST LOG - FORM IN SECTION <i>PIPE AND PIPE FITTINGS</i> TO BE COMPREHENSIVELY FILLED OUT.
		VALVE TAG AND FLOOR PLAN LOCATION CHARTS. SEE SECTION <i>MECHANICAL IDENTIFICATION</i> .
		KEYS TO ACCESS DOORS PER SECTION <i>BASIC PLUMBING MATERIALS AND METHODS</i> (PROVIDE WRITTEN RECEIPTS WITH OWNER'S ACCEPTANCE).
		KEYS TO PLUMBING STOPS AND HOSE BIBB BOXES PER SECTION <i>BASIC PLUMBING MATERIALS AND METHODS</i> AND SECTION <i>PLUMBING FIXTURES, TRIM AND ACCESSORIES</i> (PROVIDE WRITTEN RECEIPTS WITH OWNER'S ACCEPTANCE).
		PROVIDE SPARE AIR COMPRESSOR AIR FILTER CARTRIDGES (PROVIDE WRITTEN RECEIPTS WITH OWNER'S ACCEPTANCE)
		PROVIDE SPARE CIRCULATING PUMP SEALS (PROVIDE WRITTEN RECEIPTS WITH OWNER'S ACCEPTANCE)

END OF SECTION

SECTION 22 00 50

BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material, equipment and labor, etc., required to complete installation specified herein and/or shown or scheduled on Contract Drawings.
- B. The requirements of this section apply to all sections of Division 22.
- C. Definitions:
 - 1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms, including mechanical and/or equipment rooms.
 - 2. Option or Optional: CONTRACTOR'S choice of an alternate material or method.

1.02 PRODUCTS CRITERIA

- A. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
- B. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
- C. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or otherwise permanently marked on each item of equipment.

1.03 FLAME SPREAD AND SMOKE DEVELOPED PROPERTIES OF MATERIALS

- A. Materials and adhesives used throughout the mechanical and electrical systems for insulation, and jackets or coverings of any kind, or for piping or conduit system components, shall have a flame spread rating not over 25 without evidence of continued combustion and with a smoke developed rating not higher than 50. If such materials are to be applied with adhesives, they shall be tested as applied with such adhesives, or the adhesives used shall have a flame spread rating not over 25 and a smoke developed rating not higher than 50. (Note: Materials need not meet these requirements where they are entirely located outside of a building and do not penetrate a wall or roof, and do not create an exposure hazard.)
- B. "Flame-Spread Rating" and "Smoke Developed Rating" shall be as determined by the "Method of Test of Surface Burning Characteristics of Building materials," NFPA No. 255, ASTM E84, Underwriter's Laboratories, Inc., Standard". Such materials are listed in the Underwriters' Laboratories, Inc., "Building Materials List" under the heading "Hazard Classification (Fire)".

1.04 HAZARDOUS MATERIALS

- A. No products shall be used that contain any known hazardous or carcinogenic materials. Products with asbestos or radioactive content shall not be used.
- B. Handling of any hazardous material is not covered in this specification Division.

PART 2 - PRODUCTS

2.01 EQUIPMENT ACCESSORIES

- A. Provide removable guards to enclose all rotating or moving elements. Construct of galvanized steel to withstand 250 lbs. static load.
- B. Wall/Ceiling Access Doors (Required for Plumbing Equipment)
 - 1. Panels in non-rated applications shall be galvanized steel, 18 gage frame, 16 gage door with mounting accessories, continuous concealed hinge, screwdriver operated lock, and prime coat paint.
 - a. Equal to Acudor Model UF-5000 for acoustic tile or exposed masonry
 - b. Equal to Acudor Model PS-5030 for plaster finishes
 - c. Equal to Acudor Model UF-5000 (stainless steel) for ceramic or glazed structural tile.
 - 2. Panels in fire rated applications shall be painted steel type, 1 hour rated, piano hinged, exterior key lock, nominal size 24" x 36" at equipment installations as approved, equal to Air Balance, Inc. - Model "F".
 - 3. Do not duplicate. Coordinate with Section 21 00 50-Fire Protection Materials and Methods.

2.02 FIRE, SMOKE AND SOUND STOPPING

- A. UL listed penetration sleeve assembly and/or firestop that meets ASTM E-814 E119, and E84, as equal to "3M" systems for the intended applications.
- B. All fire, smoke and sound stopping to be done by a separate licensed and certified Subcontractor as approved by Professional.
- C. Do not duplicate. Coordinate with Section 21 00 50- Fire Protection Materials and Methods

2.03 PIPE SLEEVES

- A. Galvanized sheet metal sleeves shall have lock seam joints and comply with the following minimum thickness:
 - 1. 24 Gage for 3 inches and smaller.
 - 2. 22 Gage for 4 inches to 6 inches inclusive.
 - 3. 20 Gage for sizes over 6 inches.
- B. Galvanized steel sleeves shall be constructed from schedule 40 grade A53 pipe.
- C. Water tight sleeves/seals shall be equal to "Link-Seal".

2.04 WALL, FLOOR, AND CEILING PLATES

- A. Chrome plated brass, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve.
- B. The thickness shall conform to the following requirements:
 - 1. Not less than 3/32-inch for floor plates.
 - 2. For wall and ceiling plates, not less than 0.025 inch for up to 3-inch pipe and 0.035 inch for larger pipe.

- C. All escutcheons shall be equal to Beacon, Caldwell or approved equal.

2.05 PROTECTIVE DRIP PANS

- A. Fabricate pans of 20 gage galvanized sheet metal, stainless steel (if shown) or PVC, minimum two inches deep with rolled top edges.
- B. Solder all seams watertight, and cross brace pans to prevent sagging and warping.
- C. Provide dielectric union at copper pipe/galvanized pan connection point. Water heater drain pans shall have minimum one inch (1") drain outlet.

2.06 PAINTING OF PLUMBING WORK

- A. All required painting of plumbing work shall be by Division 09. See Division 09 for more information.
- B. See Section Plumbing Identification for color-coding of piping, etc. All other metal structure and hangers to be color of adjacent finish.

PART 3 - EXECUTION

3.01 EQUIPMENT ACCESSORIES

- A. Provide access panels, or doors, at concealed dampers, valves, vents, equipment, inspection points, etc., and where noted. Where ceiling is "lift out" construction, ceiling access panels are not required. Panels shall be 15" square, or larger as approved for service intended.
- B. CONTRACTOR shall provide substantial metal angle frame and support at all ceiling access doors.

3.02 FIRE, SMOKE AND SOUND STOPPING

- A. Fire and smoke stopping shall be provided and installed at all locations where mechanical Work passes thru rated assemblies. This includes all ductwork, piping and controls related conduit.
- B. Penetrations in "sound" 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.

3.03 PIPE SLEEVES

- A. Pipe sleeves shall be constructed of galvanized sheet steel except where noted below or in individual work sections.
- B. Pipe sleeves shall be constructed of galvanized steel pipe when pipes are located within or passing through the following:
 - 1. concrete beams
 - 2. waterproofed floors
 - 3. In locations where sleeve is extended above finished floor
- C. Where pipe motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe.

- D. Where pipes are insulated, make sleeves of sufficient diameter to pass pipe insulations.
- E. Check floor and wall construction and finish to determine proper length of sleeves for various locations, make actual length to suit following:
 - 1. Terminate sleeve flush with walls, partitions, and ceilings.
 - 2. In areas where pipes are concealed as in chases, terminate sleeves flush with floor.
 - 3. In finished areas where pipes are exposed, extend sleeves 1/4 inch above finished floor except in kitchen, toilets, equipment rooms, and other areas where water may accumulate on floor, extend 1-1/2 inch.
- F. 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.
- G. For drilled penetrations in existing floors provide one inch angle rings set in silicone sealant and bolted to the floor in lieu of pipe sleeves with one inch extension above floor.
- H. Below grade exterior wall penetrations into habitable spaces, including crawlspaces shall include sleeves with water tight seals as "Link-Seal".

3.04 WALL, FLOOR, AND CEILING PLATES

- A. Exposed piping passing through walls, floors and ceilings, shall be fitted with escutcheons.
- B. Inside diameter shall fit around insulation or around pipe when not insulated; outside diameter shall cover sleeve.
- 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.

3.05 PROTECTIVE DRIP PANS

- A. Provide pitched drip pans where shown under 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 shall be routed to a drain connection with discharge piped utilizing 3/4" or larger of copper tube to the nearest available open drain or outside as directed by PROFESSIONAL. Open-end slices discharging to intercepting pans are not acceptable.
- C. Provide drip/overflow pans under water heaters, pumps, etc., and where shown.

3.06 PAINTING OF PLUMBING WORK

- A. All equipment shall present a clean painted appearance; touch-up or repair as required.
- B. All surfaces shall be properly prepared prior to painting. CONTRACTOR must contact PROFESSIONAL, such that all tests, installations etc., are approved prior to painting.
- C. The CONTRACTOR shall prime (where applicable) and paint the following mechanical related Work:

1. New and modified piping outside and indoor exposed to view, including mechanical rooms, of the following types:
 - a. Natural Gas Piping (Note: Gas piping in Lab floor trench shall be pre-painted prior to installation)
 - b. Domestic Water Piping
 - c. Sanitary and Storm Drain/Vent Piping
 2. All exposed ferrous metal non-galvanized hangers, auxiliary supports, braces, etc., in all locations.
 3. All exposed access doors, fitting, boxes, etc.
 4. All pumps, valve bodies, etc., where exposed to view outdoors.
 5. All new or modified metal valve and metal box covers, gas meter/regulators, and the like. This includes items provided and installed by others, and existing on site installations.
- D. Refer to Section Plumbing Identification for color-coding of piping, etc. All other metal structure and hangers to be color of adjacent finish.

3.07 WELDING

- A. Before any welding is performed submit a copy of the Welding Procedure Specification (WPS) together with the Procedure Qualification Record as required by Section IX of the ASME Boiler and Pressure Vessel Code for each and every welder intended for use on this project and with qualifications and certifications suitable for work classification intended.
- B. Before any welder performs any welding, submit a copy of the Manufacturer's Record of Welder Operator Qualification Tests as required by Section IX of the ASME Boiler and Pressure Code. The letter or symbol (as shown on the qualification test form) shall be used to identify the work of that welder and shall be affixed, in accordance with appropriate construction code, to each completed weld. Submit certification according to Section Mechanical Submittals and Shop Drawings for each and every welder and welding associated with the project.
- C. The types and extent of non-destructive examinations required for pipe welds are shown in Table 146.4 of the Code of Pressure Piping ANSI/ASME B31.1.

3.08 TOOLS AND KEYS

- A. Furnish, and turn over to the OWNER, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Provide OWNER, at end of project with spare keys to stops, hose bibbs, control cabinets, tamper-proof controls covers, etc. Provide the following spares, and label with function/locations:
 1. Plumbing Stops - 8 keys
 2. Hose Bibbs - 8 keys
 3. Control Panels - 4 keys each panel
 4. Wall and Ceiling Access Doors - 2 keys per door

3.09 LUBRICATION

- A. During construction, all bearings and shafts shall be kept thoroughly greased and protected.
- B. After equipment has been operated seven days and before final acceptance, all bearings shall be inspected and filled to operating level with lubricant recommended by

manufacturer. Tag each piece of equipment with cloth tag showing: proper type of lubricant, and period between lubrications, date of lubrication, and worker's initials. Have space for ten (10) lubrication notations.

3.10 WORK IN AND AT EXISTING BUILDING AND/OR BUILDING SITES

- A. Perform as described or shown on Contract Drawings, for relocation of existing equipment, alterations and restoration of existing building(s).
- B. As specified on Contract Drawings, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
- C. It is important that CONTRACTOR thoroughly investigate existing conditions, utilities, services, finishes, sized, connections, etc., prior to bidding this project. The Designer's responsibility included only a cursory review of existing conditions and/or installations. It is the CONTRACTOR'S responsibility to coordinate a more thorough investigation and ascertain and confirm pertinent installation connections, etc., prior to his bid. This investigation shall be coordinated in a minimum seven (7) days advance of any published bid date such that the CONTRACTOR immediately thereafter can advise Designer in writing of any design discrepancies and/or changes required; otherwise, the CONTRACTOR shall be required to remedy any such peculiarities at his own expense and at no additional cost to the OWNER. It is the CONTRACTOR'S responsibility to verify existing size and/or location, etc., any time replacement and/or modifications to existing are included as a part of this project.
- D. The CONTRACTOR shall be responsible for obtaining the services of an "Independent Locator" whose function shall include location and identification of all underground service wiring, piping, coax, fiber optics, etc. The CONTRACTOR shall make every effort to protect and avoid conflicts with existing installations. Damage caused to existing installation by CONTRACTOR, or his Sub-contractor, etc., shall be promptly remedied and put back into service, per serving utility requirements.
- E. When obstructions that are not shown on the Contract Drawings are encountered during the progress of work and interfere so that an alteration of the Drawings is required, the ENGINEER will alter the Drawings or order a deviation in line and grade or arrange for removal, relocation, or reconstruction of the obstructions.
- F. When crossing existing pipelines or other structures, alignment and grade shall be adjusted as necessary, with the approval of the PROFESSIONAL, to provide clearance as required by federal, state or local regulations or as deemed necessary by the ENGINEER to prevent future damage or contamination of either structure.

3.11 PROTECTION AND CLEANING

- A. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the PROFESSIONAL. Damaged or defective items, in the opinion of the PROFESSIONAL, shall be replaced.
- B. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- C. Do not store insulation materials in building until it is enclosed and dry. Wet insulation shall not be installed.

- D. Fixtures, piping, ducts, equipment, etc., shall be cleaned per manufacturer's printed instructions and PROFESSIONAL'S instructions.
- E. Piping shall be: (1) flushed with clean water, (2) "blown out" with steam or compressed air, or (3) "swabbed out" as required, except where specified otherwise. All temporary connections required for flushing shall be provided and subsequently removed by the CONTRACTOR. See Section Pipe and Pipe Fittings for further instructions.
- F. Before final building interior finish is applied:
 - 1. Interior of air handling equipment shall be thoroughly cleaned.
 - 2. Drain pans shall be cleaned and then flushed with water after which all fans will run with air filters in place, etc., for 24 hours.

3.12 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 shall be (1) of quality equal to, and of appearance matching existing construction, and (2) shall restore all services and construction that remains in use, to its condition prior to this contract, unless otherwise noted.

3.13 FLASHING

- A. Where pipes, ducts, etc., pass through roof or walls, flash and caulk.
- B. Provide flashing or caulking as required at each opening through outside walls or roof. Flashing through roof of same materials and methods as under Moisture Protection Division; through walls shall be aluminum unless noted otherwise.

END OF SECTION

SECTION 22 01 40

PLUMBING SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all labor, equipment, material, etc., required to complete installation as specified herein and/or shown or scheduled on Contract Drawings.

1.02 SUPPORT

- A. Supports shall be installed in one of the following methods: (1) from wood using coach screw on open construction and hanger flanges on sheeting, (2) from concrete using inserts, (3) from steel using beam clamps, rivets or bolts, (4) from concrete blocks using toggle or through bolts. Fasten supports to building in following order of preference: (1) steel framing, (2) concrete, (3) wood framing, (4) masonry, (5) wood sheathing. Do not support from roof deck without approval. All hangers, rods, and inserts shall be Underwriters' Laboratories approved for the service intended and meet MSS #SP-58 and 69.

PART 2 - PRODUCTS

2.01 HANGERS, SUPPORTS, ANCHORS AND GUIDES

- A. All hangers, fasteners and accessories exposed to view indoors shall be galvanized or zinc plated. Similar installations outdoors shall be hot dipped galvanized materials and fasteners.
- B. Supports, hangers, anchors and guides shall be provided for all horizontal and vertical piping. Selection and application shall be in accordance with ANSI/MSS SP-69.
- C. All pipe supports shall be of type and arrangement hereinafter specified. They shall be so arranged as to prevent excessive bending stresses between supports. Specifically designed hangers shall be fabricated and installed in accordance with ANSI/MSS SP-69.
- D. All bracket clamp and rod sizes indicated in this specification are minimum size only. The CONTRACTOR under this section shall be responsible for structural integrity of all supports. All structural hanging materials except variable spring units shall have a safety factor of 5 built in.
- E. All piping routed on trapeze hangers shall be attached rigidly to same unistrut hanger bar with clamps designed by unistrut manufacturer as approved by PROFESSIONAL. Insulated piping clamps shall encapsulate piping, insulation and saddle.

2.02 BASES AND PADS

- A. Concrete equipment pads shall be constructed of minimum 3000 psi reinforced concrete. Provide ¾" chamfer on all exposed top perimeter edges of pads.
- B. Top of equipment pads outdoors shall be minimum 3" above and below worst case finished grade and be reinforced and of a strength suitable for application.

C. Pads shall be provided in the following applications:

1. Backflow preventer enclosures outside building. Size pads to extend minimum twelve (12) inches around equipment on all sides, or as indicated.
2. Floor mounted water heaters, pumps, and where shown or specified on Drawings.
3. Provide similar concrete surrounds at cleanouts, grease interceptors, wet wells, etc., and as indicated.

PART 3 - EXECUTION

3.01 PIPING SUPPORT

- A. All hangers for insulated piping shall be sized to accommodate insulation and shield. No hangers for insulated piping may be installed directly below or onto pipe itself except domestic cold water, and condensate drain piping where insulation is for condensation and/or freeze protection only.
- B. Provide hanger spaced per International Plumbing Code and International Fuel Gas Code requirements for piping type and size.
- C. Support horizontal PVC pipe with hanger or pier, located close to hub; use one support for each pipe length, or every other joint, whichever is closer. Where maintenance requirements may impose torque, as at a cleanout, support on both sides of torque point.
- D. Provide hanger within 18 inches of each elbow, also provide hanger with 18 inches of connection to each piece of equipment.
- E. Support vertical pipe at base and at each floor. In addition 1 inch or smaller copper pipe shall be supported at 5'-0" intervals or midway between floors, whichever distance is shorter.
- F. Provide PVC or other approved coating for steel, cast iron or PVC pipe riser clamps. See applicable details.
- G. Pipes passing thru walls shall not bear on building construction. Provide sleeves and fire proofing sealant as per Section Basic Plumbing Materials and Methods.
- H. Maximum weights on hanger rods assuming a maximum operating temperature of 450 degrees F. shall be such that stress in tension shall not exceed 9000 psi, using root area of threaded portion.
- I. For copper pipe, supports shall follow schedule and specifications. Supports for uncovered lines shall be especially designed for copper tubing, and shall be of exact O.D. diameter of tubing and shall be copper plated.
- J. Shields at Hangers: Insulated pipe shall be protected at the point of support by a 180 degree insert of high density, 100 psi, waterproofed calcium silicate encased in a 180 degree galvanized sheet metal inverted saddle. Insert to be same thickness as gauges shown in chart below. Insulation insert to extend 1 inch beyond sheet metal on all insulated water lines. If pipe hanger spacing exceeds 12 feet, use double layer sheet metal shields. Check Section Plumbing Insulation for Alternatives.

PIPE SIZE	SHIELD LENGTH	MINIMUM GAGE
1/2 – 2 inches	8 inches	24
2-1/2 – 4 inches	12 inches	20
6 – 8 inches	16 inches	16

- K. Provide all steel required for support of pipes and equipment other than steel shown on STRUCTURAL ENGINEER'S Drawings.
- L. All pipe supports shall be designed to avoid interferences with other piping, hangers, electrical conduits and supports, building structures and equipment.

3.02 OTHER MOUNTINGS

- A. Any piece of equipment installed in a finished ceiling or wall area shall be supported independently of the building finish. Ceiling mounted items shall be supported directly from the building structure.
- B. Support piping from structural steel members by malleable iron or formed steel beam clamps. Where suspended from concrete slabs, install inserts of malleable iron during building construction.
- C. Wire or perforated hangers will not be permitted. Provide adjustable split ring swivel malleable iron hangers for horizontal runs up to and including 3 inches pipe size. Provide adjustable steel clevis type hangers for pipes over 3 inches.
- D. Provide malleable iron split ring hanger with copper finish and copper plated malleable iron adjuster for use with copper piping. For insulated piping, provide hangers sized to accommodate insulation.

END OF SECTION

SECTION 22 01 90

PLUMBING IDENTIFICATION

PART 1 - GENERAL

1.01 SCOPE

- A. Piping System Identification
- B. Valve Identification System
- C. Equipment Identification
- D. Miscellaneous Identification

1.02 REFERENCES

- A. ANSI A13.1 - Scheme for the Identification of Piping Systems

PART 2 - PRODUCTS - SPECIFIED AS PER INDIVIDUAL APPLICATION IN PART 3

PART 3 - EXECUTION

3.01 IDENTIFICATION OF PIPING SYSTEMS

- A. Identify all pipe after final painting and/or insulation with manufacturer's preprinted labels at the following minimum locations:
 - 1. Straight runs of piping with a maximum spacing of twenty (20) feet.
 - 2. Adjacent to each valve.
 - 3. Adjacent to each branch takeoff point.
 - 4. On each side of where piping passes through walls/floors.
- B. Letter shall be sized in accordance with the following:

OUTSIDE DIAMETER OF PIPE COVERING	MINIMUM WEIGHT OF LEGEND LETTERS
Up to 3/4 inch	1/2 inch
1 to 1-1/4 inch	3/4 inch
1-1/2 to 2 inches	1 inch
2-1/2 to 6 inches	1-1/2 inch

- C. At each legend, include a manufacturer's label with an arrow to show normal flow.
- D. Identify location of outside underground piping by: (1) 4 inches by 18 inches concrete stakes, flush with finish grade, located above lines at end and/or corners or (2) 2 inches by 2 inches brass plates embedded in building walls above pipes.
- E. Identify heat tape "traced" piping per Section Piping Specialties. This is in addition to piping identification as indicated below.

3.02 IDENTIFICATION OF PIPING ABOVE GRADE

- A. All piping exposed to view or concealed shall include manufactured labels on pipe in a visible location. Label shall be attached to pipe every twenty feet (20'-0"). Labels shall be installed after piping has been painted and/or insulated.
- B. Labels to be utilized as follows.
1. In exposed applications, CONTRACTOR shall utilize pre-coiled, snap in place type markers as equal to Seton "Setmark". On 6 inches and larger pipe, CONTRACTOR shall utilize nylon ties to secure marker to piping.
 2. In concealed applications, CONTRACTOR shall utilize a pressure-sensitive tape manufactured legend on all installations. Tape shall be tamper resistant vinyl tape for indoor as equal to Seton "Opti-Code" and outdoor installations as equal to Seton "Ultra-mark."
 3. Tape legend colors shall meet ANSI recommendations.
 4. On piping where markers do not include directional arrows, CONTRACTOR shall include similar manufactured stick-on flow arrows on all pumped circulating systems as equal to Seton "Arrows On A Roll" with colors to match pipe legend tape identification.
- C. All insulated piping exposed to view everywhere and in mechanical rooms, shall include factory colored PVC jackets, non-insulated shall be similarly comprehensively painted in accordance with DIVISION 09 (to match existing installations or color coded as follows). (Verify colors with ARCHITECT and prior to painting).

SERVICE	SYMBOL	COLOR
Storm Water/Rain Leader	Rain W.	Light Grey
Sanitary Waste and Vent	San. W.	Dark Brown
Lab Waste and Vent	Lab	Light Brown
Grease Waste and Vent	Grease	Light Green
Domestic Cold Water	DCW	Dark Green
Domestic Hot Water (115 Deg)	DHW (115)	Light Blue
Domestic Hot Water Recirc. (115 Deg)	DHWR (115)	Light Blue
Domestic Hot Water (140 Deg)	DHW (140)	Maroon
Domestic Hot Water Recirc. (140 Deg)	DHWR (140)	Maroon
Natural Gas	N. Gas	Yellow
Fire Protection Sprinkler	Fire Sprinkler	Red

- D. See Section Basic Plumbing Materials and Methods for paint specification. **NOTE:** Factory colored PVC jacket, per Section Plumbing Insulation, required on all insulated water piping in all equipment rooms and where piping is exposed inside finished spaces. Outside insulated water piping and fittings shall include additional metal jacketing cover.

3.03 VALVE IDENTIFICATION

- A. All major and branch valves in the HVAC, plumbing or fire protection system (except check valves) shall be tagged and numbered. A complete system schematic and floor plan location drawing with all such valves referenced to the tag assigned to that valve shall be framed and mounted where directed by the Professional. A copy of this system schematic shall also be included in each of the Operations and Maintenance Manuals. Submit same to PROFESSIONAL for approval, prior to final mounting and inclusion in O & M Manual. Valve tags shall be brass or phenolic, minimum 1-1/4 inches in diameter, engraved with white lettering on a colored background. Background colors shall be as follows:

SERVICE	COLOR
Potable Cold Water	Dark Green
Potable Hot Water	Dark Blue
Potable Recirc. Hot Water	Light Blue
Natural/LP Gas	Yellow

- B. Lettering shall be minimum 1/2 inch high, with sequential lettering designations distinct for each separate functional service, i.e. CW-1 for 1st cold water valve, etc. Submit proposed floor plan layout with valves to be tagged, schematic of valve chart and system, etc., to PROFESSIONAL for approval. Tags shall be as equal to Seton Series 31490.

3.04 EQUIPMENT IDENTIFICATION

- A. All equipment, starters, controls panels shall be permanently labeled with equipment being served. Equipment labels shall correspond to those shown on the Contract Documents.
- B. Individual functions and equipment on indicators and controllers on control panels shall be clearly permanently identified.
1. Labels for equipment, starters and control panels shall be phenolic type with minimum 3/4 inch tall engraved lettering.
- C. A reduced scale floor plan drawing with all devices referenced to the equipment served shall be framed and mounted where directed. A copy of this reduced scale floor plan drawing shall also be included in each of the Operations and Maintenance Manuals. Submit same to PROFESSIONAL for approval, prior to final mounting and inclusion in O & M Manual.

END OF SECTION

SECTION 22 02 50

PLUMBING INSULATION

PART 1 - GENERAL

1.01 SCOPE

- A. It is intended that all storm drain piping above slab on grade and all domestic water piping above slab on grade throughout this project be insulated, except as specifically stated otherwise hereafter.
- B. Insulation shall include all insulating materials their applications, bands, tie wire, and weather protection for all pipe, fittings, valves, and equipment as indicated and as specified herein.
- C. Piping systems requiring insulation, types of insulation required, and insulation thickness shall be as listed herein. All fittings, flanges, and valves (except valve stems, hand wheels, and operators) in piping systems requiring insulation shall be insulated unless otherwise specified. Fitting, flange, and valve insulation shall be premolded, precut, or job-fabricated insulation of the same thickness and conductivity as used on adjacent piping. Insulation exterior shall be cleanable, grease resistant, non-flaking and non-peeling.

PART 2 - PRODUCTS

2.01 PIPING INSULATION

- A. Fiberglass pipe insulation (FG)
 - 1. Insulation shall have a thermal conductivity $k=0.23$ at 75 degrees F.
 - 2. Insulation shall include a white ASJ with self-sealing overlap joints and seams.
 - 3. Insulation shall be equal to Johns Manville "Micro-Lok" or approved equal.
- B. Flexible elastomeric pipe insulation (FU)
 - 1. Insulation shall have a thermal conductivity $k=0.25$ at 75 degrees F.
 - 2. Insulation shall be equal to Armacell "AP Armaflex".
- C. Cellular Glass (CG)
 - 1. Insulation shall have a thermal conductivity $k=0.35$ (density 8.5 pcf nominal).
 - 2. Insulation shall be equal to Foamglass
- D. Phenolic (P)
 - 1. Insulation shall have a thermal conductivity $k=0.15$ (density 10 pcf nominal)
 - 2. Insulation shall be equal to Insul-Phen.
- E. PVC pipe and fitting covers.
 - 1. Pipe and fitting covers shall be 20 mill thick flame retardant PVC. Fitting covers shall be neat, tight fitting radius type.
 - 2. Pipe and fitting covers shall be equal to Zeston type 300 or approved equal.

PART 3 - EXECUTION

3.01 GENERAL INSULATION INSTALLATION REQUIREMENTS

- A. The insulation shall be applied by licensed insulation applicators and all work shall be performed in a neat and workmanlike manner.
- B. No insulation shall be applied over pipes, fittings, or other surfaces, which are not clean.
- C. Insulation shall be applied after pipes have been thoroughly tested and proven tight by the CONTRACTOR.
- D. Piping insulation thru rated walls shall be coordinated with Section Basic Mechanical Materials and Methods and approved pipe sleeve and fire stop with UL Listing.
- E. Color coding of piping systems shall be in accordance with Sections Basic Mechanical Materials and Methods and Mechanical Identification. Piping identification after color coding shall be as specified in Section Mechanical Identification.
- F. Insulation shall be clean and dry when installed and during the application of any finish.
- G. Install materials neatly with smooth and even surfaces with jackets drawn tight and smoothly cemented down on longitudinal and end laps.
- H. Scrap pieces shall not be used where a full length section will fit.
- I. Pipe insulation shall be continuous through sleeves, wall and ceiling openings.
- J. A PVC grommet shall be utilized at metal stud penetrations of piping, and insulation shall be installed snug to both sides of penetration with ends of piping insulation vapor sealed if specified.
- K. Piping and ductwork shall be individually insulated.
- L. Chrome plated pipes and pipes used solely for fire protection shall not be insulated.
- M. Vapor Barrier Installation
 - 1. A complete moisture and vapor seal shall be provided wherever insulation terminates against metal hangers, anchors and other projections through insulation on cold surfaces for which a vapor seal is specified as identified in Part 3 paragraph 3.03 of this specification section.
 - 2. Seam and fitting covers shall be sealed with two (2) generous brush coat of fire resistant vapor barrier coating, applied at all longitudinal and circumferential laps.
 - 3. Ends of sections of insulation that butt against flanges, unions, valves, and fittings, and joints at intervals of not more than 12-feet on continuous runs of pipe shall be coated with a vapor barrier coating.
 - 4. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and cementing, coating as specified for butt strips. The patch shall extend not less than 1½" past the break in both directions.
 - 5. At penetrations such as thermometers, valve stems, etc., the voids in the insulation shall be filled with vapor barrier coating and the penetration sealed with a brush coat of the same coating.

6. PVC fitting jackets in concealed applications shall be with a strip of insulation jacket and brush coat of vapor barrier sealant.
7. PVC fitting jackets in exposed applications shall be neatly covered with a PVC/vinyl tape neatly smoothed.

N. Installation at Hangers and Anchors

1. Pipe insulation shall be continuous through pipe hangers.
2. Where pipe is supported by the insulation, galvanized sheet metal shields or saddles 12-inches long shall be provided. Shields/saddles shall be 20 gauge galvanized sheet metal for pipes 6" and smaller and 18 gauge for pipes 8 inches and larger.
3. Where shields are used on pipes 2-inches and larger, insulation inserts shall be provided at points of hangers and supports.
 - a. Insulation inserts shall be of calcium silicate, cellular glass (minimum 8 pcf), molded glass fiber (minimum 8 pcf), or other approved material of the same thickness as adjacent insulation.
 - b. Inserts shall have sufficient compressive strength to adequately support the pipe without compressing the inserts to a thickness less than the adjacent insulation.
 - c. Insulation inserts shall cover the bottom half of the pipe circumference 180 degrees and be not less in length than the protection shield.
 - d. Vapor barrier facing of the insert shall be of the same material as the facing on the adjacent insulation.
 - e. Seal inserts into the insulation with vapor barrier coating.
4. Where protection saddles are used, fill all voids with the same insulation material as used on the adjacent pipe.
5. Insulate and vapor seal insulation at anchors same as piping for a distance not less than four times insulation thickness to prevent condensation.

3.02 PIPING INSULATION INSTALLATION

A. Fiberglass pipe insulation (FG):

1. Install insulation with longitudinal laps and butt strips additionally smoothly secured with Benjamin-Foster 85-20 adhesive.
2. Fittings and valves on pipe shall be similarly insulated with thickness equal to the adjacent pipe.

B. Flexible elastomeric pipe insulation (FU):

1. Miter 90-degree turns and elbows, tees, and valve insulation.
2. Secure longitudinal joints with vinyl tape on 9-inch centers.
3. Bond cuts, butt joints, ends, and longitudinal joints with adhesive. After adhesive cures, apply 2-inch wide pressure sensitive adhesive vinyl tape over bonded cuts, joints, and ends.

C. PVC pipe and fitting covers:

1. PVC pipe and fitting covers shall be installed with a smooth appearance and no visible wrinkles.
2. All longitudinal seams shall be installed such the joints facing up or to the back of the finished product.

3. All longitudinal and circumferential PVC jacket joints and connections shall be spot welded every 12 inches with Perma Weld Adhesive and subsequently neatly sealed with tight fitting pressure sensitive vinyl tape, installed without wrinkles.
4. See Section Mechanical Identification for color coding of factory PVC jackets in exposed applications.

D. Metal Jacket Installation:

1. Metal jackets shall have side and end laps at least 2 inches wide with the cut edge of the side lap turned under one inch to provide a smooth edge.
2. Secure jackets in place with aluminum or stainless steel bands on 9-inch centers.
3. Place laps to shed water.
4. Seal laps with weatherproof coating.
5. Where pipes penetrate exterior walls, continue the increased insulation thickness required for piping exposed to weather and the metal jackets through the sleeve to a point 2 inches beyond the interior surface of the wall.
6. In outside locations protect fittings, flanges, and valves with a weatherproof coating prior to installation of metal covers. Secure metal covers for fittings, flanges, and valves in place with metal bands and seal with a weatherproof coating.

3.03 PIPING INSULATION MATERIAL TYPE, SERVICE JACKET, VAPOR BARRIER, AND THICKNESS CHARTS

DOMESTIC COLD WATER						
MATERIAL ("A")	TYPE OF SERVICE JACKET ("B")	VAPOR BARRIER REQUIRED	INSULATION THICKNESS (INCHES) FOR PIPE SIZE			NOTES
			1/2"- 1-1/4"	1-1/2"- 3"	3-1/2"- 6"	
FG	B	YES	1	1.5	1.5	1,2,3,4,5 ,6
FU	C	NO	1	1.5	1.5	
P	B	NO	0.5	1	1	
CG	A	YES	1	1.5	1.5	

DOMESTIC HOT WATER AND RECIRC.						
MATERIAL ("A")	TYPE OF SERVICE JACKET ("B")	VAPOR BARRIER REQUIRED	INSULATION THICKNESS (INCHES) FOR PIPE SIZE			NOTES
			1/2"- 1-1/4"	1-1/2"- 3"	3-1/2"- 6"	
FG	B	YES	1	1.5	1.5	1,2,3,4,5 ,6
FU	C	NO	1	1.5	1.5	
P	B	NO	0.5	1	1	
CG	A	YES	1	1.5	1.5	

AIR CONDITIONING CONDENSATE DRAINS INSIDE BUILDING						
MATERIAL ("A")	TYPE OF SERVICE JACKET ("B")	VAPOR BARRIER REQUIRED	INSULATION THICKNESS (INCHES) FOR PIPE SIZE			NOTES
			1/2"-1-1/4"	1-1/2"-3"	3-1/2"-6"	
FG	A OR B	YES	1	1	1	4
FU	C	NO	0.75	1	1	

RAIN LEADER (INCLUDING UNDERSIDE OR ROOF DRAIN)						
MATERIAL ("A")	TYPE OF SERVICE JACKET ("B")	VAPOR BARRIER REQUIRED	INSULATION THICKNESS (INCHES) FOR PIPE SIZE			NOTES
			3"-6"	8"-10"	12"-30"	
FG	B	NO	1	1	1	2,4
FU	C	NO	0.75	0.75	0.75	

"A" - INSULATION MATERIAL

ABBREVIATION	MATERIAL	SPECIFICATION	TYPE	CLASS/GRADE
FU	FLEXIBLE UNICELLULAR	ASTM C 534	-	-
FG	FIBERGLASS	ASTM C 547	I	1
P	PHENOLIC	ASTM C 552	-	-
CG	CELLULAR GLASS	ASTM C 1126	III	1

"B" - TYPE OF SERVICE JACKET REQUIRED

A	FOIL BACKED ALL SERVICE JACKET (ASJ)
B	PAPER ASJ
C	NONE

A. Insulation Charts Notes:

1. Flexible unicellular insulation shall be utilized on domestic piping concealed within interior and exterior walls and plumbing chases.
2. Higher density insulation inserts shall be utilized on all piping larger than 1-1/2" size, at all hanger/saddle supports.
3. Insulation located outside shall be one inch thicker than shown in tables.
4. A full coverage color-coded pvc jacket shall be required on insulated piping and fittings exposed in mechanical rooms, in crawlspace, and in interior exposed applications. See Section Plumbing Identification for color requirements.
5. Provide metal jackets over insulation on all piping exposed to outdoor weather.
6. All potable water piping outside, exposed to view in finished spaces, in crawlspace, within mechanical/equipment rooms, etc. shall be insulated with phenolic or "Foamglas".

END OF SECTION

SECTION 22 08 00

PLUMBING SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Systems and equipment Start-Up and Functional Performance Testing.
- B. Validation of proper and thorough installation of Division 22 systems and equipment.
- C. Generic Startup Documentation for plumbing systems and equipment.
- D. Development of final Startup Documentation for plumbing systems and equipment.
- E. System Startup and Turn-Over procedures.
- F. Systems balancing verification.
- G. Coordination and execution of Training Events.

1.2 GENERAL DESCRIPTION

- A. Commissioning (Cx) is the process of ensuring that (i) all building systems are installed and perform interactively according to the design intent; (ii) that systems are efficient and cost effective and meet the Owner's operational needs; (iii) that the installation is accurately documented; and (iv) that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.
- B. Commissioning Authority (CA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.
- C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.
- D. This Section outlines the Cx procedures specific to the Division 23 Contractors. Requirements common to all Sections are specified in Section 019100 and Section 019113.13 This Section and other sections of the specification details the Contractor's responsibilities relative to the Cx process.

1.3 SCOPE

- A. The following systems and equipment are included in the Scope of Commissioning for this project.
- B. Plumbing Systems:

1. Plumbing fixtures.
2. Domestic cold water.
3. Domestic hot water.
4. Domestic hot water recirculation.
5. Sanitary waste and vent.

1.4 RELATED WORK AND DOCUMENTS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents. See Division 01 for details.
- B. The Cx process references many related Sections, particularly Section 019100 - General Commissioning Requirements. It is important for all Contractors subject to the Cx process to be familiar with Section 019100.
- C. Section 019113.13 – General Commissioning Requirements for Functional Performance Testing.
- D. Section 230800 – HVAC System Commissioning.
- E. Section 230810 – BAS Commissioning.
- F. Section 260800 – Electrical Systems Commissioning.

1.5 DEFINITIONS AND ABBREVIATIONS

- A. Refer to Section 019100 for a complete list of Definitions and Abbreviations.

1.6 REFERENCE STANDARDS

- A. Refer to Section 019100 for a complete list of Definitions and Abbreviations.
- B. ASHRAE Standard 202 – Commissioning Process for Buildings and Systems.
- C. ASHRAE Guideline 0 – The Commissioning Process.
- D. ASHRAE Guideline 1.1 – HVAC&R Technical Requirements for the Commissioning Process.
- E. ASHRAE Guideline 1.3 – Building Operations and Maintenance Training for the HVAC&R Commissioning Process.
- F. ASHRAE Guideline 1.4 – Procedures for Preparing Facility Systems Manual.

1.7 DOCUMENTATION

- A. Documentation shall be as required in Section 019100. In addition, Contractor shall also provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:
 1. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to the

Acceptance Phase. Factory Test Reports should be provided in PDF electronic format. These may include but are not limited to:

- a. Plumbing fixtures.
- 2. Field Testing Agency Reports (other than TAB): Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in PDF electronic format. These may include but are not limited to:
 - a. Pipe Pressure Testing.
 - b. Gas cross-contamination.
 - c. Potable water disinfection.
- 3. TAB Plan: The Testing, Adjusting, and Balancing Plan shall include the following:
 - a. Certifications on all instruments to be used throughout the testing. Certification must be documented within the previous 6 months.
 - b. Résumés and Certification of individuals who will be balancing the systems.
 - c. Detailed step-by-step plans for each procedure to be performed by the TAB Contractor.
 - d. Sample forms to be used for each measurement.
 - e. Sample balancing report.
- 4. Piping Cleaning, Flush, and Fill Plan: Contractor shall provide this document in accordance with details in this Section. CA will review.
- 5. Temporary Operating and Conditioning Plan: Contractor shall provide in accordance with details in this Section. CA will review.
- 6. Completed TAB Reports. CA will review prior to FPT.

1.8 SEQUENCING AND SCHEDULING

- A. Refer to Section 019100.

1.9 COORDINATION MANAGEMENT PROTOCOLS

- A. Coordination responsibilities and management protocols relative to Cx are initially defined in Section 019100 and the Cx Plan, but shall be refined and documented in the Construction Phase Cx Kick-Off Meeting. Contractor shall have input into the protocols to be used and all Parties will commit to scheduling obligations. The CA will record and distribute.

1.10 CONTRACTOR RESPONSIBILITIES

- A. Refer to Section 019100: Detailed Contractor responsibilities common to all Divisions are specified in Section 019100. The following are additional responsibilities or notable responsibilities specific to Division 22.
- B. Construction Phase.
 - 1. Provide skilled technicians qualified to perform the work required.
 - 2. Provide factory-trained and authorized technicians where required by the Contract Documents.

3. Prepare and submit required draft Startup Documentation and submit along with the manufacturer's application, installation and startup information.
4. Provide assistance to the CA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review FPT procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.
5. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere in this Section.
6. Startup, test/adjust/balance, and Turn-Over systems and equipment prior to functional performance testing by the CA. Approved Startup Documentation shall be in accordance with Contract Documents, reference or industry standards, and specifically elsewhere in Part I of this Section.
7. Record Startup on approved Startup Documentation forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above. Each task or item shall be indicated with the Party actually performing the task or procedure.

C. Acceptance Phase.

1. Assist CA in Functional Performance Testing. Assistance will typically include the following:
 - a. Manipulate systems and equipment to facilitate Functional Performance Testing (as specified in Section 019100, Section 019113.13, and the Cx Plan; in some cases this will entail only an initial sample).
 - b. Provide any specialized instrumentation necessary for Functional Performance Testing.

D. Warranty Phase.

1. Maintain record documentation of any configurations, setpoints, parameters, etc. that change throughout the Warranty Period.
2. Provide representative for off-season testing as required by CA.
3. Respond to warranty issues as required by Division 01 and the General Conditions.

1.11 EQUIPMENT SUPPLIER RESPONSIBILITIES

- A. Refer to Section 019100.

1.12 CONTRACTOR NOTIFICATION AND SCHEDULING

- A. Refer to Section 019100.

1.13 STARTUP DOCUMENTATION

- A. Refer to Section 019100.

1.14 EQUIPMENT NAMEPLATE DATA

- A. Refer to Section 019100.

1.15 FUNCTIONAL PERFORMANCE TESTING

- A. Contractor shall participate in the initial samples of Functional Performance Testing as stipulated in Section 019100 and Section 019113.13.

1.16 FPT ACCEPTANCE CRITERIA

- A. Acceptance criteria for tests are indicated in Section 019100 and in the specification Sections applicable to the systems being tested. Generally, unless indicated otherwise, the criteria for acceptance will be that specified with the individual system, equipment, component, or device.

1.17 TRAINING

- A. Contractors, Subcontractor, Vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 01 91 00 and the individual Specifications.

1.18 SYSTEMS MANUAL AND O&M DOCUMENTATION CONTENT

- A. Refer to Section 019100.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

- A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:
 1. Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of +/- 0.1F.
 2. Pressure sensors shall have an accuracy of +/- 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.
 3. All equipment shall be calibrated per the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.
- B. Standard Testing Instrumentation: Standard instrumentation used for testing air and water flows, temperatures, humidity, noise levels, amperage, voltage, and pressure differential in air and water systems related to functional testing shall be provided by CA.
- C. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, per these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon project completion.

2.2 TEST KITS FOR METERS AND GAUGES

- A. Test kits for meters and gages shall be provided to the Owner new and in good condition. Previously used kits will be unacceptable. Kits shall be submitted prior to the Acceptance Phase. Kits included shall be as a minimum:
 - 1. Digital indication of temperature and pressure with associated sensors to work with the P/T test ports.
 - 2. Companion readout kit (with fittings) for calibrated balancing valve with ranges as required by all devices on this project.

PART 3 - EXECUTION

3.1 GENERAL STARTUP DOCUMENTATION

- A. This Section outlines 'generic' or minimally acceptable Startup Documentation (which are defined to include both 'Startup Checks' and 'Startup Tests') and individual systems training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimally acceptable guideline for required Contractor development of Startup Documentation. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized final Startup Documentation specific to the equipment and systems installed on this project.
- B. Section 019100 defines the systems and equipment Startup process in detail and provides definitions for Startup Documentation, including the generic Startup Documentation provided below.

3.2 STARTUP DOCUMENTATION COMMON TO ALL SYSTEMS

- A. The following Startup Documentation (Checklists and Tests) shall be considered common to all systems:
 - 1. Checkout shall proceed from lower level devices to larger components to the entire system operation.
 - 2. Verify labeling is affixed per specification and visible.
 - 3. Verify prerequisite procedures are done.
 - 4. Inspect for damage and ensure none is present.
 - 5. Verify system is installed per the manufacturer's recommendations.
 - 6. Verify system has undergone Startup per the manufacturer's recommendations.
 - 7. Verify that access is provided for inspection, operation and repair.
 - 8. Verify that access is provided for eventual replacement of the equipment.
 - 9. Verify that record drawings, submittal data and O&M documentation accurately reflect the installed systems.
 - 10. Verify all gauges and test ports are provided as required by contract documents and manufacturer's recommendations.
 - 11. Verify all recorded nameplate data is accurate.
 - 12. Verify that the installation ensures safe operation and maintenance.
 - 13. Verify specified replacement material/attic stock has been provided as required by the Contract Documents.
 - 14. Verify all rotating and moving parts are properly lubricated.

15. Verify all monitoring and ensure all alarms are active and set per Owner's requirements.
16. Complete all nameplate data and confirm that ratings conform to the design documents.

3.3 VALVES

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Startup Checks: Perform the following checks during startup and as specified in manufacturer's instructions:
 1. Operate all valves, manual and automatic, through their full stroke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.
 2. Verify actuators are properly installed with adequate clearance.
 3. Verify all valves are labeled per the construction documents. Confirm that concealed valves are indicated on the finished building surface.
 4. For automatic pneumatically-operated valves, verify spring range and adjust pilot positioners where applicable.
 5. For electronically operated valves, check the stroke and range.
 6. For all automated valves controlled by a program, ensure that the minimum and maximum stroke and ranges on the valves are coordinated with the limits entered in the program.

3.4 METERS AND GAUGES

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Startup Checks: Perform the following checks during startup and as specified in manufacturer's instructions:
 1. Adjust faces of meters and gauges to proper angle for best visibility.
 2. Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.
 3. For meters and gauges requiring temporary manual connection of read-out device such as pressure taps on a flow measuring device, ensure threads are clean and that connection can be made easily.
 4. Meters and gauges requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

3.5 MECHANICAL IDENTIFICATION

- A. Startup Checks: Perform the following checks:
 1. Verify all valve tags, piping, duct, and equipment labeling corresponds with drawings and indexes and meets requirements specified. Correct any deficiencies for all piping and duct systems.
 2. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
 3. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.6 MECHANICAL INSULATION

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Startup Checks: Examine all piping, systems and equipment specified to be insulated.
 - 1. Ensure quality of insulation. Patch and repair all insulation damaged after installation.
 - 2. Ensure the integrity of vapor barrier around all cold surfaces.

3.7 ALL PIPING

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Startup Checks: These procedures apply to all installed piping systems, including underground site utilities.
 - 1. Inspect all piping for proper installation, adequate support (with appropriate vibration isolation where applicable) and adequate isolation valves for required service.
 - 2. Submit welding certifications as required by the applicable specification section or referenced ASME specification.
 - 3. Submit certified welding inspection results per the applicable specification section or referenced ASME specification. ASME B31.1 requires 100% inspection based on pressure class.
 - 4. Provide notification of pipe cleaning and flushing activities.
 - 5. Flush and clean all piping and clean all strainers. Provide documentation of all related procedures.
 - 6. Ensure adequate drainage is provided at low points and venting is provided at high points.
 - 7. Ensure facilities to effectively drain and fill the system are in place.
 - 8. Ensure air is thoroughly removed from the system as applicable.
 - 9. Ensure all piping is adequately supported and anchored to allow expansion. Bump across-the-line pumps and inspect for excessive pipe movement.
 - 10. Provide notification of pressure testing.
 - 11. Pressure and/or leak test all applicable systems in accordance with the requirements in the applicable sections, ASME B 31.1 and 39.1 as applicable.
 - 12. Sterilize applicable piping systems as specified in the individual Sections and as required by regulatory authorities.
 - 13. Submit pressure test reports that document the pressure testing results with certification of the results.
 - 14. Verify the operation of applicable safety relief valves, operating controls, safety controls, etc. to ensure a safe installation.
 - 15. Set and adjust fill, pressure, or level controls to the required setting.

3.8 PLUMBING FIXTURES

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.
- B. Start-Up Checks: Perform the following checks during start-up:
 - 1. Inspect each installed fixture for damage. Replace damaged fixtures and components.

2. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.
3. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
4. Operate and adjust disposers, hot water dispensers, and controls. Replace damaged and malfunctioning units and controls.
5. Adjust water pressure at drinking fountains, electric water coolers, and faucets, shower valves, and flush-o-meters having controls, to provide proper flow and stream.
6. Replace washers of leaking and dripping faucets and stops.
7. Clean fixtures, fittings, and spout and drain strainers with manufacturers' recommended cleaning methods and materials.

3.9 WORK SEQUENCE ILLUSTRATION

- A. Reference Section 019100.

3.10 TRAINING

- A. System training requirements are detailed in 019100.

END OF SECTION

SECTION 22 10 60

PIPES AND PIPE FITTINGS

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material, equipment and labor, etc., required to complete installation specified and/or shown or scheduled on Contract Drawings.
- B. Work included: Pipes, fittings, unions, couplings, flanges, gaskets, and other materials and instructions.

1.02 PIPING SCHEDULE

- A. Piping systems for this project shall include the following:
 - 1. Sanitary Waste and Vent Piping.
 - 2. Storm Drain Piping (Rain Leader).
 - 3. Condensate Drain Piping.
 - 4. Domestic Water Piping.
 - 5. Equipment Utility and Relief Drain Piping.

1.03 MANUFACTURER'S ASSISTANCE

- A. Manufacturer shall provide, if required, to the CONTRACTOR a factory trained service man to properly train CONTRACTOR'S personnel in all phases of installation.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. All piping installed on this project shall be new and of full weight and size indicated and of proper specification for service intended. Only domestic pipe may be used. Pipe and pipe fittings for the various systems shall be as follows:
- B. Sanitary Waste and Vent Piping:
 - 1. Piping above and below slab on grade extending to five (5) feet outside building perimeter, shall be solid core Schedule 40 PVC with solvent weld joints and DWV fittings, except where routed and installed in spaces designated for use as return air plenums.
 - 2. Piping in return air plenum spaces shall be standard weight no hub type cast iron with no-hub gasket joints and fittings. Joints shall be secured utilizing heavy-duty couplings as Husky HD2000 or Clamp All 80. Similar piping up to 1-1/2 inch shall be schedule 40 galvanized pipe with threaded joints and cast iron fittings, type "L" hand drawn copper with solder joints and fittings, or flame retardant polypropylene.
 - 3. Sanitary waste piping below grade outside building shall be as specified in Civil Division.

C. Storm Drain Piping (Rain Leader):

1. Piping above and below slab on grade extending to five (5) feet outside building perimeter, shall be solid core Schedule 40 PVC with solvent weld joints and DWV fittings, except where routed and installed in spaces designated for use as return air plenums.
2. Piping in return air plenum spaces shall be standard weight hub type cast iron with no-hub gasket joints and fittings. Joints shall be heavy-duty couplings as Husky HD2000 or Clamp All 80. Similar piping up to 1-1/2 inch shall be schedule 40 galvanized pipe with threaded joints and cast iron fittings, type "L" hand drawn copper with solder joints and fittings, or flame retardant polypropylene.
3. Storm drain piping below grade outside building shall be as specified in Civil Division.

D. Condensate Drain Piping:

1. Condensate drain piping routed indoors shall be type "L" hard drawn copper.
2. Piping in R/A plenum space shall be galvanized steel, type "L" hard drawn copper, cast iron, or flame retardant polypropylene.
3. Piping exposed outside of building shall be Schedule 40 galvanized steel with threaded joints and fittings, or Schedule 40 PVC with solvent weld joints and fittings, paying close attention to spacing of piping supports in Section Supports and Anchors.

E. Domestic Water Piping:

1. Piping above slab on grade inside building shall be Type "L" copper with 95/5 soldered joints or specialty piping systems such as "ProPress" by Viega. "T-drill" or "pulled" taps/outlets shall NOT be utilized, only full body fittings will be allowed.
2. For entrances smaller than 2 inches, piping below slab on grade and to a point ten (10) feet from building perimeter shall be Type "K" copper pipe with brazed joints. Note: There shall be no joints below slab on grade except at building entrance service on piping 2 inches and larger.
3. For entrances 2 inches and larger, building riser from outside building to above finished floor shall be stainless steel without joints. Riser shall be equal to Ames IBR.
4. Piping routed outside building below grade, shall be as specified in Civil Division.

F. Equipment Utility and Relief Drain Piping:

1. Indoor Water heater T & P, backflow preventer and miscellaneous equipment relief and drain piping shall be full size connection Type 'L' copper with solder joints.
2. Piping exposed outside of building shall be Schedule 40 galvanized steel with threaded joints and fittings.

2.02 PIPE FITTINGS, UNIONS, FLANGES, AND GASKETS

- A. All fittings shall conform to pipe as to black steel, galvanized steel, copper, PVC or cast iron, etc. or as indicated. Fittings and accessories shall have equal or greater pressure rating than piping specified for particular application.
- B. Malleable steel fittings shall be minimum 150 psi class.
- C. Steel pipe unions shall be malleable iron having bronze-to-iron ground joints.

- D. Steel nipples shall be extra heavy type. All thread nipples prohibited. Provide a minimum of 1" of bare pipe between threaded ends of nipples.
- E. Flange bolts: Galvanized Alloy steel, ASTM #A-196, Galvanized GR. B-7; nuts' ASTM #S-194, GR. 2 H; both hex head style.
- F. Flange gaskets serving piping below 250 degrees F shall be synthetic composition type; serving above 250 degrees F gaskets shall be corrugated metallic type. Utilize gasket suitable for service intended.
- G. Couplings, steel pipe malleable iron, Grade II.
- H. Provide factory made reducers and increasers, and nipples of comparable materials as the piping. The use of bushings is not acceptable to obtain reduction or increase in sizes.
- I. Galvanized steel pipe shall be assembled with galvanized screw fittings unless specifically indicated otherwise.

2.03 DIELECTRIC FITTINGS

- A. Provide where copper and ferrous metal are joined:
 - 1. 2 inches and less: Threaded dielectric union.
 - 2. 2-1/2 inches and larger: Flange union with dielectric gasket and bolt sleeves.
 - 3. Temperature Rating, degree F: 210 for water systems.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

- A. General:
 - 1. Arrange and install piping approximately as indicated, straight, plumb and as direct as possible; form right angles or parallel lines with building walls. Keep pipes close to walls, partitions, ceilings, offset only where necessary to follow walls as directed. Locate groups of pipes parallel to each other; space them at distance to permit applying full insulation and to permit access for servicing valves. The PROFESSIONAL reserves the right to require this CONTRACTOR to make minor changes in pipe locations where conflicts occur with other trades or equipment. Such changes shall be made without extra cost to OWNER.
 - 2. Install horizontal piping as high as possible without sags or humps. Grade drainage piping at uniform slope of 1/8 inch per foot minimum and maximum 1/4 inch per foot, or as noted. Where this is impossible, maintain slope as directed, but in no case less than 1/16" per foot. Pitch piping in direction of flow.
 - 3. When piping is cut, it shall be reamed with pipe reamer and all burrs, scale, trash and foreign matter removed. If any piping is found installed without being reamed, cleaned, deburred, etc., or in any way contrary to above, it shall be sufficient reason for related erected piping to be removed, inspected by the PROFESSIONAL, corrected and reinstalled, all at CONTRACTOR'S expense.
 - 4. Where size changes on horizontal lines, use reducing fittings; bushings are prohibited. On liquid lines have eccentricity down, hold the top level. On gas or vapor lines have eccentricity up, hold the bottom level.
 - 5. Sufficient space shall be allowed in erecting piping for proper application of thermal installations including fittings. In no case shall any insulation be cut or reduced thickness because of inadequate space.

6. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping.
7. Locate valves for easy access and operation. Concealed valves shall be provided access doors. Do not locate any valves with stems below horizontal.
8. Install gauges, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gauges to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
9. Furnish and install unions or mating flanges at all connections to each piece of equipment conveniently located to facilitate quick and easy disconnecting of equipment. Flanges or union connections shall be used on both sides of traps, control valves, pressure reducing valves and meters and the like.

B. Steel Piping:

1. Where piping is threaded, dies shall be clean and sharp. Threads shall conform to ANSI B2.1; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads or steel pipe with joint compound and red lead paint for corrosion protection. The caulking of these joints will not be tolerated. Pipe joint compound must be approved by the PROFESSIONAL.
2. Where welding is specified or done, it shall be by electric arc by mechanics skilled in operation and holding a test certificate acceptable to the ENGINEER. All scale and flux shall be removed from piping after welding. Welding, beveling, spacing and other details shall conform to ANSI B31.1.

C. Plastic Piping:

1. Utilize manufacturer's recommended solvent glue and purple pipe cleaning compound on all PVC or CPVC joints where specified. Install all fittings and joints as per manufacturer's recommendation.
2. Install all underground plastic and fiberglass glass piping outside building perimeter with tracer identification tape (per Section Mechanical Identification) and minimum 12 gauge bare copper wire for future location reference.
3. Install solvent weld, mechanical or socket fusion lab waste and vent piping per manufacturer's recommendation.
4. Install grease waste and vent piping per manufacturer's recommendation.

D. Copper Piping

1. Copper tubing shall be thoroughly reamed, cleaned with steel wool or emery cloth and a non-corrosive flux used before soldering or bracing.
2. Copper tubing shall be thoroughly reamed and de-burred before joining with specialty piping systems such as Viega "Pro-Press" or equal.
3. Where solder joints are specified, use solder having 95 percent tin and 5 percent antimony. Each roll of solder shall be clearly stamped as to grade and content.
4. Where brazing joints are specified, use a brazing filler metals having a melting point above 1100 degrees F and containing at least 5 percent silver.
5. Where copper tubing extends through concrete slab on grade, tubing shall have an "Armaflex" or "Rubatex" type.
6. Provide PVC isolation wrap where copper pipe extends through masonry walls to connect plumbing fixtures or valves, etc.

3.02 PIPE EXPANSION

- A. In the installation of all pipe runs where shown or where necessary, install swing joints, flexible couplings, turns, expansion loop or long offsets to allow for expansion. Broken pipe or fittings due to rigid connections must be removed and replaced at no additional cost to the OWNER.
- B. All lines shall be securely anchored where required. Where such anchors occur, they shall be securely fastened to the steel or concrete structure of the building in a manner approved by the PROFESSIONAL. Drawings shall be submitted before installation.

3.03 ANCHORS

- A. Plastic pipe shall be jointed to steel systems with flanges. Steel system shall be anchored within five (5') feet of connection point to eliminate any thrust, stress, or torque from steel system to fiberglass and/or plastic system.

3.04 TESTS

- A. Cooperation/Scheduling:
 - 1. The ARCHITECT shall be notified no less than ninety-six (96) hours prior to any pipe test. The ARCHITECT shall also be notified in adequate time for an inspection of the test before the test is completed. The PRIME CONTRACTOR'S Superintendent shall be responsible for administering and witnessing all tests, log it for permanent record and transmit to ARCHITECT at completion of project. The PRIME CONTRACTOR'S Superintendent shall keep this on-going log on jobsite and shall include the following:
 - 2. Date of Test
 - 3. Duct/Piping Description (EX: "Sanitary Sewer")
 - 4. Location (EX: "Northwest Quadrant First Level")
 - 5. Results (EX: "Held 10 ft. of head for eight hours without leakage", etc.)
 - 6. Contractor's/Superintendent's Witness Initials
- B. Tests shall be as follows: (New and Existing Modified Piping shall be tested and all leaks repaired)
 - 1. Gravity Flow Sanitary, Grease and Lab Waste and Vent piping above and below slab: Minimum 10 feet static head and as required by ASA-A40.8 or local code, for a minimum period of four (4) hours, without discernible loss. All below grade piping and joints shall be clearly visible during test.
 - 2. Pumped Waste Piping: 30 psi hydrostatic in conjunction with manufacturer's recommendations, with no discernible pressure loss for a period of four (4) hours.
 - 3. Storm Drain piping above and below slab: Minimum 10 feet static head and as required by ASA-A40.8 or local code, for a minimum period of four (4) hours, without discernible loss. All below grade piping and joints shall be clearly visible during test. Contractor shall install temporary extensions and/or plugs on roof drain bodies to attain static head requirement.
 - 4. Gravity Flow Condensate Drain piping above and below slab: Minimum 10 feet static head and as required by ASA-A40.8 or local code, for a minimum period of four (4) hours, without discernible loss. All below grade piping and joints shall be clearly visible during test.
 - 5. Water Piping: (Domestic and circulating systems) 125 psi hydrostatic or 100 psi air, in conjunction with manufacturer's recommendations, with no discernible pressure loss for a period of eight (8) hours. Potable water piping shall be pressurized with water or air during all phases of construction such that leaks can be promptly identified and remedied.

6. Natural and LP Gas Piping: All gas piping shall be tested at twice the operating pressure, but not less than 30 psig, with compressed air or nitrogen, with no discernible pressure loss, for a period of not less than eight (8) hours. Oxygen shall not be used. All factory coated and wrapped piping below grade to be tested and proven tight with Holiday Leak Detector. All new and/or modified piping shall be tested to a minimum of 1.5 times the operating pressure or a minimum of 3 psig, whichever is greater.
7. Backflow Preventers: Per local and state governing authority requirements.
8. Compressed Air: Test to 1.5 times the normal operating pressure.

3.05 SYSTEM CLEANING, TREATMENT AND PROTECTION

- A. Potable Water System: All new and modified existing potable water lines shall be thoroughly flushed and sterilized with a solution containing not less than 50 ppm available chlorine for eight (8) hours. During sterilization, operate all valves, faucets, etc., so that all portions of the system are reached. Flush system with clear water until concentration drops to 0.5 ppm. CONTRACTOR shall furnish sample to State Health Department attesting to satisfactory condition of water. Submit copy of test reports to ARCHITECT near end of project and prior to OWNER'S use of potable water distribution system.

END OF SECTION

SECTION 22 11 00

PLUMBING VALVES

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material, equipment and labor, etc., required to complete installation as specified herein and/or shown or scheduled on Contract Drawings.

1.02 APPLICABLE STANDARDS

- A. Insofar as possible, all valves of the same type shall be of the same manufacturer.

1.03 VALVE DESCRIPTION AND IDENTIFICATION

- A. Valves shall have name or trademark of manufacturer and working pressure cast or stamped on valve body.
- B. Valve hand wheels shall be oriented when installed to provide maximum accessibility for operation.
- C. Valve discs shall be the manufacturer's standard material for the service in which the valve is used unless otherwise indicated under the individual type valve specification.

PART 2 - PRODUCTS (Other Valves from Those Listed May Be Submitted for Approval)

2.01 VALVES FOR DOMESTIC WATER APPLICATIONS

- A. All valves shall be NSF 61 compliant and contain less than 0.25 percent lead (Pb) by weight.
- B. Ball Valves:
 - 1. Valves 2 inches and smaller shall be two-piece brass or stainless steel construction, 1-1/4 inch extended neck, chrome plated ball with full port, P.T.F.E. seals and seats. Heavy duty steel handle with vinyl grip, quarter turn operation. Valves shall be suitable for working pressure of 200 psig and maximum 250 degrees F.
 - 2. Valves 2-1/2 inches and larger shall be same as above except that two or three-piece brass or stainless steel construction may be utilized.
 - 3. Valves shall be equal to Apollo 77FLF-100 Series.
- C. Silent Check Valves:
 - 1. Silent check valves 2 inches and smaller shall be horizontal or vertical silent spring check type. Valves shall be rated for 200# WOG.
 - 2. Valves shall be equal to Watts Series LF600.
- D. Balancing Valves:
 - 1. Manual Type:
 - a. Combination balancing and positive shut-off valves shall incorporate a position indicator and memory stop or locking device so the valve can be closed without disturbing the setting, and be returned to the balanced position without further adjustment.

- b. Balancing valves for sizes 3 inches and smaller shall be calibrated bronze balancing valves with provisions for connecting a portable differential pressure meter. Meter connections shall have built-in check valves and knurled caps. Valves shall have integral pointers to indicate the degree of valve opening.
 - c. Valve shall be equal to Bell & Gossett Circuit Setter Plus.
- 2. Automatic Balancing Flow Restrictor Type:
 - a. Valves shall incorporate a stainless steel spring and plunger loaded flow control device to automatically provide flow setpoint within plus or minus 5 percent with a wide range of system pressure range fluctuation. Water pressure drop through entire flow restrictor/shut-off valve assembly shall not exceed 5 feet.
 - b. Valves shall be stainless steel spring/piston type with provisions for connecting a portable differential pressure meter to two (2) P/T ports and include an identification tag indicating g.p.m. setting. Meter connections shall have built-in check valves and knurled caps. Body shall allow removal of flow control cartridge without disturbing piping connections.
 - c. Valves shall be equal to Griswold K-Valve.

2.02 CHROME PLATED VALVES

- A. Valves in exposed domestic plumbing connections to equipment shall have chrome plated finish.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation shall be such that the valve can be fully opened and have at least 6" clearance beyond valve stem handle and sufficient clearance to remove stem for repair.
- B. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawings. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.

3.02 DISCHARGE FROM SAFETY AND/OR RELIEF VALVES

- A. Relief valves relieving steam, gas of any type, including compressed air, or liquid above 120 degrees F., shall be piped full size to outside building or as indicated so that discharge cannot hit any person or structure.

3.03 RELIEF VALVE CAPACITY

- A. Valve relieving capacity shall meet all code requirements and also be equal to at least 1.25 of possible heat input to be relieved.

END OF SECTION

SECTION 22 11 20

PLUMBING PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all labor, equipment, materials, etc., required to complete installation as specified herein and/or shown or scheduled on Contract Drawings.
- B. Work Included: Piping specialties to connect fire protection and plumbing equipment.

PART 2 - PRODUCTS

2.01 BACKFLOW PREVENTORS

- A. Install a backflow prevention device at main service entrance for potable water and at any point in the domestic water system where the potable water supply comes in contact with a potential source of contamination. Devices shall be certified by a recognized testing laboratory and be AWWA C-511-89 FCCCHR of USC, UPC, and IPC compliant. Listed below is a partial list of connection to the water system which shall be protected against backflow or back siphonage.
 - 1. Reduced Pressure Backflow Preventer:
 - a. Water service entrance
 - b. Science Lab Branch Potable Water Connection
 - 2. Double Check Backflow Preventer:
 - a. Water service entrance
 - b. Low Hazard potable water applications
 - 3. Atmospheric Vacuum Breaker:
 - a. Hose bibbs and sink faucets w/threaded outlets.
- B. Domestic water backflow preventers shall be provided with the following:
 - 1. Drain air gap receptor and full connection size drain to outside with elbow turned down with insect screen, and pressure gauges on both sides of valves.
 - 2. Shut-off valves on both sides of assembly.
 - 3. Epoxy coated (FDA approved) inside and out.
 - 4. Pressure gauges both sides of backflow device.
 - 5. Stainless steel mesh strainer upstream of valve assembly.
 - 6. Valve shall be equal to the following:
 - a. Sizes up through 2-1/2 inches – equal to Watts Series LF909-QT-S. Provide union or flanged connections both ends, and manufacturer's funnel. Provide strainer ball valve blow down and pipe size with full size relief drain from funnel to outside, or to a floor drain in a location approved by PROFESSIONAL.
 - b. Sizes 2-1/2 inches and Larger – Equal to Watts Series LF909-S/FDA-QT/FDA. Provide flanged connections both ends and manufacturer's funnel. Provide strainer ball valve blow down and pipe size with full size relief drain from funnel to outside, or to a floor drain in a location approved by PROFESSIONAL.

2.02 GAGES, PRESSURE

- A. Type 1, (pressure for water), initial mid-scale accuracy one-percent of scale (Qualify grade), metal or phenolic case, 4-1/2 inches in diameter, 1/4-inch NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.
- B. Provide brass, lever handle union cock. Provide brass/bronze pressure snubber for gages in water service. Gage cocks shall be Weksler Type A, Trecise No. 880 or Weiss Type LC.
- C. Range of Gages: For services not listed provide range equal to at least 130 percent of normal operating range:
 - 1. Domestic Water.....0 to 100 psig

2.03 THERMOMETERS

- A. Light powered, liquid crystal display, °F or °C selector switch and 6" brass stem with adjustable angle as required to read display from eye level.
- B. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.
- C. Scale range may be slightly greater than shown to meet manufacturers' standard. Required ranges in degrees F:
 - 1. Domestic Water.....30 to 180
- D. Equal to Weiss Instruments, Inc "Digital Vari-angle" or Weksler "AAD" series.
- E. Provide all thermometers located outdoors with waterproof cover equal to Weiss DVC-4.

2.04 WATER PRESSURE REDUCING VALVE AND CONNECTIONS

- A. Less than three (3) inches, bronze body and trim, three (3) inches and over, cast-iron body with bronze trim. Single-seated, for dead-end service for 30 to 90 pounds range on low-pressure side. Composition diaphragm and bronze spring shall act directly on valve stem. Delivered pressure shall not vary more than one pound for each ten (10) pounds variation in inlet pressure.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All equipment shall be installed as per manufacturer's recommendation and applicable codes and standards. Provide appurtenances as required for a complete system. Provide all appurtenances as indicated on Contract Drawings, where specified or not.

END OF SECTION

SECTION 22 31 70

ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 MECHANICAL WORK

- A. All work performed under this Contract shall be in accordance with Division Electrical.

PART 2 - PRODUCTS

2.01 STARTERS

- A. For each and every motor provided by CONTRACTOR, a new proper motor starter shall be furnished for installation, except that all starters for 1/2 horsepower single phase and smaller motors as specified and/or required shall be manual type.
- B. Heaters shall be of the melting alloy type, sized to the exact nameplate running current of the motor. Manually operated motors with magnetic controllers shall be provided with oil-tight pushbutton stations and automatically controlled motors shall be provided with oil-tight "hands-off-auto" automatic switches. All magnetic starters shall be provided with red bull's eye pilot light in cover. Energy for controlled circuits shall be taken from the load contacts from the starters. All power wiring and control wiring shall be run in rigid conduit in damp locations or electrical metallic tubing in dry locations, and shall conform to NEC Standards. Provide two sets each of normally open and normally closed auxiliary contacts for all magnetic starters.
- C. For all starters for three phase motors, provide both overload and under-voltage and over-voltage protection in all phases and protection from phase loss and phase reversal.
- D. For manual and automatic controlled operation of 3/4 HP and larger motors, furnish magnetic motor starter with:
 - 1. Maintained contact starter with "hand-off-auto" switches.
 - 2. Trip free, thermal overload relays.
 - 3. Capable of accepting 3 external electric interlocks.
 - 4. "Red" run pilot bulb indicator.
- E. Where interlock or automatic operation is specified, regardless of HP, provide magnetic starter complete with "run-off-auto" switch so connected that in "run" or "auto" all safety controls shall stop the motor. Provide number and type of auxiliary normally open and/or closed contacts as required by specified control sequence.
- F. Size 2 and larger starters shall have control circuits individually fused from line side of starter, or lead side of breaker, on combination unit. Starters on service above 240 volts shall have 120 volts, built-in control circuit transformer fused from line side.
- G. Each electrically operated item of equipment shall be suitable for proper operation on the electrical supply to which it is to be connected as directed on the Electrical Drawings. Prior to delivery on job site, it shall be the responsibility of the CONTRACTOR and any Sub-Contractors, equipment suppliers, etc. to determine from the Electrical Drawings the characteristics of the electrically operated item, and to furnish each item accordingly. CONTRACTOR shall pay the cost due to any modifications resulting from differences as compared to Basis of Design products.

- H. Provide soft start and soft stop magnetic motor starters for all motor three phase loads above 5 HP, as Magnetek Series RVS-DN with digital microprocessor circuitry, and include the safeties as detailed above, with auto reset.

2.02 MOTORS

- A. All motors under this Contract shall be provided with thermal overload protection.
- B. Equipment shall operate properly under a 10 percent plus or minus voltage variation, and a 5 percent plus or minus frequency variation.
- C. Unless noted otherwise, motors shall be squirrel cage induction type with ball bearings. Motors 1/2 HP and smaller shall be 120 volts, single phase, with permanently lubricated bearings; 3/4 HP and larger shall be 3 phase, Design "B" or "C", drip-proof type, of minimum power factor and energy efficiency as listed herein.
- D. Motors shall be premium efficiency type as defined by energy policy act of 1992 (EPACT) and latest version of IEEE Standard 112, Test Method B.

HP	EFFICIENCY	POWER FACTOR
1	84	72
1.5	85.5	73..5
2	85.5	70.6
3	89.5	77.5
5	89.5	81
7.5	91.7	78.9
10	91.7	83
15	93	81
20	93.6	84
25	93.6	83.5
30	94	85.1
40	95.5	76
50	95.5	84.2
60	95.5	84.5
75	96	83.4
100	96	84.4

- E. Motors shall be rated for continuous, full-load duty and capable of withstanding momentary overloads of 50 percent. Select motors so actual load does not exceed nameplate ratings, and does not use motor "service factor". All motor furnished for this project shall have minimum service rating factor of 1.15. All motors shall be highest energy efficient type for all mechanical applications.
- F. Except where interlock or automatic control is required, single speed single phase motors, 1/2 HP and smaller shall have manual motor switch with pilot light and thermal overload protection.
- G. Each motor to be installed outdoors shall be of the totally-enclosed fan-cooled type, or housed in a weatherproof housing. Motors for hazardous locations shall be properly furnished to suit application.

- H. Multi-speed motors shall, except as noted, be consequent pole, variable torque, single winding. When the speed ratios or the load characteristic dictates, the multispeed motors shall be separate winding types. Variable speed motors operating over an adjustable range of speeds shall be motors specifically designed and rated for this duty.

2.03 ELECTRICAL FOR EQUIPMENT

- A. Motor controllers, protection devices, etc., for control and protection of equipment shall be furnished with the equipment, but installed and electrically connected to power source under Division 26 - Electrical.
- B. NEMA Standards shall be taken as minimum requirements for Electrical equipment.
- C. CONTRACTOR shall provide and install all disconnects for all MECHANICAL motors and loads unless equipment is provided with integral disconnect(s).
- D. All three phase motors in occupied areas shall be "quiet" rated and so marked.
- E. On all three phase motors, provide both overload and under-voltage and over-voltage protection in all phases and protection from phase loss and phase reversal.
- F. Suitable enclosures for all electrical equipment shall be provided to suit environment as per NEMA and NFPA standards.
- G. Clearances of 36 inches shall be maintained around equipment less than 400V. Clearances of 48 inches shall be maintained around equipment greater than 400V.

PART 3 - EXECUTION

3.01 GENERAL

- A. Where electrical voltage and phase characteristics are specified hereinafter, verify them with the Electrical Drawings. In case of discrepancy between the Specifications and the Electrical Drawings, the Electrical Drawings shall govern.
- B. The CONTRACTOR shall provide power to all circuits, controls, and safety devices to every piece of mechanical equipment specified or shown on Drawings whether a power source is indicated or not on Electrical Drawings.
- C. Control wiring (120V. and less) shall be provided under Division 22 - Plumbing and extended from the 120V. power circuits indicated on the Electrical Drawings. All wiring for voltages higher than 30 volts shall be done by a licensed electrician.

END OF SECTION

SECTION 22 44 30

PLUMBING SPECIALTIES

PART 1 - GENERAL

1.01 SCOPE

- A. Domestic water, sewer, roof drainage and condensate drains, including piping, equipment and all necessary accessories as designated in this section.
- B. Furnish all cleanouts and/or test tees as shown on Contract Drawings and required by Code. Cleanouts shall be the same size as the pipe they serve, except that 4 inches shall be the largest size required. Cleanouts shall be provided at the foot of each soil stack and of each run, change in direction, and mains, not to exceed 50 feet apart inside of building and 80 feet apart outside of building. The smallest flush floor cleanout shall be 3 inches unless otherwise noted.

PART 2 - PRODUCTS

2.01 FLOOR DRAINS

- A. Floor drains shall be in accordance with ANSI A112.21.1. Provide caulking flange for connection to cast iron pipe, screwed outlets for connection to steel pipe, and side outlet when shown. Provide suitable clamping device and extensions if required, where installed in connection with waterproofing membrane. (Submit detailed shop drawings of these drains). Double drainage pattern floor drains shall have integral seepage pan for embedding in floor construction, and weep holes to provide adequate drainage from pan to drain pipe.
- B. The scheduled plumbing drains are Zurn Models, however equal Jay R. Smith and Wade models are acceptable. Note: Provide flashing clamp when required with waterproofing membrane. See Drawing Schedules for more information.

2.02 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 PROFESSIONAL over routing of such drains.

2.03 OTHER DRAINS

- A. Other required drains, including condensate drain piping, relief and overflow drain piping shall be provided and installed by CONTRACTOR. See BASIC MECHANICAL MATERIALS AND METHODS for piping specifications. Drains with outlets outdoors shall include insect screen neatly attached over opening.

2.04 CLEANOUTS

- A. Cleanouts shall be as manufactured by Wade, Jay R. Smith, or Zurn, and shall be as follows:
 - 1. Inside building, exposed on walls - Zurn Model Z1446.
 - 2. Inside building where tile floors occur - Zurn Model Z1400.
 - 3. Inside building where ceramic or quarry tile occurs - Zurn Model Z1400.
 - 4. Outside building where concrete occurs - Zurn Model Z1406.
 - 5. Outside building, no paving - Zurn Model Z1449 with 18 inches by 18 inches by 4 inches concrete pad poured around cleanout with sloped top to shed water.
 - 6. Inside/Outside Building, acid resistant type, as Orion type "FCO-RD".
- B. All interior cleanouts to have polished bronze finish and exterior cleanouts a brass finish unless otherwise noted. All flush grade cleanouts and cleanouts in walks, etc., shall have inset square key stainless steel covers.

PART 3 - EXECUTION

3.01 INSTALLATION: (DRAINS)

- A. Floor and roof drains shall be installed according to manufacturer's recommendations. Provide and install all flashing and weatherproofing as required. Adjust extension sections on all drains as required for proper height adjustment.
- B. All floor drains connected to sanitary waste system to be trapped. Connect floor drains to sanitary waste piping as indicated on Contract Drawings.
- C. The CONTRACTOR shall connect to roof drains and exterior roof downspouts and route new piping to its conclusion outside of building as indicated on Contract Drawings.
- D. 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.
- E. Each water relief valve discharge shall be piped down to 6 inches 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.
- F. The top of all floor and trench drain strainer covers shall be cleaned and polished prior to final inspection by the PROFESSIONAL.
- G. 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 PROFESSIONAL to permit servicing of equipment, systems, etc.

3.02 INSTALLATION: (CLEANOUTS)

- A. Install cleanouts such that each type is flush with floor, walls, outside grade, etc. Except as explicitly noted, all inside floor cleanouts shall be flush with finished floor surface.
- B. Flush grade cleanouts shall include a concrete pad surrounding cleanout as indicated above concrete pad and cleanout top shall be flush with finished grade.
- C. All cleanout plug threaded sections to be installed with appropriate lubricant and sealant for future maintenance and access.
- D. The top and faceplate of all cleanouts indoors shall be cleaned and polished prior to final inspection by the PROFESSIONAL.

END OF SECTION

SECTION 22 44 40

PLUMBING FIXTURES, TRIM & ACCESSORIES

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all labor, equipment, materials, etc., required to complete installation as specified herein and/or shown or scheduled on plans.
- B. Work Included: Plumbing fixtures, associated trim and fittings necessary to make a complete installation from wall or floor connections to rough piping, and certain accessories.

1.02 APPLICABLE STANDARDS

- A. Die-cast zinc alloy will not be accepted. Dimensions for lavatories and sinks are indicated in the following order: Length, Width (distance from wall), and Depth.
- B. Corrosion-Resistant Steel (CRS):
 - 1. Plate, Sheet and Strip: CRS flat products shall conform to chemical composition requirements of any 300 series steel specified in ASTM A276.
 - 2. Finish: Exposed surfaces shall have standard polish (ground and polished) equal to finish No. 4 as specified in NAAMM.
- C. Traps:
 - 1. 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 or 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.
 - 2. All drains, overflows, condensate and relief drains are to be routed to a trapped hub or floor drain. If plans are not specific, check with the ENGINEER for routing of such drains.

PART 2 - PRODUCTS

2.01 STOPS AND SUPPLIES

- A. All stops and supplies shall be NSF 61 compliant and contain less than 0.25 percent lead (Pb) by weight.
- B. Stops and supplies for lavatories, sinks, tank type water closets, etc., shall be chrome-plated brass, angle all bronze compression quarter turn ball type. Provide lock-shield, loose key or screwdriver pattern angle stops for exposed connections to water closet, lavatory or sink applications in public accessible areas. Straight stops or stops integral with faucet handles, with compression type connections may be utilized in concealed applications, including eyewash and laboratory installations in casework. Locate stops centrally above or below fixture in accessible locations. Stops shall be as ball valve convertible all bronze construction type, as McGuire, with handles within cabinet locations only.

- C. Stops for non-public or concealed applications may be angle compression ball quarter turn type with handle if concealed within cabinets. This included all faucets, whether specifically called for or not, including sinks in wood and metal casework, laboratory furniture and kitchen equipment. Locate stops centrally above or below fixture in accessible location. Supplies for sinks, lavatories, EDFs, etc., in concealed applications shall be stainless steel braided flexible type with compression rubber/neoprene ends to match connections.
- D. Furnish one (1) key for each lock-shield stops (for each stop installed) to OWNER. See Section Basic Mechanical Materials and Methods and Section Mechanical Close-out Requirements for additional information.
- E. Provide stainless steel braided reinforced flexible supply water piping connection to refrigerate ice makers, residential washing machines, residential water heaters, etc.

2.02 ESCUTCHEONS

- A. Provide chrome-plated brass escutcheons on all water and drain piping in wall, floor and ceiling penetrations. 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.

2.03 AERATORS

- A. Provide aerators for fixtures only where specified.

2.04 CARRIERS

- A. Where wall hung water closets, urinals, lavatories, electric drinking fountains, or sinks are installed back-to- back and carriers are specified, provide one carrier to serve both fixtures in lieu of individual carriers. Provide appropriate carriers for all wall mounted water closets, urinals, lavatories, EDF's and sinks, 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 PROFESSIONAL.

2.05 FIXTURE TRIM

- A. All plumbing fixture brass trim shall be so designed that all wearing parts are to be in a standardized renewable operating unit, which can be removed without detaching the supply fixture or faucet proper. The standardized renewable operating unit are to be interchangeable with all supply fixtures and faucets whether quick compression or self-closing. All exposed metal parts of all fixtures, including faucets, waste fittings, waste plugs, flush valves, traps, supplies, nipples, and escutcheons shall be chrome-plated brass unless other materials or finish is specified. Chrome plated brass/copper supplies shall be provided on all water supplies to fixtures. All hot/cold faucet handles for lavatories, sinks and bath/shower supply fittings shall include red and blue color code indications. Basket and similar strainer assemblies for sinks shall be stainless steel.
- B. Drain and waste assemblies below lavatories and sinks shall be minimum 17 gage chrome plated brass and traps shall include cleanout plugs.

2.06 HANDICAPPED SERVICES

- A. Provide where required and/or indicated plumbing fixtures and installations that comply with the latest version of "American with Disabilities Act" (ADA).
- B. Provide neat pre-packaged molded insulation protection on an exposed drain and water piping below sinks and lavatories equal to Truebro Models #102 and #105.

2.07 PLUMBING FIXTURES AND TRIM

- A. Furnish and install all plumbing fixtures specified herein and shown on plans. Zurn fixtures are specified, however, Kohler, or American Standard may be used if they are equal in all respects to those specified. CONTRACTOR shall submit data on trim as well as fixtures. All water closets, urinals and other fixtures associated with flush valves shall be water conservation type unless specified otherwise. All lavatory and shower supply fittings shall be of the flow restrictor type, unless specified otherwise. Flush valves shall be Zurn type "AV" or Sloan Royal with clog resistant design.
- B. Water Closets: All water closets shall be provided with open front white plastic seat with stainless steel mounting post and fasteners with "Sta-Tite" technology as Bemis. Provide right or left hand flush valve on ADA water closets to meet ADA requirements. See Drawing Schedules for more information.
- C. Urinals: See architectural drawings for mounting height. See Drawing Schedules for more information.
- D. Lavatories: Provide with two (2) each supplies with stops, offset grid drain (grid drain strainer finish is to match supply fitting finish) and tailpiece, and 1-1/4" cast brass trap. See architectural drawings for mounting height. See Drawing Schedules for more information.
- E. Trap Primers: See Drawing Schedules for more information.
- F. Sinks: The scheduled stainless steel sinks are Elkay Models with Zurn faucets and trim, however, equal Dayton or Just models shall be acceptable. Provide with two (2) each supplies with stops, Elkay Model LK-35 basket with stainless steel strainer, C.P. Brass 1-1/2 inch tailpiece, 1-1/2 inch cast brass P-trap with cleanout. See Drawing Schedules for more information.
- G. Water Hammer Arrestors:
 - 1. Water hammer arrestors shall be piston type.
 - 2. Water hammer arrestors shall be type approved for installation with no access panel required.
 - 3. All water hammer arrestors shall be NSF 61 compliant and contain less than 0.25 percent lead (Pb) by weight.
 - 4. The following schedule for Zurn Shoktrol arrestors shall apply:

<u>P.D.I. SYMBOL</u>	<u>FIXTURE UNIT RATINGS</u>
A	4-11
B	12-32
C	33-60
D	61-113
E	114-154
F	155-330

- H. Utility Box: Recessed stainless steel metal box with outlets and inlets as scheduled. Drain connections to be 2 inches. Inlets shall be 1/2 inch MIP/Sweat fittings with 1/4 turn ball valves and integral water hammer arrestors. See Drawing Schedules for more information.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Fixture Setting: Opening between fixture and floor and wall finish shall be sealed with silicone based caulking. Grout other excessive gaps as required.
- B. Supports and Fastenings: Secure all fixtures, equipment and trimmings to partitions, walls, etc., with brass through bolts, toggle bolts, expansion bolts, or power set fasteners, as required. Exposed heads of bolts and nuts in finished rooms to be hexagonal, polished chromium plated brass with rounded tops.
 - 1. Through Bolts: For free standing marble and metal stud partitions.
 - 2. Toggle Bolts: For hollow masonry units, finished or unfinished.
 - 3. Expansion Bolts: For brick or concrete or other solid masonry. To be 1/4-inch bolts, 20 threads per inch, and to extend at least three inches into masonry; to be fitted with loose tubing or sleeves extending into masonry. Wood plugs, fiber plugs, lead or other soft metal shields are prohibited.
 - 4. Power Set Fasteners: May be used for concrete walls, shall be 1/4-inch threaded studs, 20 threads per inch, and shall extend at least 1-1/4-inches into wall.
- C. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury.
- D. On wall mounted water closets, where water closet waste pipe has to be offset due to beam interference, provide correct carrier and/or additional piping necessary to eliminate relocation of water closet. On floor mounted water closets, offset shall not be more than 3/4" and non-reducing.
- E. 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.
- F. All exposed metal trim and piping shall be chrome plated brass and polished.
- G. Trim which can be removed or disassembled without tools is not permitted.
- H. Furnish and install plumbing fixtures and pertaining appurtenances of the manufacturer and model number as indicated in these specifications and/or noted on the plans.
- I. Replace any fixtures or equipment broken, cracked, discolored, pitted, or otherwise imperfect.
- J. Setting height or location of fixtures shall be as dimensioned or as directed by ARCHITECT. Support or anchor fixtures by the use of bolts or other adequate means. Support wall hung lavatories and urinals by appropriate carriers. Attach floor closets to closet flange.

- K. Provide plumbing fixtures with accessible stops in supplies or with integral stops in faucets. Provide lavatory faucets, sink faucets, and supply stops with renewable seats.
- L. Provide closets with white bolt caps with retainer clips. Use all mineral gasket with plastic discharge sleeve having ethane core reinforcement.
- M. Install all wall, roof and ground hydrants in strict accordance with manufacturer's recommendations and applicable details on Drawings. Hydrants shall be installed such that box/hydrant is square and plumb with adjacent building construction. Where wall hydrants are specified to match standard brick dimensions, adjust location in field to avoid cutting bricks and install with long dimension horizontal and hinge on bottom of box.
- N. Install all fixtures in strict accordance with manufacturer's recommendations.
- O. 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.

3.02 CLEANING

- A. At completion of all work, fixtures, exposed materials and equipment shall be thoroughly cleaned.

END OF SECTION

SECTION 23 00 10 MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material, equipment and labor, etc., required to complete installation specified herein and/or shown or scheduled on Contract Drawings.

1.02 MECHANICAL SPECIFICATION SECTION INDEX

Division 23 - Heating, Ventilating and Air Conditioning (HVAC)

Section 23 00 10 - Mechanical General Provisions

Section 23 00 20 - Basic Mechanical Requirements

Section 23 00 30 - Mechanical Submittals and Shop Drawings

Section 23 00 35 - Mechanical Systems and Equipment Warranties

Section 23 00 40 - Mechanical Close-out Requirements

Section 23 00 50 - Basic Mechanical Materials and Methods

Section 23 01 40 - Mechanical Supports and Anchors

Section 23 01 70 - Mechanical Electrical Requirements

Section 23 01 90 - Mechanical Identification

Section 23 02 40 - Mechanical Sound and Vibration Control

Section 23 02 50 - Mechanical Insulation

Section 23 09 60 - Energy Management System

Section 23 09 90 - Testing, Adjusting and Balancing

Section 23 20 60 - Mechanical Pipes and Pipe Fittings

Section 23 21 00 - Mechanical Valves

Section 23 21 20 - Mechanical Piping Specialties

Section 23 38 90 - Ductwork

Section 23 39 10 - Ductwork Accessories

Section 23 48 85 - Air Cleaning/Treatment

Section 23 48 89 - Bi-polar Ionization Air Purification System

Section 23 78 55 - Air Handling Units

Section 23 89 30 - Variable Air Volume Boxes

1.03 ABBREVIATIONS

A.	A/E RECORD for	ARCHITECT; ENGINEER AND OTHER PROFESSIONALS OF this project
B.	A.P.D.	Air Pressure Drop
C.	A.S.A.P.	As Soon As Possible
D.	CFH	Cubic Feet Per Hour
E.	CFM	Cubic Feet Per Minute
F.	CO2	Carbon Dioxide
G.	E.A.T.	Entering Air Temperature
H.	E/A	Exhaust Air
I.	E.S.P.	External Static Pressure
J.	FT	Foot or Feet
K.	F.F.E.C.	Food Facilities Equipment Contractor
L.	HVAC	Heating, Ventilating and/or Air Conditioning
M.	HP	Horsepower
N.	i.e.	That is
O.	in. w.g.	Inches Water Gauge
P.	L.A.T.	Leaving Air Temperature
Q.	N.C.	Normally closed
R.	N.O.	Normally open
S.	O/A	Outside Air
T.	p.p.m.	Parts per Million
U.	PVC	Poly Vinyl Chloride
V.	R/A	Return Air
W.	S/A	Supply Air
X.	S.P.	Static Pressure
Y.	s/s	Stainless Steel
Z.	T/A	Transfer Air
AA.	TAB	Testing, Adjusting and Balancing

AB. T.S.P.	Total Static Pressure
AC. UL	Underwriters Laboratories
AD. VOC	Volatile Organic Compound
AE. vs	Versus
AF. W.P.D.	Water Pressure Drop

1.04 DEFINITIONS

- A. ARCHITECT: Architectural Design firm or ARCHITECT OF RECORD, meaning general building designer whose professional seal appears on the majority of general construction Contract Documents, or their authorized representative.
- B. ENGINEER (ENGINEER-OF-RECORD): ENGINEER whose professional stamp appears on Contract Drawings, etc. In general, unless specifically denoted otherwise, ENGINEER-OF-RECORD in 20, 21, 22 and 23 Specification Sections denotes MECHANICAL ENGINEER-OF-RECORD.
- C. Exposed, or exposed to view: Those installations which can be seen, in whole or part.
- D. Finished Spaces: Inside the building extents.
- E. Inspect and/or Inspection: Utilized for the PROFESSIONAL'S construction period services and defines as "visits by the PROFESSIONAL to the Project at appropriate intervals during construction to become generally familiar with the progress and quality of the CONTRACTOR'S work and to determine if the work is proceeding in accordance with the Contract Documents."
- F. Outside: Synonymous with outdoors, outside of building, exposed to weather, etc.
- G. Plans: Denotes general Construction Drawings prepared by the A/E.
- H. PROFESSIONAL: Authorized representative of ENGINEER-OF-RECORD'S firm.
- I. Provide: Unless specifically denoted otherwise, the CONTRACTOR referred to shall be responsible for furnishing, providing, installing, connecting, and making item or system fully functional in a safe manner as recommended by the manufacturer and by Industry Standards.

1.05 APPLICABLE STANDARDS

- A. The intent is that the complete installation shall comply with applicable laws and ordinances, utility company regulations, and applicable requirements from the latest edition of the following:
 - 1. ANSI - American National Standard Institute
 - 2. ASHRAE - ASHRAE guides, Latest Editions
 - 3. ASME - American Society of Mechanical Engineers
 - 4. ASTM - American Society of Testing Materials
 - 5. ICC - International Code Congress
 - 6. NFPA - National Fire Protection Association
 - 7. OSHA - Occupational Safety and Health Administration
 - 8. SMACNA - Sheet Metal and Air Conditioning Contractors National Association

- 9. UL - Underwriters Laboratories
 - 10. City of Jackson, Mississippi, Fire, Building, Gas, Plumbing and Mechanical Codes and Regulations, and governing authority having jurisdiction.
- B. Other applicable building, safety or fire codes having jurisdiction over equipment, materials or methods. The decision of the ENGINEER will be final in event of dispute over Code to use or its interpretation.

1.06 GENERAL CONDITIONS

- A. The General Conditions, Information to Bidders, General Requirements, and other pertinent documents issued by the ARCHITECT are a part of these Specifications and shall be complied with in every respect.
- B. By the act of submitting a bid, this CONTRACTOR agrees that all of the Contract Documents and each of the divisions of the complete Specifications have been reviewed and studied, and all requirements and coordination resulting there from are included.
- C. This CONTRACTOR shall conform to standards prescribed by City, County, and State regulations or ordinances having jurisdiction. Any changes that may be necessary to conform to such regulations or ordinances shall be made by this CONTRACTOR without extra costs to the OWNER. Where code requirements are less than those shown on the Plans or in the Specifications, the Plans and Specifications shall be followed. Where applicable, NFPA requirements shall be met.
- D. The CONTRACTOR shall comply with all applicable provisions of the William-Steiger Occupational Safety and Health Act (O.S.H.A.).
- E. Permits required for the installation of the work, as well as all authorized code inspections, including all fees and assessments, shall be borne by and arranged for by the CONTRACTOR. The CONTRACTOR shall verify specific mechanical related provisions for permitting in advance, especially where additional design/installation documentation may be required, and include provisions and/or cost of same in this bid.
- F. This 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, required or implied, for the completion of the various systems.

1.07 EXPLANATION AND PRECEDENCE OF DRAWINGS

- A. For purposes of clearness and legibility, Drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale whenever possible, the CONTRACTOR shall make use of all data in the Contract Documents and shall verify this information at building site.
- B. Do not scale drawings having 1/4 inch or smaller scale. The Drawings indicate required size and points of termination of pipes and ducts, and suggest proper routes of pipe to conform to structure, avoid obstructions and preserve clearances. Because of small scale, it is not intended that Drawings indicate all necessary offsets, and it shall be the work of this Section to install work in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear without further instruction or cost to the OWNER.

- C. It is intended that all apparatus be located symmetrically with architectural elements, and shall be installed at exact height and locations as shown on the Architectural Drawings.
- D. The CONTRACTOR shall be solely responsible for taking his own measurements and installing his work to suit conditions encountered.

1.08 SPECIAL CONDITIONS, MECHANICAL

- A. The right is reserved to move any element as much as ten (10') feet at no increase in cost provided CONTRACTOR is notified before work in question is fabricated or installed.
- B. The CONTRACTOR shall fully inform himself regarding any and all peculiarities and limitations of spaces available for the installation of all work and materials furnished and installed under the contract. He shall exercise due and particular caution to determine that all parts of his work are made quickly and easily accessible. The CONTRACTOR shall be guided by the architectural details and conditions existing at the job, correlating this work with that of the other trades, and report to the OWNER any discrepancies or interferences that are discovered. Failure to report such discrepancies and interferences shall result in the correcting of these errors or omissions by the CONTRACTOR at his own expense. All work which deviates from the Drawings and Specifications without prior approval of the OWNER, shall be altered by the CONTRACTOR at his own expense to comply with the Drawings and Specifications as directed.
- C. If equipment or fixtures to be furnished by OWNER and/or OWNER'S vendor are not delivered prior to final acceptance, services shall be capped or plugged at walls or floor as directed by ARCHITECT, ready for future connection.
- D. The CONTRACTOR shall coordinate his work with that of the OWNER, in order that there will be no delay in the proper installation and completion of the work. If, in the opinion of the OWNER, any piping, equipment, etc., has been improperly placed or installed due to lack of coordination with the other trades, such piping and equipment shall be relocated as directed by the OWNER at the CONTRACTOR'S expense.

1.09 SITE SAFETY

- A. CONSULTANT'S site responsibilities are limited solely to the activities of CONSULTANT and CONSULTANT'S employees on site. These responsibilities shall not be inferred by any party to mean that CONSULTANT has responsibility for site safety. Safety in, on, or about the site is the sole and exclusive responsibility of the CONTRACTOR alone. The CONTRACTOR'S methods of work performance, superintendence of the CONTRACTOR'S employees and sequencing of construction are also the sole and exclusive responsibilities of the CONTRACTOR alone. The CONTRACTOR shall, to the fullest extent permitted by law, waive any claim against CONSULTANT and his employees and indemnify, defend, and hold CONSULTANT harmless from any claim or liability for injury or loss arising from CONSULTANT'S alleged failure to exercise site safety responsibility. The CONTRACTOR also shall compensate CONSULTANT for any time spent or expenses incurred by CONSULTANT in defense of any such claim. Such compensation shall be based upon CONSULTANT'S prevailing fee schedule and expense reimbursement policy. The term "any claim" used in this provision means "any claim in contract, tort or statute alleging negligence, errors, omissions, strict liability, statutory liability, breach of contract, breach of warranty, negligent misrepresentation, or other acts giving rise to liability.

PART 2 - PRODUCTS - NOT APPLICABLE**PART 3 - EXECUTION****3.01 WORKMANSHIP, MATERIALS AND EQUIPMENT**

- A. All work shall be performed in a workmanlike manner and shall present a neat and mechanical appearance when completed. All materials shall be of type, quality and minimum rating prescribed herein or indicated on the Contract Drawings.
- B. If equipment or fixtures to be furnished by OWNER and/or OWNER'S vendor are not delivered prior to final acceptance, services shall be capped or plugged at walls or floor as directed by ARCHITECT, ready for future connection.

3.02 CLEAN-UP

- A. Do not allow mechanical related waste material or rubbish to accumulate in or about job site.
- B. At completion of work, remove all rubbish, tools, scaffolding and surplus materials from and about building, leaving work clean and ready for use without further cleaning required. Clean all equipment, piping, valves, fixtures, and fittings of grease, metal cuttings, insulation cement, dust, dirt, paper labels, etc.
- C. Any discoloration or other damage to parts of building, its finish or furnishings due to failure to properly clean or keep clean mechanical systems shall be repaired without additional cost to OWNER.
- D. All equipment, fixtures and installations, especially where installations are exposed to view, shall be thoroughly cleaned, polished, seams smoothed and/or sealed for a neat appearance.

3.03 INSPECTION OF PROPOSED CONSTRUCTION

- A. Prior to submitting his bid, the CONTRACTOR shall visit the site of the proposed construction and shall thoroughly acquaint himself with existing utilities, working conditions to be encountered, etc. No additional compensation shall be allowed for conditions increasing the CONTRACTOR'S cost which were not known or appreciated by him when submitting his proposal if the condition was obvious and could have been discovered by him if he had visited the project site and thoroughly informed himself of all existing conditions which would affect his work, including requirements of local authorities to meet their procedures, special requirements, codes, etc.

3.04 TEMPORARY ENVIRONMENTAL CONDITIONING

- A. Temporary heating, cooling and dehumidification capability shall be provided for this project beginning a minimum of 90 days prior to the original contract 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 adhesives, finishes, wall covering(s), tile ceiling/floors, etc. It is highly dependent upon the CONTRACTOR's comprehensive project coordination and scheduling efforts and shall be lengthened (begun earlier) should the CONTRACTOR install such systems and/or finishes which are recommended by the system and/or finish manufacturer to be installed and/or maintained in a minimum environmental condition. This interior space conditioning, known hereafter as "temporary HVAC", 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. During this minimal temporary HVAC period, the interior space shall be continuously monitored and controlled to provide the following:
 - 1. maximum 85 degrees Fahrenheit dry bulb temperature.
 - 2. minimum 60 degrees Fahrenheit dry bulb temperature.
 - 3. maximum 60% relative humidity.
- C. In effect, automatic controls for refrigeration, dehumidification, and heating shall be provided such that the indoor building environment, as described above, can be continually maintained. If a system and/or finish manufacturer recommends a more stringent requirement for conditioning, same shall be provided.
- D. CONTRACTOR may utilize temporary thermostats/sensors/controllers in conjunction with these temporary HVAC provisions. These temporary thermostats are not required to be the same grade unit specified herein, but rather intended to protect overall system performance during construction periods. Less expensive thermostats/controllers are acceptable. Temporary thermostats/controllers should be replaced with specified units prior to beginning Testing, Adjusting and Balancing per Section Controls and Instrumentation.
- E. The CONTRACTOR shall coordinate such temporary provisions with the all trades and utility companies to accomplish this requirement including adequate temporary power to equipment, etc. All cost and coordination for these temporary HVAC provisions shall be the responsibility of the CONTRACTOR and included in his base bid.
- F. While operating the systems, the intent is to protect the installations from dirt, dust, debris, etc. such that at substantial completion the systems are new, clean and ready for the OWNER's beneficial use. The CONTRACTOR is responsible for protection of the WORK to meet the design intent identified herein. The following minimum requirements shall be met:
 - 1. The exterior building envelope is complete including installation of all permanent doors, windows, walls, louvers, roof openings, etc.
 - 2. ALL interior and exterior dust generating activities and subsequent cleanup is complete and approved by the ARCHITECT. Examples of this are exterior sitework around the building, interior sheet rock installation/finishing, floor grinding, spray application of paints/sealers, etc.
 - 3. HVAC Systems shall have pleated air filters of types indicated in Section Air Cleaning/Treatment installed, monitored and periodically replaced when loaded.

4. All R/A grilles and/or openings into ductwork/plenums are fully covered, and protected with filter material of types indicated in Section Air Cleaning/Treatment. These filters shall be continually monitored and periodically replaced when loaded.
 5. There is no reduction in specified equipment warranty, capacity, performance, or life of the equipment.
 6. HVAC equipment manufacturer's recommendations don't indicate construction practices and installations are harmful to systems, equipment, etc.
- G. If new HVAC equipment cannot be utilized for providing indoor environmental control during construction for finishes, etc., the CONTRACTOR shall arrange for other temporary HVAC capacity as required.
- H. If the CONTRACTOR fails to adhere to these guidelines for operation of the permanent building mechanical systems, corrective action by the CONTRACTOR will be required. Corrective action will be determined by the ENGINEER but may include any combination of the following:
1. Cleaning or Replacing Ductwork should it be found with visible dust/debris. A third party testing/inspection representative may be required depending upon the extent of contamination.
 2. Replacement or Cleaning of Equipment should it be found with visible dust/debris/damage. The respective equipment manufacturer's representative will be required to inspect and make written recommendations as to the corrective actions necessary to return the equipment to like new conditions.
- I. The CONTRACTOR will be solely responsible for and include all cost associated with any required corrective actions.
- J. However, permanent HVAC equipment, as described above, shall be fully operational during the last 30 days of the temporary HVAC period such that system performance and controls can be tested, adjusted and balanced per Section Testing, Adjusting and Balancing.

3.05 EXISTING UTILITIES AND SERVICES

- A. When encountered in work, protect existing active sewer, water, gas, electric, other utility services, structures; where required for proper execution of work, relocate them as directed. If existing active services are not indicated, contact PROFESSIONAL for instructions.
- B. When encountered in work area, whether or not indicated, cap or plug or otherwise discontinue existing inactive sewer, water, gas, electric, other utility service structures, of which action should be taken. If removal is required, request instructions from PROFESSIONAL.
- C. While work is in progress, except for designated short intervals during which connections are to be made, continuity of service shall be maintained to all existing utilities and systems. Interruptions shall be scheduled and coordinated with ARCHITECT and OWNER and approved in advance with the OWNER and serving utilities. If requested, downtime shall be limited to weekends and/or night periods to least disrupt normal use of these utilities. The CONTRACTOR shall be responsible for any interruptions to service and shall promptly repair any damages to existing systems caused by his operations.

- D. The accuracy of the location of existing underground, and otherwise concealed, HVAC, domestic, fire protection, sanitary and storm drainage utilities is not guaranteed. The CONTRACTOR shall, early in the project, prior to demolition of existing work and layout of new work, verify all underground and concealed work in the proximity of connections to existing services and routings.
- E. Immediately upon commencing construction, and prior to construction of any part of the facility involved in any way with utilities, the CONTRACTOR shall investigate thoroughly the size, capacity, arrangement and location of all mechanically related utilities. The CONTRACTOR shall immediately report any discrepancies or apparent problem involving the project that pertains to utilities. This applies to private as well as public utilities. This CONTRACTOR shall coordinate and utilize the services of public and private "locators" to ascertain the whereabouts of all underground utilities in the area where work is to be performed.

END OF SECTION

SECTION 23 00 20

BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE

- A. Furnish all labor, materials, services, and equipment required to complete the installation of complete and acceptable mechanical systems in accordance with these Specifications and the Contract Drawings.

1.02 TESTS

- A. This CONTRACTOR shall conduct such tests as required to determine that systems and equipment, which he installs, conform to Specifications. CONTRACTOR shall supply all labor, materials, instruments, operations, etc., required to facilitate testing.
- B. Gages, thermostats, and instruments used in testing shall be accurate, recently calibrated and approved by the PROFESSIONAL prior to test. Instruments installed permanently in systems as specified herein may be used in testing when approved by the ENGINEER.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 MISCELLANEOUS WORK REQUIRED

- A. The CONTRACTOR shall provide foundations for equipment, chases, furring, framed openings in wall, partitions, etc., installation of wall louvers and grilles in doors, finish painting and all other similar work of a general construction nature. All roof flashing by CONTRACTOR.
- B. The CONTRACTOR shall bring adequate power to and make final connections to all equipment furnished under this Contract.
- C. All items of labor, materials and equipment not specifically stated herein or on Contract Drawings to be by others are required to make the systems complete and operative, shall be by this CONTRACTOR.

3.02 PROTECTION OF EQUIPMENT AND MATERIALS

- A. Responsibility for care and protection of equipment and materials under this Contract rests with this CONTRACTOR until equipment or materials have been tested and accepted.
- B. All pipe ends, valves, ductwork and parts of equipment left unconnected, permanently or temporary, shall be capped, plugged or properly protected at the end of each working day to prevent entry of foreign matter. During the construction process, cover ductwork exposed to weather and/or when not yet installed, with sheet metal caps screwed in place and sealed.
- C. Store equipment, ductwork including pipe and valves, off the ground and under cover. For storage outdoors, minimum 6-mil thick plastic shall be fitted to withstand splattering, ground water, precipitation and wind.

- D. Protect air handling unit coils by use of protective sheet metal panels or plywood.
- E. Damaged equipment shall be repaired or replaced at the option of the PROFESSIONAL. Finishes and/or scratched paint on equipment, etc., shall be repaired and repainted to match new condition(s).
- F. Do not bring insulated equipment or ductwork to job site until same can be adequately protected from wind, rain and damage, etc. In general, store ductwork in building(s) not yet fully enclosed, off the ground and under minimum 6-mil plastic sheeting, etc. This includes dual wall spiral and interior lined rectangular ductwork, and other similar equipment with liners, controls, etc., not recommended to be exposed to wind and water, etc. Such ductwork and equipment found damaged and/or damp shall be immediately replaced and shall not be utilized for this project.
- G. This CONTRACTOR shall protect his work at all times from danger by freezing, breakage, dirt, foreign materials, etc., and shall replace all work so damaged. The CONTRACTOR shall use every precaution to protect the work of others, and he will be held responsible for all damage to other work caused by his work or through the neglect of his workmen.

3.03 INSTALLATION COORDINATION

- A. The mechanical plans do not give exact elevations or locations of lines, nor do they show all the offsets, control lines, or other installation details. The CONTRACTOR shall carefully lay out his work at the site to conform to the structural conditions, to provide proper grading of lines, to avoid all obstructions, to conform to details of installation supplied by the manufacturers of the equipment to be installed, and to thereby provide an integrated, coordinated and satisfactory operating installation. In general ductwork has the right-of-way.
- B. If the CONTRACTOR proposes to install equipment, including piping and ductwork requiring space conditions other than those shown, or to rearrange the equipment, he shall assume full responsibility for the rearrangement of the space and shall have the ARCHITECT review the change before proceeding with the work. The request for such changes shall be accomplished by Shop Drawings of the space in question.
- C. The CONTRACTOR shall so coordinate the work of the several various trades that it may be installed in the most direct and workmanlike manner without hindering the other trades. Piping interferences shall be handled by giving precedence to pipe lines, which require a stated grade for proper operation. For example sewer lines and condensate piping shall take precedence over water lines in determination of elevations. Where there is interference between sewer lines and condensate lines, the sewer lines shall have precedence and provisions shall be made in the condensate lines for looping them around the sewer lines. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork.
- D. Piping, equipment, or ductwork shall not be installed in electrical equipment rooms or elevator machine rooms except as serving only those rooms. Outside of electrical equipment rooms, do not run piping or ductwork, or locate equipment, with respect to switchboards, panel boards, power panels, motor control centers or dry type transformers:
 - 1. Within 42 inches in front (and rear if free standing) of equipment; or
 - 2. Within 36 inches of sides of equipment.
 - 3. Clearances apply vertically from floor to structure/ceiling.

3.04 INSTALLATION DIRECTIONS

- A. Obtain manufacturer's printed installation directions to aid in properly executing work on equipment requiring such directions. Submit such directions and installation details to PROFESSIONAL for approval prior to time of installation for use in supervising work. If the manufacturer's installation instructions or details conflict with the Contract Document requirements, CONTRACTOR shall promptly make PROFESSIONAL aware in writing and request clarification.

3.05 MECHANICAL VERIFICATION AND INSPECTIONS

- A. The CONTRACTOR shall coordinate, with the A/E with a minimum ten (10) days advance notice, the inspection of mechanical sub-systems for the following:
 - 1. in-wall ductwork
 - 2. above ceiling ductwork
 - 3. in-attic ceiling ductwork

These inspections shall be coordinated prior to wall and/or ceiling/attic insulation installation, (concealment) etc., such that these mechanical installations can be easily visually inspected by A/E for general conformance with Contract requirements. These installations shall not be concealed until such time the A/E indicates these mechanical installations are acceptable. If a re-inspection is required, an A/E revisit and a follow-up inspection shall be similarly coordinated with sufficient advance notice as approved by the A/E. Therefore, it is pertinent for the CONTRACTOR to inspect these type installations himself and verify that these installations are complete and in conformance with specified standards to minimize any time delays and/or coordination of construction sequencing, etc.

- B. The CONTRACTOR should note the following requirement for administering the punch list(s) and mechanical closeout documents associated with a substantial completion and/or final, etc. In general, the punch list(s) will be furnished with blanks for the CONTRACTOR and/or his Sub-Contractor(s) to initial and date, adjacent to each item, for coordination and verification efforts. The completed punch list shall be transmitted to A/E to allow them to thereafter schedule a follow-up visit for re-inspection and verification. It is, therefore, prudent for the CONTRACTOR, to administer the overall process, and verify that all punch list items are complete and in compliance with Contract requirements, prior to requesting a follow-up A/E inspection effort.
- C. The CONTRACTOR shall be liable for inspections and further administrative involvement required of the A/E after 30 days of the original scheduled completion date, and for re-inspections and involvement by the A/E caused by the CONTRACTOR'S negligence and failure to fully complete punch lists and Closeout Documents when required and/or requested.

END OF SECTION

SECTION 23 00 30

MECHANICAL SUBMITTALS AND SHOP DRAWINGS

PART 1 - GENERAL

1.1 SUBMITTALS AND SHOP DRAWINGS

- A. The submittal data to be furnished for this project shall comply with the Specifications and Contract Documents in their entirety.
- B. CONTRACTOR shall submit to the ARCHITECT/ENGINEER list of materials, fixtures and equipment to be utilized for this project.
- C. Failure to submit data for approval within specified time limits will result in the CONTRACTOR being required to furnish equipment as called for by name.
- D. Reproduction of Design Documents in any portion for use in a submittal is not acceptable.
- E. Whether or not the CONTRACTOR is utilizing the equipment as called for by name or not, does not relieve the CONTRACTOR of providing submittals. Submittals shall be required for all equipment as directed herein and as directed by the PROFESSIONAL.
- F. CONTRACTOR shall not delegate the authority to material supply houses to present data for approval. This shall be done by the CONTRACTOR.
- G. Materials/equipment not initially submitted, incomplete, or rejected shall be revised and re-submitted within twenty (20) days. The same format is required for all resubmitted data.
- H. All Submittals and Shop Drawings shall be thoroughly reviewed for general conformance with Contract Documents and with other crafts/trades.
- I. The CONTRACTOR shall verify with local governing authority and provide all additional documentation required to obtain permanent permit for this project. This shall include, but not limited to HVAC, details, calculations, etc. Should an ENGINEER'S stamp or specific designer's credentials also be required on this supplemental design and/or installation documentation, the CONTRACTOR shall comply. The cost of all such extended documentation shall be considered a normal part of the shop drawing for installation coordination documentation, and the full cost of same shall be included in the CONTRACTOR'S base bid.
- J. CONTRACTOR's Selection of Materials and Equipment:
 - 1. Where a definite material or brand name is specified, it is not the intent to discriminate against any product of another manufacturer. Reference to a specific manufacturer's product by name, make or catalog number is intended to establish standards of quality, design, dimensions and appearance.
 - 2. Open competition is expected, but in all cases, complete data must be submitted on all proposed substitutions and samples shall be submitted for comparison and test when requested by the PROFESSIONAL. Burden of "proof of equality" lies solely with the CONTRACTOR.

3. 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 ascertain if the submitted materials and equipment will fit into the space allotted as conveniently as the materials and equipment utilized as the basis of design. Furthermore, the CONTRACTOR 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 PROFESSIONAL, the CONTRACTOR shall install items specified even though materials and equipment had been previously approved. PROFESSIONAL'S approval of materials and equipment other than the basis of design is for performance only.
 4. When submitting materials and equipment other than the basis of design, the CONTRACTOR should note the following minimum considerations: (1) capacities shown are absolute minimum and must be equaled, (2) physical size limitation for space allotted, (3) static and dynamic weight limitation, (4) structural properties, (5) noise level, (6) vibration generation, (7) interchangeability, (8) accessibility for maintenance and replacement, (9) compatibility with other materials, assemblies, and (10) similar items shall be same manufacture and style whenever possible.
 5. The availability of service is of prime importance to the OWNER and was a major consideration in selecting the materials and equipment that are listed as the basis for design. The CONTRACTOR is advised, therefore, to exercise caution in accepting prices in the "or equal" clause in this specification. Competent service must not only be available, but must, in the case of specialty HVAC equipment and control systems, be a direct arm of the manufacturer. Further, the service agency, as a representative of this manufacturer, must have been in continuous operation in this area sufficient time to indicate a degree of permanence as required by the PROFESSIONAL.
 6. All material and equipment, for which a U.L. Standard, and AGA approval, or an ASME requirement is established, shall be so approved and labeled or stamped.
- K. Submittal format and information shall be provided as follows:
1. Submittals for HVAC data shall be bound containing one copy of all specified submittals. Electronic submittals are acceptable as long as all information is included. **FAILURE TO BIND AND IDENTIFY SUBMITTALS WILL RESULT IN THE AUTOMATIC REJECTION OF THE SUBMITTAL DATA WITH NO EXCEPTION. ANY PARTIAL SUBMITTALS WILL BE RETURNED TO THE CONTRACTOR FOR RE-SUBMITTAL. ONLY COMPLETE SUBMITTALS WILL BE ACCEPTABLE.**
 2. All submitted equipment must be identified with same "Mark Numbers" as identified on Drawings or in Specifications.
 3. Reference to all pertinent data such as electrical characteristics and horse power, capacities, construction material of equipment, UL labels where required, accessories specified, manufacturer, make and model number, weights where specified, size and characteristics of the equipment, name of the project and a space large enough to accept an approval stamp.
 4. The bound submittals shall be provided with an identification tab for each and every Specification Section that requires submittals. Each item in each tabbed section shall be identified with the paragraph number relating to the item submitted by the use of a cover sheet or by high lighting the paragraph on the first page concerning the item.

5. Any deviation from any part of the Contract Documents shall be clearly and completely highlighted.
6. Each and every submittal shall be stamped by the CONTRACTOR confirming that the submittals have been checked for compliance with the Contract Documents.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.1 SUBMITTALS AND SHOP DRAWINGS

- A. The following list of materials and equipment shall be submitted to PROFESSIONAL for approval.
- B. Submittals are required for the following within 30 days after project "Notice to Proceed":
 1. SECTION 23 00 50 - BASIC MECHANICAL MATERIALS AND METHODS
 - a. Fire Stopping for Piping, Conduit and Ductwork
 - b. Wall and Plenum Access Doors
 - c. Welders Test and Certification
 2. SECTION 23 01 90 - MECHANICAL IDENTIFICATION
 - a. List and Size/Color(s) of all Starter, Switch, Disconnect Switch, Time clock and Equipment and Warning Phenolic Labels
 - b. Piping Markers
 3. SECTION 23 02 40 - MECHANICAL SOUND AND VIBRATION CONTROL
 - a. Pipe, Duct and Equipment Vibration Isolation
 4. SECTION 23 02 50 - MECHANICAL INSULATION
 - a. Insulation for all piping applications
 - b. Insulation for all ductwork applications
 - c. Piping fitting insulation and cover
 - d. Vinyl cover
 - e. Vapor Sealant
 - f. Vinyl Tape
 5. SECTION 23 21 00 - VALVES
 - a. Ball Valves
 - b. Gas Valves
 - c. Check Valves
 6. SECTION 23 21 20 - PIPING SPECIALTIES
 - a. Pressure Gauges
 - b. Thermometers
 7. SECTION 23 38 60 - FANS
 - a. All Fans, Construction, Accessories, and Finishes
 - b. Submit Fan and Curb Housing Color Chart for ARCHITECT Color Selection
 - c. Kitchen Hood Supply Fan and Pre-Heater
 8. SECTION 23 38 90 - DUCTWORK
 - a. Round to Rectangular Duct Adapters (Bell mouth)
 - b. Joint Sealant
 - c. Flexible Duct
 - d. Exposed Spiral Duct, Fittings and Shop Drawing Layout
 - e. Dual Wall Spiral Duct Insulation Liner Data
 9. SECTION 23 39 10 - DUCTWORK ACCESSORIES
 - a. Duct Access Doors
 - b. Volume Dampers

- c. Backdraft Dampers
 - d. Wall Louvers with Color/Finish Selection Chart and Screen Data
 - e. Air Distribution Devices
 - f. Life Safety Dampers with each application identified (i.e. - MPSA, LPSA, LPRA, etc.)
 - g. Brick Vents with Screen Data
 - h. Dryer Vent Outlet
 - i. Spun Aluminum Roof Mounted Intake/Relief Hoods
 - j. Low Silhouette Roof Mounted Intake/Relief Hoods
 - k. Variable Air Volume Dampers and Controls
 - 10. SECTION 23 48 85 - AIR CLEANING/TREATMENT
 - a. Air Filters for Construction Period and Spares for Permanent use.
 - 11. SECTION 23 48 89 - BI-POLAR IONIZATION AIR PURIFICATION SYSTEM
 - a. Bi-Polar Ionization Units for each Type Unit Served
 - 12. SECTION 23 78 55 - AIR HANDLING UNITS
 - a. Air Handlers and Accessories
 - b. Warranty Information
 - 13. SECTION 23 89 30 - VARIABLE AIR VOLUME BOXES
 - a. Variable Air Volume Boxes - All types and configurations
- C. Submittals are required for the following within 60 days after project "Notice to Proceed":
- 1. SECTION 23 09 60 - CONTROLS AND INSTRUMENTATION
 - a. DDC Controllers
 - b. Local Temperature Relay Panel & Labeling
 - c. Wiring Diagrams and Shop Drawings
 - d. Sequence of Operation
 - e. Thermostat and Humidistat and Covers
 - f. Microprocessor Controls/Panel and Devices
 - 2. SECTION 23 09 90 - TESTING, ADJUSTING AND BALANCING
 - a. Testing, Adjusting and Balancing Agency, Certification Credentials, Sample Forms, Instrument List with Calibration History.
- D. Shop drawings are required for the following within 180 days after project "Notice To Proceed":
- 1. SECTION 23 00 10 - MECHANICAL GENERAL PROVISIONS
 - a. Mechanical Coordination Drawings
- E. Submittals, within 10 days of request for Date of Completion inspection, are required as follows:
- 1. SECTION 23 09 90 - TESTING, ADJUSTING AND BALANCING
 - a. TAB Report - Preliminary with certification of mechanical systems safety and operating controls.

END OF SECTION

SECTION 23 00 35

MECHANICAL SYSTEMS AND EQUIPMENT WARRANTIES

PART 1 - GENERAL

1.01 SCOPE

- A. Furnish all labor, materials, services, and equipment warranties as outlined herein for mechanical systems and equipment.

1.02 GUARANTEE AND WARRANTY

- A. See Division 01 Section 01 77 00 – Closeout Procedures for warranty start date.
- B. Industry Standard Guarantee: See Architectural Specifications.
- C. Test Period: Each piece of equipment shall meet performance specifications after three months' actual operation to OWNER'S satisfaction.
- D. CONTRACTOR shall replace, or make good, any defect due to faulty workmanship or material, which shall develop within one year from the beginning of the warranty period. This guaranty shall cover both material and labor. Leaking pipe work is considered faulty workmanship. This warranty shall include repair, removal of defective parts and installation of replacements. The CONTRACTOR shall also be responsible for property damage that results from defects in materials, improper controls or setup, and/or installation during the warranty period.
- E. For first year after the warranty begins, CONTRACTOR shall provide, at no cost to the OWNER, any required maintenance and service necessary to assure the proper operation of the installations and systems. Latent defects arising during this period shall, upon notification by the OWNER, be promptly corrected at no additional cost to the OWNER. This shall include:
 - 1. Refrigerant and Oil Replacement in Refrigeration Systems: Leaking refrigerant systems shall be repaired, proved tight, and charged with manufacturer's recommended refrigerant and lubricant, within any standard warranty period.
 - 2. Any adjustments and service required, excluding filter monitoring and replacement.
 - 3. Any necessary adjustments in system control set points when required, excluding filter monitoring.
- F. The CONTRACTOR shall make inspections at end of 6th and 11th months after beginning of warranty related to the HVAC control system. During these inspections the CONTRACTOR shall verify all control settings and recalibrate controls and sensors to match requirements as can be coordinated with PROFESSIONAL based on historical trend by data and to optimize system performance. Temperature and safety controls shall be adjusted as necessary to insure continuous, trouble free, safe, and automatic operation of systems including gas burner, refrigerating equipment, etc.
- G. Extended Equipment Warranties:
 - 1. Definitions and General Requirements
 - a. Extended warranties, defined as a warranty after the standard one (1) year warranty.

- b. "Comprehensive" is defined as a complete warranty except for acts of God and negligent maintenance or operation of the specified equipment as required of the OWNER.
 - c. All comprehensive equipment warranties shall include all parts, labor, shipping, postage, freight, handling fees, etc., to accomplish any repair and/or replacement at no additional cost to OWNER. These warranty provisions will be binding on any CONTRACTOR and/or supplier/manufacturer unless specifically approved otherwise in writing by OWNER.
 - d. Lack of specific action on any manufacturer's, supplier, and/or CONTRACTOR submitted alternate warranty shall not be construed as approval of same and shall not void the manufacturer and/or CONTRACTOR'S contractual obligation to provide specified warranty.
 - e. Third party insurance and/or split CONTRACTOR labor/manufacturer's equipment/material warranties shall not be acceptable. Only manufacturer's comprehensive warranties shall be acceptable.
2. Extended Warranties Required
- a. Section Packaged Air Conditioners - 4 years compressor parts only non-prorated.
 - b. Section Packaged Ventilation Equipment - 4 years compressor parts only non-prorated.
 - c. Section Packaged Heat Recovery Equipment - 4 years compressor parts only non-prorated.
 - d. Section Packaged Water Source Heat Pumps - 4 years compressor parts only non-prorated.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 GUARANTEE AND WARRANTY

- A. All certificates shall first be presented to the ARCHITECT for approval. After approval, copies of the certification(s) shall be forwarded to the OWNER by the CONTRACTOR.

END OF SECTION

SECTION 23 00 40

MECHANICAL CLOSE-OUT REQUIREMENTS

PART 1 - GENERAL - NOT APPLICABLE

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 AS-BUILT DRAWINGS

- A. Project Record Documents and As-Built Drawings:
- B. 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.
- C. 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.
- D. At the completion of the project, furnish the OWNER three (3) set(s) of bluelines and three (3) 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 Blueline sets and Specifications.

3.02 OPERATION AND MAINTENANCE MANUALS

- A. Submit three (3) complete sets of bound brochures in 8-1/2 inches by 11 inches spring post binders, indexed and tabled by equipment type (Air Handler, Plumbing Fixtures, etc.).
- B. Include in these brochures written submittal data, manufacturers operating and maintenance procedures and recommendations, spare parts lists and suppliers and any interlocking control or wiring diagrams for all equipment. The information listed herein is to be bound in the following order:
 - 1. First sheet to list ARCHITECT, ENGINEER, CONTRACTOR and Sub-Contractors with addresses for each.
 - 2. Second sheet to list type of equipment with sequential number, the manufacturer, make, model and serial number of the actual equipment nameplate data rated horsepower, full load rated amps, voltage and phase.
 - 3. Next, actual copy of approved submittal data including all manufacturers published information on capacities, capacity curves or tables, accessory and control item lists, and other pertinent information as requested by ENGINEER. Cross-reference all equipment to Contract Documents.
 - 4. Next, copy of all spare parts list and suppliers' contact information.
 - 5. Next, include the manufacturer's published operating and maintenance procedures.
 - a. Include instructions to stop and start each piece of equipment including reference to controls and interlocks and an itemized maintenance schedule detailing procedure and interval of periodic maintenance items. Start this log of the maintenance list(s) by accomplishing the initial required maintenance procedure(s) for each and every maintenance item.

- b. Operating instructions shall also include recommended periodic maintenance and seasonal changeover procedures, and suggested procedures in operation of all systems in this particular building to promote energy conservation. These instructions must be written expressly for this project and shall refer to equipment, valves, etc., by mark number from project schedules. Operating instructions and procedures shall be submitted in draft form, for approval prior to final issue of complete brochures. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions. Bulletins shall be clearly marked for the equipment furnished. Where a bulletin contains more information than that for the installed equipment, such extended information shall be deleted by crossing it out or by stripping it from the bulletin.
- 6. All system operating instructions that were earlier approved by PROFESSIONAL and utilized for OWNER personnel training shall also be inserted herein.
- C. This bound information will require the PROFESSIONAL'S signed approval before this contract is complete. No exceptions will be granted.
- D. A copy of HVAC equipment operation and maintenance (O & M) Manufacturer's recommended brochures shall be transmitted to the TAB Agent within ninety (90) days after Notice To Proceed such that TAB Agent shall utilize same in preparation of Owner's Personnel Training/Agenda.
- E. The manuals shall be previously approved by the PROFESSIONAL and transmitted to the OWNER at least one week prior to the final inspection.

3.03 OWNER TRAINING

- A. OWNER Representative Training and Operating and Maintenance instructions
 - 1. During the last phase of the project, the CONTRACTOR, in conjunction with the Fire Alarm, Controls, Sprinkler and MECHANICAL (Sub) CONTRACTORS shall coordinate and facilitate the start-up, Testing, Adjusting and Balancing, and subsequent OWNER'S representatives training and instructions.
 - 2. The OWNER Training shall be administered by the CONTRACTOR, with special training/instructions from equipment technical representatives, CONTRACTOR qualified representatives, etc.
 - a. The training and instructions for the OWNER will include a complete walk-through of the facility, review of all mechanically related systems, and comprehensive training of the pertinent operating and maintenance requirements.
 - b. This shall include an overview of system components and descriptions, seasonal provisions/changes required, major valve location/function, safety provisions and concerns, normal operating and energy conservation techniques, actions to be taken with system failure or malfunction, start-up and shut-down instructions, reaction to fire and safety alarm annunciation, normal operating parameters, etc.
 - c. The training/data shall include all pertinent data from industry standards, minimal recommendations indicated herein and further as recommended by each manufacturer's O&M manuals.
 - d. All equipment and material suppliers will also be expected to participate. The CONTRACTOR shall coordinate and schedule the OWNER'S training with the A/E and designated OWNER'S Representative(s).
 - e. Additional instruction and training sessions shall be provided subsequent to the initial session to provide additional training as required to fully train the OWNER'S operators.

3. The CONTRACTOR shall submit to the PROFESSIONAL in draft form, an outline of the contents of this training, with agenda and list of pertinent training personnel, a minimum of thirty (30) days prior to project completion date and scheduling said training with the OWNER and PROFESSIONAL.
 4. When the seminar and subsequent instruction periods are completed, CONTRACTOR shall furnish ARCHITECT a letter signed by the OWNER certifying that his representative(s) has received adequate instruction in operation of installed equipment and systems. This letter shall be furnished prior to final acceptance of this project.
- B. Some suggestions for pertinent subject matter to include in the administration of the training of OWNER'S operation and maintenance personnel, is as follows:
1. Nominal Split and Packaged Direct Expansion Cooling and Heating Systems:
 - a. Air filter size, monitoring and changeout (note that CONTRACTOR is to provide a schedule to OWNER, indicating all systems, filter grilles, etc., and matched sizes) and number of air filters.
 - b. Periodic bearing lubrication
 - c. Periodic belt monitoring and adjustment
 - d. Periodic evaporator and condenser coil inspection and cleaning
 - e. Periodic monitoring of refrigerant charge by (1) visual observation of site glass, and (2) discharge air temperature monitoring
 - f. Normal temperature and fan controls setpoints for occupied and on occupied periods. (no lower than 65°F. during unoccupied periods)
 - g. Normal indoor humidity setpoints for all periods
 - h. Condensate drain periodic inspection and maintenance; including algaecide
 - i. Smoke detection and fire alarm interaction
 2. Exhaust Fans:
 - a. Periodic bearing lubrication
 - b. Periodic belt monitoring and adjustment
 - c. Periodic fan blade & grille inspection for excessive dust build-up, etc.
 3. Variable Air Volume Diffusers:
 - a. Describe purpose and temperature adjustment capability, and manufacturer's recommended O & M procedures.
 4. Controls:
 - a. Describe Time Clock (MCP) scheduling in regards to staggering of HVAC systems to minimize electrical demand charges.
 - b. Describe functional zones and corresponding overrides.
 - c. Describe setup and operation (including override functions) of programmable thermostats.
 - d. Calibration of sensors (CO2, humidity, etc.)
 - e. Describe purpose of duct smoke detection, HVAC unit shut-down, and remote smoke detector alarm panels and reset procedures.
 5. General:
 - a. Warranties: Explain the various warranties. Explain to OWNER his role during the warranty period(s), his limitations who he is to call when a problem tied to a warranty issue occurs, for both the one year standard warranty and extended warranties, etc.
 - b. Special tools and spare parts
 - c. Air filter spares
 - d. Purpose of O & M Manuals (spare parts, O & M manufacturer's recommendations, trouble-shooting, etc.)

3.04 CLOSEOUT DOCUMENTATION

- A. Seven (7) days prior to requesting a final inspection, the CONTRACTOR shall submit all O&M and closeout documentation to the ARCHITECT, to be turned over to the OWNER at the end of the project.
- B. The following checklist 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 fax or email copy of the completed checklist to the PROFESSIONAL prior to final inspection request.

CLOSEOUT DOCUMENTATION CHECKLIST		
MECHANICAL		
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)
		MECHANICAL HVAC OPERATION & MAINTENANCE MANUALS (3 EA)
		AS-BUILT DRAWINGS WITH CONTRACTOR'S STAMP (3 EACH)
		EXTENDED WARRANTIES: (SEE SECTION <i>MECHANICAL SYSTEMS AND EQUIPMENT WARRANTIES</i>)
		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).
		VIBRATION ISOLATION AND SEISMIC RESTRAINT MANUFACTURER'S REPRESENTATIVE CERTIFICATION THAT ALL INSTALLATIONS HAVE BEEN INSTALLED PER MANUFACTURER'S RECOMMENDATIONS. SEE SECTION <i>MECHANICAL SEISMIC AND WIND RESTRAINTS</i> .
		PROVIDE LIST OF ALL SPARE AIR FILTER SETS PER SECTION <i>AIR CLEANING/TREATMENT</i> . LIST NUMBER, SIZE, TYPE AND LOCATION/EQUIPMENT MATCH-UP.
		PIPE TEST LOG - FORM IN SECTION <i>PIPE AND PIPE FITTINGS</i> TO BE COMPREHENSIVELY FILLED OUT.
		DUCT TEST LOG - FORM IN SECTION <i>DUCTWORK</i> TO BE COMPREHENSIVELY FILLED OUT.

		CD OF AS-BUILT CUSTOMIZED SOFTWARE OF MECHANICAL CONTROLS SET-UP, TREND LOGS, ETC., PER SECTION <i>CONTROLS AND INSTRUMENTATION</i> .
		VALVE TAG AND FLOOR PLAN LOCATION CHARTS. SEE SECTION <i>MECHANICAL IDENTIFICATION</i> .
		ON A REDUCED FLOOR PLAN DRAWING, THE CONTRACTOR SHALL INDICATE THE LOCATION OF ALL STARTERS AND SWITCHES. THESE DEVICES SHALL BE PROPERLY MARKED TO INDICATE EQUIPMENT THEY SERVE AS DESIGNATED ON THE CONTRACT DOCUMENTS. SEE SECTION <i>MECHANICAL IDENTIFICATION</i> .
		KEYS TO CONTROL PANELS, SENSOR/CONTROLLER, AND ACCESS DOORS COVERS PER SECTION <i>BASIC MECHANICAL MATERIALS AND METHODS</i> AND SECTION <i>CONTROLS AND INSTRUMENTATION</i> (PROVIDE WRITTEN RECEIPTS WITH OWNER'S ACCEPTANCE).

END OF SECTION

SECTION 23 00 50

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material, equipment and labor, etc., required to complete installation specified herein and/or shown or scheduled on Contract Drawings.
- B. The requirements of this section apply to all sections of Division 23.
- C. Definitions:
 - 1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms, including mechanical and/or equipment rooms.
 - 2. Option or Optional: CONTRACTOR'S choice of an alternate material or method.

1.02 PRODUCTS CRITERIA

- A. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
- B. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
- C. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or otherwise permanently marked on each item of equipment.

1.03 FLAME SPREAD AND SMOKE DEVELOPED PROPERTIES OF MATERIALS

- A. Materials and adhesives used throughout the mechanical and electrical systems for insulation, and jackets or coverings of any kind, or for piping or conduit system components, shall have a flame spread rating not over 25 without evidence of continued combustion and with a smoke developed rating not higher than 50. If such materials are to be applied with adhesives, they shall be tested as applied with such adhesives, or the adhesives used shall have a flame spread rating not over 25 and a smoke developed rating not higher than 50. (Note: Materials need not meet these requirements where they are entirely located outside of a building and do not penetrate a wall or roof, and do not create an exposure hazard.)
- B. "Flame-Spread Rating" and "Smoke Developed Rating" shall be as determined by the "Method of Test of Surface Burning Characteristics of Building materials," NFPA No. 255, ASTM E84, Underwriter's Laboratories, Inc., Standard". Such materials are listed in the Underwriters' Laboratories, Inc., "Building Materials List" under the heading "Hazard Classification (Fire)".

1.04 HAZARDOUS MATERIALS

- A. No products shall be used that contain any known hazardous or carcinogenic materials. Products with asbestos or radioactive content shall not be used.
- B. Handling of any hazardous material is not covered in this specification Division.

PART 2 - PRODUCTS

2.01 EQUIPMENT ACCESSORIES

- A. Provide removable guards to enclose all rotating or moving elements. Construct of galvanized steel to withstand 250 lbs. static load.
- B. Wall/Ceiling Access Doors
 - 1. Panels in non-rated applications shall be galvanized steel, 18 gage frame, 16 gage door with mounting accessories, continuous concealed hinge, screwdriver operated lock, and prime coat paint.
 - a. Equal to Acudor Model UF-5000 for acoustic tile or exposed masonry
 - b. Equal to Acudor Model PS-5030 for plaster finishes
 - c. Equal to Acudor Model UF-5000 (stainless steel) for ceramic or glazed structural tile.
 - 2. Panels in fire rated applications shall be painted steel type, 1 hour rated, piano hinged, exterior key lock, nominal size 24 inches by 36 inches at equipment installations as approved, equal to Air Balance, Inc. - Model "F".

2.02 FIRE, SMOKE AND SOUND STOPPING

- A. UL listed penetration sleeve assembly and/or firestop that meets ASTM E-814 E119, and E84, as equal to "3M" systems for the intended applications.
- B. All fire, smoke and sound stopping to be done by a separate licensed and certified Subcontractor as approved by Professional.

2.03 PIPE SLEEVES

- A. Galvanized sheet metal sleeves shall have lock seam joints and comply with the following minimum thickness:
 - 1. 24 Gage for 3 inches and smaller.
 - 2. 22 Gage for 4 inches to 6 inches inclusive.
 - 3. 20 Gage for sizes over 6 inches.
- B. Galvanized steel sleeves shall be constructed from schedule 40 grade A53 pipe.
- C. PVC sleeves shall be constructed from solid core Schedule 40 PVC pipe.
- D. Water tight sleeves/seals shall be equal to "Link-Seal".

2.04 WALL, FLOOR, AND CEILING PLATES

- A. Chrome plated brass, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve.
- B. The thickness shall conform to the following requirements:
 - 1. Not less than 3/32-inch for floor plates.
 - 2. For wall and ceiling plates, not less than 0.025 inch for up to 3-inch pipe and 0.035 inch for larger pipe.
- C. All escutcheons shall be equal to Beacon, Caldwell or approved equal.

2.05 PROTECTIVE DRIP PANS

- A. Fabricate pans of 20 gage galvanized sheet metal, stainless steel (if shown) or PVC, minimum two inches deep with rolled top edges.
- B. Solder all seams watertight, and cross brace pans to prevent sagging and warping.
- C. Provide dielectric union at copper pipe/galvanized pan connection point. Water heater drain pans shall have minimum one inch drain outlet.

2.06 PAINTING OF MECHANICAL WORK

- A. All painting of mechanical systems shall be by Division 09 contractor. See Division 09 for more information.
- B. See Section Mechanical Identification for color-coding of piping, etc. All other metal structure and hangers to be color of adjacent finish.

PART 3 - EXECUTION

3.01 EQUIPMENT ACCESSORIES

- A. Provide access panels, or doors, at concealed dampers, valves, vents, equipment, inspection points, etc., and where noted. Where ceiling is "lift out" construction, ceiling access panels are not required. Panels shall be 15 inches square, or larger as approved for service intended.
- B. CONTRACTOR shall provide substantial metal angle frame and support at all ceiling access doors.

3.02 FIRE, SMOKE AND SOUND STOPPING

- A. Fire and smoke stopping shall be provided and installed at all locations where mechanical Work passes thru rated assemblies. This includes all ductwork, piping and controls related conduit.
- B. Penetrations in "sound" 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.

3.03 PIPE SLEEVES

- A. Pipe sleeves shall be constructed of galvanized sheet steel except where noted below or in individual work sections.
- B. Pipe sleeves shall be constructed of galvanized steel or schedule 40 PVC pipe when pipes are located within or passing through the following:
 - 1. concrete beams
 - 2. outside walls
 - 3. foundations
 - 4. footings
 - 5. waterproofed floors
 - 6. In locations where sleeve is extended above finished floor

- C. Where pipe motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe.
- D. Where pipes are insulated, make sleeves of sufficient diameter to pass pipe insulations.
- E. Check floor and wall construction and finish to determine proper length of sleeves for various locations, make actual length to suit following:
 - 1. Terminate sleeve flush with walls, partitions, and ceilings.
 - 2. In areas where pipes are concealed as in chases, terminate sleeves flush with floor.
 - 3. In finished areas where pipes are exposed, extend sleeves 1/4 inch above finished floor except in kitchen, toilets, equipment rooms, and other areas where water may accumulate on floor, extend 1-1/2 inch.
- F. 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.
- G. For drilled penetrations in existing floors provide one inch angle rings set in silicone sealant and bolted to the floor in lieu of pipe sleeves with one inch extension above floor.

3.04 WALL, FLOOR, AND CEILING PLATES

- A. Exposed piping passing through walls, floors and ceilings, shall be fitted with escutcheons.
- B. Inside diameter shall fit around insulation or around pipe when not insulated; outside diameter shall cover sleeve.
- 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.

3.05 PROTECTIVE DRIP PANS

- A. Provide pitched drip pans where shown under 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 shall be routed to a drain connection with discharge piped utilizing 3/4" or larger of copper tube to the nearest available open drain or outside as directed by PROFESSIONAL. Open-end slices discharging to intercepting pans are not acceptable.
- C. Provide drip/overflow pans under water heaters, air conditioning equipment, pumps, etc., and where shown.

3.06 PAINTING OF MECHANICAL WORK

- A. All equipment shall present a clean painted appearance; touch-up or repair as required.
- B. All surfaces shall be properly prepared prior to painting. CONTRACTOR must contact PROFESSIONAL, such that all tests, installations etc., are approved prior to painting.

- C. The CONTRACTOR shall prime (where applicable) and paint the following mechanical related Work:
 - 1. All exposed ferrous metal non-galvanized hangers, auxiliary supports, braces, etc., in all locations.
 - 2. All exposed and exterior galvanized ductwork, plenums, access doors, and control conduit, fitting, boxes, etc.
 - 3. All insulated refrigerant piping, pumps, valve bodies, etc., where exposed to view outdoors.
- D. Refer to Section Mechanical Identification for color-coding of piping, etc. All other metal structure and hangers to be color of adjacent finish.

3.07 WELDING

- A. Before any welding is performed submit a copy of the Welding Procedure Specification (WPS) together with the Procedure Qualification Record as required by Section IX of the ASME Boiler and Pressure Vessel Code for each and every welder intended for use on this project and with qualifications and certifications suitable for work classification intended.
- B. Before any welder performs any welding, submit a copy of the Manufacturer's Record of Welder Operator Qualification Tests as required by Section IX of the ASME Boiler and Pressure Code. The letter or symbol (as shown on the qualification test form) shall be used to identify the work of that welder and shall be affixed, in accordance with appropriate construction code, to each completed weld. Submit certification according to Section Mechanical Submittals and Shop Drawings for each and every welder and welding associated with the project.
- C. The types and extent of non-destructive examinations required for pipe welds are shown in Table 146.4 of the Code of Pressure Piping ANSI/ASME B31.1.

3.08 TOOLS AND KEYS

- A. Furnish, and turn over to the OWNER, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Provide OWNER, at end of project with spare keys to stops, hose bibbs, control cabinets, tamper-proof controls covers, etc. Provide the following spares, and label with function/locations:
 - 1. Control Panels - 4 keys each panel
 - 2. Tamper-proof Controls Cover - 2 keys per cover
 - 3. Wall and Ceiling Access Doors - 2 keys per door

3.09 LUBRICATION

- A. During construction, all bearings and shafts shall be kept thoroughly greased and protected.
- B. After equipment has been operated seven days and before final acceptance, all bearings shall be inspected and filled to operating level with lubricant recommended by manufacturer. Tag each piece of equipment with cloth tag showing: proper type of lubricant, and period between lubrications, date of lubrication, and worker's initials. Have space for ten (10) lubrication notations.

3.10 WORK IN AND AT EXISTING BUILDING AND/OR BUILDING SITES

- A. Perform as described or shown on Contract Drawings, for relocation of existing equipment, alterations and restoration of existing building(s).
- B. As specified on Contract Drawings, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
- C. It is important that CONTRACTOR thoroughly investigate existing conditions, finishes, sized, connections, etc., prior to bidding this project. The Designer's responsibility included only a cursory review of existing conditions and/or installations. It is the CONTRACTOR'S responsibility to coordinate a more thorough investigation and ascertain and confirm pertinent installation connections, etc., prior to his bid. This investigation shall be coordinated in a minimum seven (7) days advance of any published bid date such that the CONTRACTOR immediately thereafter can advise Designer in writing of any design discrepancies and/or changes required; otherwise, the CONTRACTOR shall be required to remedy any such peculiarities at his own expense and at no additional cost to the OWNER. It is the CONTRACTOR'S responsibility to verify existing size and/or location, etc., any time replacement and/or modifications to existing are included as a part of this project.
- D. When obstructions that are not shown on the Contract Drawings are encountered during the progress of work and interfere so that an alteration of the Drawings is required, the ENGINEER will alter the Drawings or order a deviation in line and grade or arrange for removal, relocation, or reconstruction of the obstructions.

3.11 PROTECTION AND CLEANING

- A. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the PROFESSIONAL. Damaged or defective items, in the opinion of the PROFESSIONAL, shall be replaced.
- B. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- C. Do not store insulation materials in building until it is enclosed and dry. Wet insulation shall not be installed.
- D. Piping, ducts, equipment, etc., shall be cleaned per manufacturer's printed instructions and PROFESSIONAL'S instructions.
- E. Piping shall be: (1) flushed with clean water, (2) "blown out" with steam or compressed air, or (3) "swabbed out" as required, except where specified otherwise. All temporary connections required for flushing shall be provided and subsequently removed by the CONTRACTOR. See Section Mechanical Pipe and Pipe Fittings for further instructions.
- F. Before final building interior finish is applied:
 - 1. Interior of air handling equipment shall be thoroughly cleaned.
 - 2. Drain pans shall be cleaned and then flushed with water after which all fans will run with air filters in place, etc., for 24 hours.

3.12 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 shall be (1) of quality equal to, and of appearance matching existing construction, and (2) shall restore all services and construction that remains in use, to its condition prior to this contract, unless otherwise noted.

3.13 FLASHING

- A. Where pipes, ducts, etc., pass through roof or walls, flash and caulk.
- B. Provide flashing or caulking as required at each opening through outside walls or roof. Flashing through roof of same materials and methods as under Moisture Protection Division; through walls shall be aluminum unless noted otherwise.

END OF SECTION

SECTION 23 01 40

SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all labor, equipment, material, etc., required to complete installation as specified herein and/or shown or scheduled on Contract Drawings.

1.2 SUPPORT

- A. Supports shall be installed in one of the following methods: (1) from wood using coach screw on open construction and hanger flanges on sheeting, (2) from concrete using inserts, (3) from steel using beam clamps, rivets or bolts, (4) from concrete blocks using toggle or through bolts. Fasten supports to building in following order of preference: (1) steel framing, (2) concrete, (3) wood framing, (4) masonry, (5) wood sheathing. Do not support from roof deck without approval. All hangers, rods, and inserts shall be Underwriters' Laboratories approved for the service intended and meet MSS #SP-58 and 59.

PART 2 - PRODUCTS

2.01 HANGERS, SUPPORTS, ANCHORS AND GUIDES

- A. All hangers, fasteners and accessories exposed to view indoors shall be galvanized or zinc plated. Similar installations outdoors shall be hot dipped galvanized materials and fasteners.
- B. Supports, hangers, anchors and guides shall be provided for all horizontal and vertical piping. Selection and application shall be in accordance with ANSI/MSS SP-69.
- C. All pipe supports shall be of type and arrangement hereinafter specified. They shall be so arranged as to prevent excessive bending stresses between supports. Specifically designed hangers shall be fabricated and installed in accordance with ANSI/MSS SP-69.
- D. All bracket clamp and rod sizes indicated in this specification are minimum size only. The CONTRACTOR under this section shall be responsible for structural integrity of all supports. All structural hanging materials except variable spring units shall have a safety factor of 5 built in.
- E. All piping routed on trapeze hangers shall be attached rigidly to same unistrut hanger bar with clamps designed by unistrut manufacturer as approved by PROFESSIONAL. Insulated piping clamps shall encapsulate piping, insulation and saddle.

2.02 BASES AND PADS

- A. Concrete equipment pads shall be constructed of minimum 3000 psi reinforced concrete. Provide 3/4 inch chamfer on all exposed top perimeter edges of pads.
- B. Top of equipment pads outdoors shall be minimum 3 inches above and below worst case finished grade and be reinforced and of a strength suitable for application.

- C. Pads shall be provided in the following applications:
1. Air conditioning equipment outside building. Size pads to extend from building perimeter and extend minimum eighteen (18) inches around equipment on remaining three sides, or as indicated.
 2. Air handling units, boilers, pumps, and where shown or specified on Drawings.

PART 3 - EXECUTION

3.01 PIPING SUPPORT

- A. All hangers for insulated piping shall be sized to accommodate insulation and shield. No hangers for insulated piping may be installed directly below or unto pipe itself.
- B. Provide hanger spaced per International Mechanical Code requirements for piping type and size.
- C. Provide hanger within 18 inches of each elbow, also provide hanger with 18 inches of connection to each piece of equipment.
- D. Support vertical pipe at base and at each floor. In addition 1 inch or smaller copper pipe shall be supported at 5' intervals or midway between floors, whichever distance is shorter.
- E. Provide PVC or other approved coating for steel, cast iron or PVC pipe riser clamps. See applicable details.
- F. Pipes passing thru walls shall not bear on building construction. Provide sleeves and fire proofing sealant as per Section Basic Mechanical Materials and Methods.
- G. Maximum weights on hanger rods assuming a maximum operating temperature of 450 degrees F. shall be such that stress in tension shall not exceed 9000 psi, using root area of threaded portion.
- H. For copper pipe, supports shall follow schedule and specifications. Supports for uncovered lines shall be especially designed for copper tubing, and shall be of exact O.D. diameter of tubing and shall be copper plated.
- I. Shields at Hangers: Insulated pipe shall be protected at the point of support by a 180 degree insert of high density, 100 psi, waterproofed calcium silicate encased in a 180 degree galvanized sheet metal inverted saddle. Insert to be same thickness as gauges shown in chart below. Insulation insert to extend 1" beyond sheet metal on all insulated water lines. If pipe hanger spacing exceeds 12 feet, use double layer sheet metal shields. Check Section Mechanical Insulation for Alternatives.

PIPE SIZE	SHIELD LENGTH	MINIMUM GAGE
1/2 inch – 2 inches	8 inches	24
2-1/2 inches – 4 inches	12 inches	20
6 inches - 8 inches	16 inches	16

- J. Provide all steel required for support of pipes and equipment.
- K. All pipe supports shall be designed to avoid interferences with other piping, hangers, electrical conduits and supports, building structures and equipment.

3.02 OTHER MOUNTINGS

- A. Any piece of equipment installed in a finished ceiling or wall area shall be supported independently of the building finish. Ceiling mounted items shall be supported directly from the building structure.
- B. Support piping from structural steel members by malleable iron or formed steel beam clamps. Where suspended from concrete slabs, install inserts of malleable iron during building construction.
- C. Wire or perforated hangers will not be permitted. Provide adjustable split ring swivel malleable iron hangers for horizontal runs up to and including 3 inches pipe size. Provide adjustable steel clevis type hangers for pipes over 3 inches.
- D. Provide malleable iron split ring hanger with copper finish and copper plated malleable iron adjuster for use with copper piping. For insulated piping, provide hangers sized to accommodate insulation.

END OF SECTION

SECTION 23 01 70

ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 MECHANICAL WORK

- A. All work performed under this Contract shall be in accordance with Division Electrical.

PART 2 - PRODUCTS

2.01 STARTERS

- A. For each and every motor provided by CONTRACTOR, a new proper motor starter shall be furnished for installation, except that all starters for 1/2 horsepower single phase and smaller motors as specified and/or required shall be manual type.
- B. Heaters shall be of the melting alloy type, sized to the exact nameplate running current of the motor. Manually operated motors with magnetic controllers shall be provided with oil-tight pushbutton stations and automatically controlled motors shall be provided with oil-tight "hands-off-auto" automatic switches. All magnetic starters shall be provided with red bull's eye pilot light in cover. Energy for controlled circuits shall be taken from the load contacts from the starters. All power wiring and control wiring shall be run in rigid conduit in damp locations or electrical metallic tubing in dry locations, and shall conform to NEC Standards. Provide two sets each of normally open and normally closed auxiliary contacts for all magnetic starters.
- C. For all starters for three phase motors, provide both overload and under-voltage and over-voltage protection in all phases and protection from phase loss and phase reversal.
- D. For manual and automatic controlled operation of 3/4 HP and larger motors, furnish magnetic motor starter with:
 - 1. Maintained contact starter with "hand-off-auto" switches.
 - 2. Trip free, thermal overload relays.
 - 3. Capable of accepting 3 external electric interlocks.
 - 4. "Red" run pilot bulb indicator.
- E. Where interlock or automatic operation is specified, regardless of HP, provide magnetic starter complete with "run-off-auto" switch so connected that in "run" or "auto" all safety controls shall stop the motor. Provide number and type of auxiliary normally open and/or closed contacts as required by specified control sequence.
- F. Size 2 and larger starters shall have control circuits individually fused from line side of starter, or lead side of breaker, on combination unit. Starters on service above 240 volts shall have 120 volts, built-in control circuit transformer fused from line side.
- G. Each electrically operated item of equipment shall be suitable for proper operation on the electrical supply to which it is to be connected as directed on the Electrical Drawings. Prior to delivery on job site, it shall be the responsibility of the CONTRACTOR and any Sub-Contractors, equipment suppliers, etc. to determine from the Electrical Drawings the characteristics of the electrically operated item, and to furnish each item accordingly. CONTRACTOR shall pay the cost due to any modifications resulting from differences as compared to Basis of Design products.

- H. Provide soft start and soft stop magnetic motor starters for all motor three phase loads above 5 HP, as Magnetek Series RVS-DN with digital microprocessor circuitry, and include the safeties as detailed above, with auto reset.

2.02 MOTORS

- A. All motors under this Contract shall be provided with thermal overload protection.
- B. Equipment shall operate properly under a 10 percent plus or minus voltage variation, and a 5 percent plus or minus frequency variation.
- C. Unless noted otherwise, motors shall be squirrel cage induction type with ball bearings. Motors 1/2 HP and smaller shall be 120 volts, single phase, with permanently lubricated bearings; 3/4 HP and larger shall be 3 phase, Design "B" or "C", drip-proof type, of minimum power factor and energy efficiency as listed herein.
- D. Motors shall be premium efficiency type as defined by energy policy act of 1992 (EPACT) and latest version of IEEE Standard 112, Test Method B.

HP	EFFICIENCY	POWER FACTOR
1	84	72
1.5	85.5	73.5
2	85.5	70.6
3	89.5	77.5
5	89.5	81
7.5	91.7	78.9
10	91.7	83
15	93	81
20	93.6	84
25	93.6	83.5
30	94	85.1
40	95.5	76
50	95.5	84.2
60	95.5	84.5
75	96	83.4
100	96	84.4

- E. Motors shall be rated for continuous, full-load duty and capable of withstanding momentary overloads of 50 percent. Select motors so actual load does not exceed nameplate ratings, and does not use motor "service factor". All motor furnished for this project shall have minimum service rating factor of 1.15. All motors shall be highest energy efficient type for all mechanical applications.
- F. Except where interlock or automatic control is required, single speed single phase motors, 1/2 HP and smaller shall have manual motor switch with pilot light and thermal overload protection.
- G. Each motor to be installed outdoors shall be of the totally-enclosed fan-cooled type, or housed in a weatherproof housing. Motors for hazardous locations shall be properly furnished to suit application.

- H. Multi-speed motors shall, except as noted, be consequent pole, variable torque, single winding. When the speed ratios or the load characteristic dictates, the multispeed motors shall be separate winding types. Variable speed motors operating over an adjustable range of speeds shall be motors specifically designed and rated for this duty.

2.03 ELECTRICAL FOR EQUIPMENT

- A. Motor controllers, protection devices, etc., for control and protection of equipment shall be furnished with the equipment, but installed and electrically connected to power source under Division 26 - Electrical.
- B. NEMA Standards shall be taken as minimum requirements for Electrical equipment.
- C. CONTRACTOR shall provide and install all disconnects for all MECHANICAL motors and loads unless equipment is provided with integral disconnect(s).
- D. All three phase motors in occupied areas shall be "quiet" rated and so marked.
- E. On all three phase motors, provide both overload and under-voltage and over-voltage protection in all phases and protection from phase loss and phase reversal.
- F. Suitable enclosures for all electrical equipment shall be provided to suit environment as per NEMA and NFPA standards.
- G. Clearances of 36 inches shall be maintained around equipment less than 400V. Clearances of 48 inches shall be maintained around equipment greater than 400V.

PART 3 - EXECUTION

3.01 GENERAL

- A. Where electrical voltage and phase characteristics are specified hereinafter, verify them with the Electrical Drawings. In case of discrepancy between the Specifications and the Electrical Drawings, the Electrical Drawings shall govern.
- B. The CONTRACTOR shall provide power to all circuits, controls, and safety devices to every piece of mechanical equipment specified or shown on Drawings whether a power source is indicated or not on Electrical Drawings.
- C. The CONTRACTOR shall provide and extend fire alarm connections to all larger air handling equipment and provide code required smoke/heat detection sensors, etc., and automatic shutdown in the event of positive fire/smoke detection from any fire alarm sensor in same zone as served by same air system.
- D. Control wiring (120V. and less) shall be provided under Division 23 and extended from the 120V. power circuits indicated on the Electrical Drawings. All wiring for voltages higher than 30 volts shall be done by a licensed electrician.

END OF SECTION

SECTION 23 01 90

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SCOPE

- A. Piping System Identification
- B. Valve Identification System
- C. Equipment Identification

1.02 REFERENCES

- A. ANSI A13.1 - Scheme for the Identification of Piping Systems

PART 2 - PRODUCTS - SPECIFIED AS PER INDIVIDUAL APPLICATION IN PART 3

PART 3 - EXECUTION

3.01 IDENTIFICATION OF PIPING SYSTEMS

- A. Identify all pipe after final painting and/or insulation with manufacturer's preprinted labels at the following minimum locations:
 - 1. Straight runs of piping with a maximum spacing of twenty (20) feet.
 - 2. Adjacent to each valve.
 - 3. Adjacent to each branch takeoff point.
 - 4. On each side of where piping passes through walls/floors.
- B. Letter shall be sized in accordance with the following:

OUTSIDE DIAMETER OF PIPE COVERING	MINIMUM WEIGHT OF LEGEND LETTERS
Up to 3/4 inch	1/2 inch
1 inch to 1-1/4 inch	3/4 inch
1-1/2 inch to 2 inches	1 inch
2-1/2 inches to 6 inches	1-1/2 inch

- C. At each legend, include a manufacturer's label with an arrow to show normal flow.
- D. Identify heat tape "traced" piping per Section Piping Specialties. This is in addition to piping identification as indicated below.

3.02 IDENTIFICATION OF PIPING ABOVE GRADE

- A. All piping exposed to view or concealed shall include manufactured labels on pipe in a visible location. Label shall be attached to pipe every 20 feet. Labels shall be installed after piping has been painted and/or insulated.
- B. Labels to be utilized as follows.
1. In exposed applications, CONTRACTOR shall utilize pre-coiled, snap in place type markers as equal to Seton "Setmark". On 6 inches and larger pipe, CONTRACTOR shall utilize nylon ties to secure marker to piping.
 2. In concealed applications, CONTRACTOR shall utilize a pressure-sensitive tape manufactured legend on all installations. Tape shall be tamper resistant vinyl tape for indoor as equal to Seton "Opti-Code" and outdoor installations as equal to Seton "Ultra-mark."
 3. Tape legend colors shall meet ANSI recommendations.
 4. On piping where markers do not include directional arrows, CONTRACTOR shall include similar manufactured stick-on flow arrows on all pumped circulating systems as equal to Seton "Arrows On A Roll" with colors to match pipe legend tape identification.
- C. All insulated piping exposed to view everywhere and in mechanical rooms, shall include factory colored PVC jackets, non-insulated shall be similarly comprehensively painted in accordance with DIVISION 09 (colored coded as follows). (Verify colors with ARCHITECT prior to painting).

SERVICE	SYMBOL	COLOR
Chilled Water (Supply & Return)	CHS/CHR	Blue
Heating Water (Supply & Return)	HWS/HWR	Orange

- D. See Section Basic Mechanical Materials and Methods for paint specification. NOTE: Factory colored PVC jacket, per Section Mechanical Insulation, required on all insulated water piping in all equipment rooms and where piping is exposed inside finished spaces. Outside insulated water piping and fittings shall include additional metal jacketing cover.

3.03 EQUIPMENT IDENTIFICATION

- A. All equipment, starters, controls panels, switches, thermostats, humidistats and other control devices shall be permanently labeled with equipment being served. Equipment labels shall correspond to those shown on the Contract Documents.

- B. Individual functions and equipment on indicators and controllers on control panels shall be clearly permanently identified. Color code of labels, marking and identification shall be approved by PROFESSIONAL. This applies to the HVAC system, override panel, microprocessor time clocks and specialty annunciation specified in Section Controls and Instrumentation.
 - 1. Labels for equipment, starters and control panels shall be phenolic type with minimum 3/4 inch tall engraved lettering.
 - 2. Identification for individual controls devices including thermostats, humidistats, relays, switches, etc. shall be labeled with either phenolic type with minimum 1/2 inch tall engraved lettering or stick-on type from lettering machine.
- C. A reduced scale floor plan drawing with all devices referenced to the equipment served shall be framed and mounted where directed. A copy of this reduced scale floor plan drawing shall also be included in each of the Operations and Maintenance Manuals. Submit same to PROFESSIONAL for approval, prior to final mounting and inclusion in O & M Manual.

3.04 LIFE SAFETY DAMPER IDENTIFICATION

- A. Each and every fire, smoke or combination damper shall be permanently labeled on duct adjacent to damper and/or neatly visible on wall above ceiling. Damper labels shall be phenolic type, minimum 3/4 inch tall lettering, color of lettering and background, and exposed label location approved by ARCHITECT. Damper identification (above ceiling) may be spray-on stencil type, with minimum 3 inches tall lettering identifying "Fire Damper, Fire/Smoke Damper", etc. Provide, also, for above ceiling installations, on top of ceiling tile directly below damper locations, color coordinated tape dots plus or minus 1/2 inch diameter, as can be coordinated with PROFESSIONAL.

END OF SECTION

SECTION 23 02 40

MECHANICAL SOUND AND VIBRATION CONTROL

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material, equipment and labor, etc., required to complete installation specified herein and/or shown or scheduled on Contract Drawings.

1.02 APPLICABLE STANDARDS

- A. ASHRAE, 2015 HVAC Applications Handbook, Chapter 47, "Sound and Vibration Control".
- B. The CONTRACTOR shall be responsible for providing and installing vibration isolation of the appropriate type and size for proper weight loading to meet the requirements of the specifications, and in accordance with instructions of the equipment manufacturer or vibration isolator manufacturer or its vendor.
- C. On completion of the work, the ENGINEER shall carry out an inspection and shall inform the installing CONTRACTOR of any further work that must be completed before final approval is obtained.

1.03 MANUFACTURER

- A. All vibration isolators shall be supplied by a single approved manufacturer.
- B. The manufacturer's standard vibration isolation will be acceptable only if it meets this specification.

1.04 VIBRATION AND SOUND CONTROL

- A. All rotating equipment shall be isolated from correcting piping, ductwork, structure or other rigid utilities, etc., by means of the appropriate vibration isolation. The CONTRACTOR shall provide and install the appropriate vibration isolation on any equipment, etc., with moving parts, whether indicated on Plans or not.
- B. The CONTRACTOR shall provide and install appropriate sound isolation as required to restrict sound production or transmission. CONTRACTOR shall install this insulation, baffle, etc., where indicated or as directed by ENGINEER.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATOR TYPES

- A. Unit FN (Floor Neoprene) - Smaller floor mounted equipment and for spacing between equipment and drain pans:
 - 1. These isolators shall be double deflection neoprene waffle pad. Pads shall be a minimum of 5/16 inch thick with size cut as required for particular equipment weight being supported.
 - 2. Isolators shall be Mason Type W - Neoprene Waffle Pads or approved equal.

- B. Unit FS (Free Standing) - Floor mounted air handling equipment with motors between 3 and 7-1/2 HP:
 - 1. These isolators shall be free standing and laterally stable without any housing. All mounts shall have leveling bolts. Spring diameter shall be not less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection.
 - 2. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately one. Each isolator shall be mounted 2 layers of 5/16 inch thick ribbed or waffle neoprene. A square bearing plate shall be provided as required to load the pad uniformly in range of 40 to 50 psi.
 - 3. Isolators shall be Mason Type "SLF", Korfund Type "WSC", Amber-Both Type "SW", Peabody Noise Control Type "FDS", Vibration Mounting & Controls Series "A" or approved equal.
- C. Unit FSTL (Floor Spring Travel Limited) - Floor mounted air handling equipment with motor loads larger than 7-1/2 HP:
 - 1. These isolators shall be open stable steel springs including vertical travel limit stops to control extension when weight is removed. The housing of the spring unit shall serve as blocking during erection of the equipment. Each isolator shall be mounted on 2 layers of 5/16 inch thick ribbed or waffle neoprene.
 - 2. Isolators shall be Mason Industries Type "SLR", Peabody Noise Control Type "FSL", Korfund Type "WSCL", Amber-Booth Series "SW" with limit stops, Vibration Mounting & Controls Series "AWR" or approved equal.
- D. Unit HS (Hanger Spring) - suspended fans and equipment:
 - 1. These isolators shall contain steel spring set in a neoprene cup manufactured with a grommet to prevent short-circuiting of the hanger rod. The cup shall contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion. Spring diameters and hanger box lower-hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short-circuiting the spring. Springs have a minimum additional travel to solid equal to 50 percent of the rated deflection.
 - 2. Unit HS hangers shall be Mason Type "30", Peabody Noise Control Type "SH" or approved equal.

2.02 EXTERIOR METAL PARTS

- A. All metal parts of vibration isolation units installed out-of-doors shall be hot-dip galvanized after fabrication.
- B. Galvanizing shall comply with ASTM A123, A153 and 386 as applicable.
- C. At the time of shipment to the job site, submit to the CONTRACTOR with copy to the ENGINEER, a certified statement by the galvanizer indicating conformity of galvanizing to ASTM Specification.

PART 3 - EXECUTION

3.01 GENERAL

- A. Minimum static deflection of each vibration isolator unit shall be as shown in the equipment schedules and/or as described for each specific piece of equipment in these Specifications.
- B. Locations of all vibration isolation devices shall be selected for ease of inspection and adjustment.

3.02 EQUIPMENT MOUNTING

- A. No equipment unit shall bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators and such direct support is approved by the equipment manufacturer. All support frames shall be sufficiently stiff and rigid so as to prevent distortion and misalignment of components installed thereon.
- B. Unless otherwise indicated, all equipment mounted on vibration-isolated bases shall have a minimum operating clearance of 2-inches between the equipment and the concrete housekeeping pad or floor beneath the equipment. The clearance space shall be checked by the CONTRACTOR to ensure that no construction debris has been left to short circuit or restrict the proper operation of the vibration isolation system.
- C. All wiring and other connections to vibration-isolated units shall be made flexible in order to avoid short-circuiting the isolators. A minimum 4 foot length of armored flexible conduit or cable installed in the shape of a U is acceptable for electrical connections. In the case of large diameter conduits, a sheet metal duct with flexible connection may be used for conduit connections to vibrating equipment. Flexible material shall be the same as that described for ducts connecting to fans.
- D. Under no conditions shall piping, ductwork or conduit be suspended from one another or physically contact one another. Vibrating systems shall be kept free from non-vibrating systems.
- E. Vibration isolation hangers shall be positioned so that hanger housings may rotate a full 360 degrees without contacting any object.

3.03 DUCTS

- A. The AHU returns, OSA, and discharge shall be connected to the ductwork with a flexible connector as described below, in order to prevent short-circuiting, and for sound and vibration isolation. Weatherproofing material shall be utilized when installed on exterior installations. Install connectors with slack, avoiding tight or misaligned connections.
- B. All other ducts connecting fans, etc., shall have a flexible connector as described above.

C. Flexible duct connectors shall be:

APPLICATION	METAL END CONNECTIONS	FABRIC
Split systems and fans less than 2200 CFM air delivery capacity.	Minimum 3 inches wide 28 gage galvanized, as equal to Duro Dyne "Econo Fab" Series with minimum 4 inches wide fabric.	Indoors: Minimum 15 oz./sq. yd., as equal to Duro-Dyne "Excelon" Series with vinyl coated woven nylon/polyester blend. Outdoors: Minimum 17 oz./sq. yd., as equal to Duro-Dyne "Therma Fab" Series with Silicon Rubber coated woven fiberglass fabric.
Larger Commercial HVAC Systems with air delivery above 2200 CFM air delivery capacity.	Minimum 3 inches wide 24 gage galvanized, as equal to Duro Dyne "Super Metal Fab" Series, with minimum 6" wide fabric.	Indoors: Minimum 22 oz./sq. yd., as equal to Duro-Dyne "Excelon" Series with vinyl coated woven nylon/polyester blend. Outdoors: Minimum 24 oz./sq. yd. As equal to DD "Duroton" Series with Hypalon coated woven fiberglass.

3.4 PIPE SUSPENSION ISOLATION

- A. All pipe runs connected to mechanical air handling, based mounted pump and boiler equipment shall be mounted on steel spring and/or elastometer isolators. Unless otherwise specified, the minimum deflection of the isolator shall be 3/8 inch.
- B. Pipes connected to coils of air handling or packaged ventilation units shall be isolated as if they were connected to vibrating machinery.
- C. Pipes connected to vibration isolated assemblies shall in no way strain or force out of alignment the vibration isolators supporting the assembly nor shall pipes restrict a unit from "floating" freely on its isolators.
- D. Pipe elbows at inlets or discharges of floor mounted pumps, which require support from below shall be braced to the unit base above the vibration isolators. All inlet and discharge piping, including associated heat exchangers, expansion tanks, strainers, valves, etc., shall be isolated as specified in Paragraph E below.
- E. Ceiling suspended piping in Mechanical Equipment Room shall be isolated on Unit HSN (with preloading feature if required for alignment) or HN isolators as required to achieve the specified deflection. The minimum static deflection of the steel spring element of the first three isolators (supply and discharge pipe) following isolated mechanical equipment. The minimum static deflection of the steel spring element of all isolators within a distance of at least 50 feet along a pipe in either direction from the equipment isolated shall be 1 inch.

END OF SECTION

SECTION 23 02 50

MECHANICAL INSULATION

PART 1 - GENERAL

1.01 SCOPE

- A. It is intended that all heating and/or air conditioning ductwork and piping for the Adm. Building 3rd Floor Renovations be insulated, except as specifically stated otherwise hereafter.
- B. Insulation shall include all insulating materials their applications, bands, tie wire, and weather protection for all pipe, fittings, valves, and equipment as indicated and as specified herein.
- C. Piping systems requiring insulation, types of insulation required, and insulation thickness shall be as listed herein. All fittings, flanges, and valves (except valve stems, hand wheels, and operators) in piping systems requiring insulation shall be insulated unless otherwise specified. Fitting, flange, and valve insulation shall be premolded, precut, or job-fabricated insulation of the same thickness and conductivity as used on adjacent piping. Insulation exterior shall be cleanable, grease resistant, non-flaking and non-peeling.

PART 2 - PRODUCTS

2.01 PIPING INSULATION

- A. Fiberglass pipe insulation (FG):
 - 1. Insulation shall have a thermal conductivity $k=0.23$ at 75 degrees F.
 - 2. Insulation shall include a white ASJ with self-sealing overlap joints and seams.
 - 3. Insulation shall be equal to Johns Manville "Micro-Lok" or approved equal.
- B. Flexible elastomeric pipe insulation (FU):
 - 1. Insulation shall have a thermal conductivity $k=0.25$ at 75 degrees F.
 - 2. Insulation shall be equal to Armacell "AP Armaflex".
- C. Cellular Glass (CG):
 - 1. Insulation shall have a thermal conductivity $k=0.35$ (density 8.5 pcf nominal).
 - 2. Insulation shall be equal to Foamglass
- D. Phenolic (P):
 - 1. Insulation shall have a thermal conductivity $k=0.15$ (density 10 pcf nominal)
 - 2. Insulation shall be equal to Insul-Phen.
- E. PVC pipe and fitting covers:
 - 1. Pipe and fitting covers shall be 20 mill thick flame retardant PVC. Fitting covers shall be neat, tight fitting radius type.
 - 2. Pipe and fitting covers shall be equal to Zeston type 300 or approved equal.

F. Custom Removable/Re-useable Piping Covers:

1. Insulation Encapsulating Material/Covering: Silicone or Teflon impregnated fiberglass fabric with a minimum density of 16 ounces per square yard.
2. Insulation Material: 1000 degree F elevated temperature blanket with a 1.1 pcf density. Insulation shall have a thermal conductivity $k=0.28$ at 100 degrees F.
3. Thread: Teflon coated fiberglass with a 20 lb tensile strength and 1500 yards/lb weight. Stapled or "hot-ringed" covers are not acceptable.
4. Covers shall be equal to Advance Thermal Corp. or approved equal.

2.02 DUCTWORK INSULATION

A. Rectangular Ductwork Interior Acoustical Liner: See Section 23 38 90 - Ductwork.

B. External Ductwrap Insulation (Ductwrap):

1. Insulation shall be 2-1/3" thick and 3/4 pcf density fiberglass material with FSK facing. The "k" factor at 75° F., mean temperature shall not exceed 0.31 and shall meet NFPA 90A & 90B Standards.

C. Dual Wall Round and/or Oval Ductwork Insulation: See Section 23 38 90 - Ductwork.

D. Rigid Board Insulation (Board):

1. Insulation shall be one inch (1") thick with FSK outer skin and black matte durable finish meeting the requirements of ASTM G21 and G22.
2. Insulation shall be equal to Knauf "Ductboard M" or CertainTeed "Ductboard with Enhanced Facing".

E. Fire Wrap Insulation:

1. Insulation system shall be tested and classified to provide 2-hour clearance to combustible construction and a 2 hour fire rating per ASTM E 2336.
2. Insulation shall be equal to "FireMaster FastWrap XL" by Thermal Ceramics.

PART 3 - EXECUTION

3.01 GENERAL INSULATION INSTALLATION REQUIREMENTS

- A. The insulation shall be applied by licensed insulation applicators and all work shall be performed in a neat and workmanlike manner.
- B. No insulation shall be applied over pipes, fittings, or other surfaces, which are not clean.
- C. Insulation shall be applied after pipes have been thoroughly tested and proven tight by the CONTRACTOR.
- D. Piping insulation thru rated walls shall be coordinated with Section Basic Mechanical Materials and Methods and approved pipe sleeve and fire stop with UL Listing.
- E. Color coding of piping systems shall be in accordance with Sections Basic Mechanical Materials and Methods and Mechanical Identification. Piping identification after color coding shall be as specified in Section Mechanical Identification.
- F. Insulation shall be clean and dry when installed and during the application of any finish.

- G. Install materials neatly with smooth and even surfaces with jackets drawn tight and smoothly cemented down on longitudinal and end laps.
- H. Scrap pieces shall not be used where a full length section will fit.
- I. Pipe insulation shall be continuous through sleeves, wall and ceiling openings.
- J. Piping and ductwork shall be individually insulated.
- K. Equipment nameplates, access plates in fan housings and ductwork and the like for ventilating and air heating systems, shall not be insulated but insulation must be carefully beveled and sealed around it.
- L. Ductwork insulation shall be continuous through sleeves, wall and ceiling openings except at fire dampers in ductwork systems.
- M. Vapor Barrier Installation:
 - 1. A complete moisture and vapor seal shall be provided wherever insulation terminates against metal hangers, anchors and other projections through insulation on cold surfaces for which a vapor seal is specified as identified in Part 3 paragraph 3.03 of this specification section.
 - 2. Seam and fitting covers shall be sealed with two (2) generous brush coat of fire resistant vapor barrier coating, applied at all longitudinal and circumferential laps.
 - 3. Ends of sections of insulation that butt against flanges, unions, valves, and fittings, and joints at intervals of not more than 12-feet on continuous runs of pipe shall be coated with a vapor barrier coating.
 - 4. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and cementing, coating as specified for butt strips. The patch shall extend not less than 1½" past the break in both directions.
 - 5. At penetrations such as thermometers, valve stems, etc., the voids in the insulation shall be filled with vapor barrier coating and the penetration sealed with a brush coat of the same coating.
 - 6. PVC fitting jackets in concealed applications shall be with a strip of insulation jacket and brush coat of vapor barrier sealant.
 - 7. PVC fitting jackets in exposed applications shall be neatly covered with a PVC/vinyl tape neatly smoothed.
- N. Installation at Hangers and Anchors:
 - 1. Pipe insulation shall be continuous through pipe hangers.
 - 2. Where pipe is supported by the insulation, galvanized sheet metal shields or saddles 12-inches long shall be provided. Shields/saddles shall be 20 gauge galvanized sheet metal for pipes 6" and smaller and 18 gauge for pipes 8" and larger.
 - 3. Where shields are used on pipes 2-inches and larger, insulation inserts shall be provided at points of hangers and supports.
 - a. Insulation inserts shall be of calcium silicate, cellular glass (minimum 8 pcf), molded glass fiber (minimum 8 pcf), or other approved material of the same thickness as adjacent insulation.
 - b. Inserts shall have sufficient compressive strength to adequately support the pipe without compressing the inserts to a thickness less than the adjacent insulation.
 - c. Insulation inserts shall cover the bottom half of the pipe circumference 180 degrees and be not less in length than the protection shield.

- d. Vapor barrier facing of the insert shall be of the same material as the facing on the adjacent insulation.
- e. Seal inserts into the insulation with vapor barrier coating.
- 4. Where protection saddles are used, fill all voids with the same insulation material as used on the adjacent pipe.
- 5. Insulate and vapor seal insulation at anchors same as piping for a distance not less than four times insulation thickness to prevent condensation.

3.02 PIPING INSULATION INSTALLATION

A. Fiberglass pipe insulation (FG):

- 1. Install insulation with longitudinal laps and butt strips additionally smoothly secured with Benjamin-Foster 85-20 adhesive.
- 2. Fittings and valves on pipe shall be similarly insulated with thickness equal to the adjacent pipe.

B. Flexible elastomeric pipe insulation (FU):

- 1. Miter 90-degree turns and elbows, tees, and valve insulation.
- 2. Secure longitudinal joints with vinyl tape on 9-inch centers.
- 3. Bond cuts, butt joints, ends, and longitudinal joints with adhesive. After adhesive cures, apply 2-inch wide pressure sensitive adhesive vinyl tape over bonded cuts, joints, and ends.

C. PVC pipe and fitting covers:

- 1. PVC pipe and fitting covers shall be installed with a smooth appearance and no visible wrinkles.
- 2. All longitudinal seams shall be installed such the joints facing up or to the back of the finished product.
- 3. All longitudinal and circumferential PVC jacket joints and connections shall be spot welded every 12 inches with Perma Weld Adhesive and subsequently neatly sealed with tight fitting pressure sensitive vinyl tape, installed without wrinkles.
- 4. See Section 23 01 90 - Mechanical Identification for color coding of factory PVC jackets in exposed applications.

D. Metal Jacket Installation:

- 1. Metal jackets shall have side and end laps at least 2 inches wide with the cut edge of the side lap turned under one inch to provide a smooth edge.
- 2. Secure jackets in place with aluminum or stainless steel bands on 9-inch centers.
- 3. Place laps to shed water.
- 4. Seal laps with weatherproof coating.
- 5. Where pipes penetrate exterior walls, continue the increased insulation thickness required for piping exposed to weather and the metal jackets through the sleeve to a point 2 inches beyond the interior surface of the wall.
- 6. In outside locations protect fittings, flanges, and valves with a weatherproof coating prior to installation of metal covers. Secure metal covers for fittings, flanges, and valves in place with metal bands and seal with a weatherproof coating.

E. Custom Removable/Re-useable Piping Covers:

1. Fabricate such that allowances are made to cover all protrusions including valve bonnets, handles, etc. Packing glands shall not be covered.
2. Overlap adjoining permanent insulations a minimum of 2 inches and the overlapping section shall be full thickness of the blanket.
3. Inside and outside surfaces of the covers shall completely encapsulate the entire insulation core to form a weatherproof assembly.

3.03 PIPING INSULATION MATERIAL TYPE, SERVICE JACKET, VAPOR BARRIER, AND THICKNESS CHARTS

CHILLED WATER						
MATERIAL ("A")	TYPE OF SERVICE JACKET ("B")	VAPOR BARRIER REQUIRED	INSULATION THICKNESS (INCHES) FOR PIPE SIZE			NOTES
			1/2"-3"	3-1/2"-6"	8"-10"	
CG	A	YES	2	2.5	3.5	1,2,4,5,6,7,8,10
FU	C	NO	1	-	-	
P	A	YES	1	1.5	2	

3.04 CONDENSER WATER

HEATING WATER						
MATERIAL ("A")	TYPE OF SERVICE JACKET ("B")	VAPOR BARRIER REQUIRED	INSULATION THICKNESS (INCHES) FOR PIPE SIZE			NOTES
			1/2"-3"	3-1/2"-6"	8"-10"	
FG	B	YES	1.5	2	2	1,2,4,5,6,7,8
FU	C	NO	1	-	-	
P	B	YES	1	1	1.5	
CG	A	YES	2	2.5	2.5	

AIR CONDITIONING CONDENSATE DRAINS INSIDE BUILDING						
MATERIAL ("A")	TYPE OF SERVICE JACKET ("B")	VAPOR BARRIER REQUIRED	INSULATION THICKNESS (INCHES) FOR PIPE SIZE			NOTES
			1/2"-1-1/4"	1-1/2"-3"	3-1/2"-6"	
FG	A OR B	YES	1	1	1	9
FU	C	NO	0.75	1	1	

"A" - INSULATION MATERIAL

ABBREVIATION	MATERIAL	SPECIFICATION	TYPE	CLASS/GRADE
FU	Flexible Unicellular	ASTM C 534	-	-
FG	Fiberglass	ASTM C 547	I	1
P	Phenolic	ASTM C 552	-	-
CG	Cellular Glass	ASTM C 1126	III	1

"B" - TYPE OF SERVICE JACKET REQUIRED

A	Foil Backed all Service Jacket (ASJ)
B	Paper ASJ
C	None

A. Insulation Charts Notes:

- Higher density insulation inserts shall be utilized on all HVAC piping larger than 1-1/2 inch size, at all hanger/saddle supports.
- Insulation located outside shall be one inch thicker than shown in table.
- Liquid refrigerant piping on heat pump systems where changeover valve is located in condensing unit, where recommended by manufacturer or where required to prevent condensation, shall be insulated same as refrigerant suction piping.
- A full coverage color-coded pvc jacket shall be required on insulated piping and fittings exposed in mechanical rooms, in crawlspace, and in interior exposed applications. See Section Mechanical Identification for color requirements.
- Provide metal jackets over insulation on all piping exposed to outdoor weather.
- All HVAC piping outside, exposed to view in finished spaces, in crawlspace, within mechanical/equipment rooms, etc. shall be insulated with phenolic or "Foamglas".
- Flexible unicellular insulation may be utilized only on HVAC piping run outs, 1 inch or smaller, to individual equipment. This type installation shall be limited to a maximum of 10 linear feet for each unit and allowed only in concealed applications.
- All valves and piping specialties requiring routine maintenance and adjustment shall be insulated with removable/reusable covers. Thickness shall be 2 inches up through 2-inch pipe sizes and 3 inches on piping 2-1/2 inches and larger.
- Drain piping in concealed applications may be insulated with flexible unicellular or fiberglass insulation.
- Chilled water over 10 inches with fiberglass insulation shall be 4.5 inches.

3.05 DUCTWORK INSULATION INSTALLATION**A. Rectangular Ductwork Interior Acoustical Liner: See Section 23 38 90 - Ductwork.****B. External Ductwrap Insulation:**

- Insulation shall be installed in a manner to prevent compression of the insulation.
- When ductwork (rectangular or flat oval) with any vertical or bottom side is greater than 18 inches, install pins and clips in a 12 inches on center grid, with pins within 4 inches of any longitudinal edge. Excess length of pins shall be snipped and top of pin/washer covered with pressure UL 181 pressure sensitive tape.
- All longitudinal and circumferential insulation seams shall be sealed with 3-inch wide pressure sensitive tape bearing the UL 181 label.

C. Dual Wall Round and/or Oval Ductwork Insulation: See Section 23 38 90 - Ductwork.

D. Rigid Board Insulation:

1. Insulation shall be installed in a manner to prevent compression of the insulation.
2. When ductwork (rectangular or flat oval) with any vertical or bottom side is greater than 18 inches, install pins and clips in a 12 inches on center grid, with pins within 4 inches of any longitudinal edge. Excess length of pins shall be snipped and top of pin/washer covered with pressure UL 181 pressure sensitive tape.
3. All longitudinal and circumferential insulation seams shall be sealed with 3-inch wide pressure sensitive tape bearing the UL 181 label.

E. Fire Wrap Insulation:

1. Install per instructions specified in an ICC-ES building code report and manufacturer's recommendations to provide specified fire rating.

3.06 DUCTWORK INSTALLATION APPLICATIONS

DUCTWORK INSULATION MATERIAL, THICKNESS, AND VAPOR BARRIER CHART				
DUCTWORK TYPE AND FUNCTION	INSULATION MATERIAL	VAPOR BARRIER REQ'D	INSULATION THICKNESS (INCHES)	NOTES
RECTANGULAR LOW PRESSURE SUPPLY	DUCT WRAP	YES	2.33	1
ROUND/OVAL LOW PRESSURE SUPPLY	DUCT WRAP	YES	2.33	2
RECTANGULAR LOW PRESSURE RETURN	DUCT WRAP	YES	2.33	1
ROUND/OVAL LOW PRESSURE RETURN	DUCT WRAP	YES	2.33	
RECTANGULAR LOW PRESSURE EXHAUST AIR	SEE NOTES	-	-	3
ROUND/OVAL LOW PRESSURE EXHAUST AIR	NONE	-	-	4
RECTANGULAR LOW PRESSURE OUTSIDE AIR	DUCT WRAP	YES	2.33	1
ROUND/OVAL LOW PRESSURE OUTSIDE AIR	DUCT WRAP	YES	2.33	2
RECTANGULAR LOW PRESSURE TRANSFER AIR	DUCT WRAP	-	-	
ROUND/OVAL LOW PRESSURE TRANSFER AIR	DUCT WRAP	YES	2.33	
RECTANGULAR MEDIUM PRESSURE SUPPLY AIR	DUCT WRAP	YES	2.33	1
ROUND/OVAL MEDIUM PRESSURE SUPPLY AIR	DUCT WRAP	YES	2.33	2
RECTANGULAR MEDIUM PRESSURE OUTSIDE AIR	DUCT WRAP	YES	2.33	1
ROUND/OVAL MEDIUM PRESSURE OUTSIDE AIR	DUCT WRAP	YES	2.33	2
TRANSFER AND RETURN AIR GRILLE PLENUM BOXES	DUCT WRAP	YES	2.33	5
MISCELLANEOUS DUCTWORK AND ACCESSORIES	DUCT WRAP	YES	2.33	4

A. Chart Notes:

1. See Ductwork Section for ductwork located outdoors.
2. See Section Ductwork for double wall sandwich insulation required for dual wall ductwork.
3. See Section Ductwork for acoustical internal insulation required.
4. Miscellaneous Insulation and Acoustical Treatment Requirements:
 - a. Air Distribution Devices (Grilles, Registers and Diffusers):
 - 1) The concealed frame and housing of all such devices above ceilings, in attics, walls, crawlspaces, etc., shall be factory insulated.
 - 2) When factory insulation is not available, ductwrap insulation shall be installed on any concealed frame, housings, plenums, etc.
 - b. Fire, Smoke, Combination Fire/Smoke shall be insulated per detail on Drawings and Damper Manufacturer's recommendations.
 - c. Control and Manual dampers shall be insulated such that automatic or manual operator is not impeded.
 - d. Dryer exhaust ductwork routed concealed indoors, in walls, attics, etc., shall be insulated.
5. See Details on Drawings for more information and construction requirements.
6. Kitchen hood exhaust ductwork insulation thickness varies by application and manufacturer. Provide thickness as required to meet specified fire resistance rating.

3.7 EQUIPMENT INSULATION INSTALLATION

A. Flexible elastomeric pipe insulation (FU):

1. Miter 90-degree turns and elbows, tees, and valve insulation.
2. Secure longitudinal joints with vinyl tape on 9-inch centers.
3. Bond cuts, butt joints, ends, and longitudinal joints with adhesive. After adhesive cures, apply 2-inch wide pressure sensitive adhesive vinyl tape over bonded cuts, joints, and ends.

END OF SECTION

SECTION 23 08 00
HVAC SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Building Automation System (BAS) Startup and Functional Performance Testing.
- B. Validation of proper and thorough installation of Division 23 systems and equipment.
- C. Generic Startup Documentation for mechanical systems and equipment.
- D. Development of final Startup Documentation for mechanical systems and equipment.
- E. System Startup and Turn-Over procedures.
- F. Systems balancing verification.
- G. Coordination and execution of Training Events.

1.2 GENERAL DESCRIPTION

- A. Commissioning (Cx) is the process of ensuring that (i) all building systems are installed and perform interactively according to the design intent; (ii) that systems are efficient and cost effective and meet the Owner's operational needs; (iii) that the installation is accurately documented; and (iv) that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.
- B. Commissioning Authority (CA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.
- C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.
- D. This Section outlines the Cx procedures specific to the Division 23 Contractors. Requirements common to all Sections are specified in Section 019100 and Section 019113.13 This Section and other sections of the specification details the Contractor's responsibilities relative to the Cx process.

1.3 SCOPE

- A. The following systems and equipment are included in the Scope of Commissioning for this project.

- B. Mechanical/HVAC Systems: All Division 23 equipment and systems are subject to commissioning, including but not limited to the systems listed below. All components and devices (sensors, valves, etc.) that make up these systems are included.
 - 1. Air Handling Units (AHU).
 - 2. VAV terminal units.
 - 3. CHW Hydronic Pumping System.
 - 4. HW Hydronic Pumping System.
- C. Building Automation System (BAS).
 - 1. The BAS and all BAS Sub-Systems shall be subject to commissioning, including all hardware components, software, networking, programming and engineering services, and controls documentation.

1.4 RELATED WORK AND DOCUMENTS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents. See Division 01 for details.
- B. The Cx process references many related Sections, particularly Section 019100 - General Commissioning Requirements. It is important for all Contractors subject to the Cx process to be familiar with Section 019100.
- C. Section 019113.13 – General Commissioning Requirements for Functional Performance Testing.
- D. Section 220800 – Plumbing System Commissioning.
- E. Section 230810 – BAS Commissioning.
- F. Section 260800 – Electrical Systems Commissioning.

1.5 DEFINITIONS AND ABBREVIATIONS

- A. Refer to Section 019100 for a complete list of Definitions and Abbreviations.

1.6 REFERENCE STANDARDS

- A. Refer to Section 019100 for a complete list of Definitions and Abbreviations.
- B. ASHRAE Standard 202 – Commissioning Process for Buildings and Systems.
- C. ASHRAE Guideline 0 – The Commissioning Process.
- D. ASHRAE Guideline 1.1 – HVAC&R Technical Requirements for the Commissioning Process.
- E. ASHRAE Guideline 1.3 – Building Operations and Maintenance Training for the HVAC&R Commissioning Process.
- F. ASHRAE Guideline 1.4 – Procedures for Preparing Facility Systems Manual.

1.7 DOCUMENTATION

- A. Documentation shall be as required in Section 019100. In addition, Contractor shall also provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:
1. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to the Acceptance Phase. Factory Test Reports should be provided in PDF electronic format. These may include but are not limited to:
 - a. Air Handling Units.
 - b. Variable Frequency Drives.
 - c. Fans Capacity.
 - d. Fan Sound Power Levels.
 2. Field Testing Agency Reports (other than TAB): Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in PDF electronic format. These may include but are not limited to:
 - a. Pipe Pressure Testing.
 - b. Duct Air Leakage Testing.
 - c. Vibration Testing.
 - d. Generated Noise and Resultant Noise Level.
 - e. Water Treatment.
 3. TAB Plan: The Testing, Adjusting, and Balancing Plan shall include the following:
 - a. Certifications on all instruments to be used throughout the testing. Certification must be documented within the previous 6 months.
 - b. Résumés and Certification of individuals who will be balancing the systems.
 - c. Detailed step-by-step plans for each procedure to be performed by the TAB Contractor.
 - d. Sample forms to be used for each measurement.
 - e. Sample balancing report.
 4. Piping Cleaning, Flush, and Fill Plan: Contractor shall provide this document in accordance with details in this Section. CA will review.
 5. Temporary Operating and Conditioning Plan: Contractor shall provide in accordance with details in this Section. CA will review.
 6. Completed TAB Reports. CA will review prior to FPT.

1.8 SEQUENCING AND SCHEDULING

- A. Refer to Section 019100.

1.9 COORDINATION MANAGEMENT PROTOCOLS

- A. Coordination responsibilities and management protocols relative to Cx are initially defined in Section 019100 and the Cx Plan, but shall be refined and documented in the Construction Phase Cx Kick-Off Meeting. Contractor shall have input into the protocols to be used and all Parties will commit to scheduling obligations. The CA will record and distribute.

1.10 CONTRACTOR RESPONSIBILITIES

- A. Refer to Section 019100: Detailed Contractor responsibilities common to all Divisions are specified in Section 019100. The following are additional responsibilities or notable responsibilities specific to Division 23.
- B. Construction Phase.
 - 1. Provide skilled technicians qualified to perform the work required.
 - 2. Provide factory-trained and authorized technicians where required by the Contract Documents.
 - 3. Prepare and submit required draft Startup Documentation and submit along with the manufacturer's application, installation and startup information.
 - 4. Provide assistance to the CA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review FPT procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.
 - 5. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere in this Section.
 - 6. Startup, test/adjust/balance, and Turn-Over systems and equipment prior to functional performance testing by the CA. Approved Startup Documentation shall be in accordance with Contract Documents, reference or industry standards, and specifically elsewhere in Part I of this Section.
 - 7. Record Startup on approved Startup Documentation forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above. Each task or item shall be indicated with the Party actually performing the task or procedure.
 - 8. TAB: As outlined in Section 230990. Specifically, as it relates to Cx:
 - a. Attend Construction Phase Cx Kick-Off Meeting and Cx progress meetings beginning within 2 months of start of TAB work.
 - b. Submit TAB Plan as indicated above.
 - c. Meet with Cx team to review TAB procedures and documentation required.
 - d. Demonstrate TAB procedures for repetitive tasks (zone balancing, AHU adjusting) as called for by the CA.
 - e. Participate in Action List dialogue.
 - f. Provide all documentation electronically.
- C. Acceptance Phase.
 - 1. Assist CA in Functional Performance Testing. Assistance will typically include the following:
 - a. Manipulate systems and equipment to facilitate Functional Performance Testing (as specified in Section 019100, Section 019113.13, and the Cx Plan; in some cases this will entail only an initial sample).
 - b. Manipulate BAS and other control systems to facilitate Functional Performance Testing (as specified in Section 019100, Section 019113.13, and the Cx Plan; in some cases, this will entail only an initial sample).
 - c. Provide a TAB technician to work at the direction of CA for up to 16 hours beyond assistance specified above.
 - d. Provide a BAS technician to work at the direction of CA for up to 16 hours beyond assistance specified above.
- D. Warranty Phase.

1. Maintain record documentation of any configurations, setpoints, parameters, etc. that change throughout the Warranty Period.
2. Provide representative for off-season testing as required by CA.
3. Respond to warranty issues as required by Division 01 and the General Conditions.

1.11 EQUIPMENT SUPPLIER RESPONSIBILITIES

- a. Provide any specialized instrumentation necessary for Functional Performance Testing.

B. Refer to Section 019100.

1.12 CONTRACTOR NOTIFICATION AND SCHEDULING

A. Refer to Section 019100.

1.13 STARTUP DOCUMENTATION

A. Refer to Section 019100.

1.14 EQUIPMENT NAMEPLATE DATA

A. Refer to Section 019100.

1.15 PIPING CLEANING, FLUSH AND FILL PLAN

- A. Contractors shall provide a "Piping Cleaning, Flush, and Fill Plan" to the CA that provides a descriptive narrative and supporting calculations of the means and methods that will be used to clean out, flush, and fill the piping systems.
- B. The "Piping Cleaning, Flush, and Fill Plan" shall incorporate and be inclusive of all requirements of individual Divisions and Sections relating to piping and pipe cleaning and flushing. In addition to the requirements of any other related Section, this document shall consist of the following at a minimum for each individual hydronic loop:
 1. Overview schematic diagram of each of the hydronic systems, showing individual flow components such as chillers, boilers, pumps, heat exchangers, cooling towers, control valves, and strainers.
 2. Narrative and illustration indicating the equipment that will either participate or be bypassed by fluid flow during the clean and flush process.
 3. For equipment to be bypassed, description of the means for providing the bypass, including the type, size, and length of hoses or piping to be used.
 4. Description of how flow is to be induced (permanent pumps, temporary pumps, etc.) and flow rates to be imposed during the flush process.
 5. Calculation of resultant flow velocities in various portions of the piping system, with specific identification of the minimum velocity sections of the piping loop. Velocities should generally be shown to be above a 7 feet-per-second minimum speed to provide for adequate capability to flush and carry debris through the system to the appropriate strainer or clean-out location.

6. Description of cleaning methods and materials to be used to flush the system. Description shall include cleaning material and concentration, details of the cleaning process including duration of circulation and flushing intervals, criteria for determining a "clean" flush, and name and qualifications of cleaning or chemical treatment subcontractors to be used.
7. Identification and discussion of any isolated sections or 'dead-legs' that will be present, including means to provide cleaning and flushing for these sections.
8. Details of the strainers to be used for the flush and clean process, as well as final strainers to be used after cleaning. Contractor shall clean all strainers prior to turning over the system for commissioning.
9. If the cleaning and flushing process is to be phased in sections, details should be provided to clarify how clean sections will be protected as other sections are flushed.

1.16 TEMPORARY OPERATION AND CONDITIONING PLAN

- A. Contractor shall be allowed to use permanent building equipment to provide temporary conditioning ONLY upon the approval of the A/E, Owner, and the CA. Approval for such will only be given upon acceptance of a detailed Temporary Operating and Conditioning Plan provided by the individually involved subcontractors and compiled by the GC. The Temporary Operating and Conditioning Plan shall consider/address the following at a minimum:

1. Indicate that the full Startup protocol, including development and documentation of Startup Documentation as required by the specification will be performed for the temporary startup. The Temporary Conditioning Plan shall include the Startup Documentation to be used, which shall be the same as those that will be used for final Startup.
2. Contractor shall address how equipment will be maintained in good, clean condition. Specifically address:
 - a. Temporary Filtering of Air: Air filters used for construction shall be as or more effective than those specified for permanent use. Contractor shall remove construction filters and replace with new filters prior to FPT. Filters shall be maintained and replaced at the specified final pressure drop. Contractor shall install a magnehelic gauge for visual indication of pressure drop as well as setting and adjusting the loaded filter DP switch for monitoring on the BAS.
 - b. Temporary Filtering of Water and Condensate: Construction strainers shall be used while circulating fluid during construction. Construction strainer shall be finer than that specified for final strainers.
 - c. Sealing/Filtering of Open Ducts: Address that all open ducts shall be either sealed or protected with filter media. Return or exhaust systems shall not be used during construction unless otherwise approved.
 - d. Lubrication and Maintenance: Contractor shall maintain the systems and equipment in accordance with the manufacturer's instructions. Contractor shall coordinate lubricants used with Owner's operators. Frequency of lubrication and inspection shall be as recommended by manufacturer's literature. Applicable maintenance lubrication schedules shall be included in the Plan. Draft maintenance logs shall be submitted with Plan and completed as maintenance is performed.
 - e. Operation Outside of Normal Ranges: Systems and equipment shall not be operated outside the range of specified conditions. The Temporary Conditioning Plan shall address how the Contractor will ensure that operation will not harm the equipment.
 - f. Emergency Condition Identification and Response Protocols: The Temporary Conditioning Plan shall address protocols for responding to equipment malfunctions and or harmful operation. Automatic safeties and remote enunciation shall be in place to protect people and property. Temporary operation shall not be allowed until there is an automatic communication/enunciation medium such as a phone connection or an Internet connection. At a minimum, an alarm on the equipment used for temporary service shall be automatically sent to the Contractor's 24-hour

monitoring service and to the Owners' help desk. The Contractor shall respond to and be responsible for securing conditions within the building. Owner shall assess the situation and as necessary secure utilities feeding the building from isolation points outside of the building.

3. Building Protection: Address how the system will be controlled to avoid humidity conditions that could either promote mold growth or cause corrosion or damage.
4. Equipment Reconditioning: Address with specific means and methods how the equipment used for temporary conditioning will be reconditioned to like-new condition. Belts, seals, bearings, couplings, or other parts that wear more than 3% of their expected life shall be replaced.
5. Cleaning: Address how ducts, pipes, coils, converters, air handling equipment, terminal units, etc. shall be cleaned prior to Turn-Over.
6. Operations Log: Contractor responsible for operating the equipment shall maintain a log of all activities associated with operating and maintaining equipment. Log shall be submitted to Owner on a frequency specified by the Owner.
7. Operating System Alterations: The Temporary Conditioning Plan shall address specific protocol for doing work on the systems.
8. Damages: Any material, device, component, or equipment that is assessed as damaged or as having a substantially shortened life as a result of temporary conditioning operation shall be replaced by the Contractor at no cost to the Owner or to the project.
9. Segregation: Where only portions of a system are to be used, Contractor shall specifically indicate how the used portion will be isolated from the unused portion. The Temporary Conditioning Plan shall address how to ensure that the reduced operation condition will be maintained within acceptable ranges, and/or how capacity will be throttled to keep all operating parameters in recommended ranges.

1.17 TRAINING EVENTS AND TRAINING PLAN

- A. Contractors, subcontractor, vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 019100 and the individual Specifications.

1.18 SYSTEMS MANUAL AND O&M DOCUMENTATION CONTENT

- A. Refer to Section 019100.

1.19 BAS TRENDING REQUIREMENTS

- A. The BAS and BAS Sub-System Contractors shall configure and analyze all trends required under Division 23.

1.20 FUNCTIONAL PERFORMANCE TESTING.

- A. Contractor shall participate in the initial samples of Functional Performance Testing as stipulated in Section 019100.

1.21 FPT ACCEPTANCE CRITERIA

- A. Acceptance criteria for tests are indicated in Section 019100 and in the specification Sections applicable to the systems being tested. Unless indicated otherwise, the criteria for acceptance will typically be that specified with the individual system, equipment, component, or device.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

- A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:
 1. Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of +/- 0.1F.
 2. Pressure sensors shall have an accuracy of +/- 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.
 3. All equipment shall be calibrated per the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.
- B. Standard Testing Instrumentation: Standard instrumentation used for testing air and water flows, temperatures, humidity, noise levels, amperage, voltage, and pressure differential in air and water systems related to functional testing shall be provided by CA.
- C. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, per these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon project completion.

2.2 TEST KITS FOR METERS AND GAUGES

- A. Test kits for meters and gages shall be provided to the Owner new and in good condition. Previously used kits will be unacceptable. Kits shall be submitted prior to the Acceptance Phase. Kits included shall be as a minimum:
 1. Digital indication of temperature and pressure with associated sensors to work with the P/T test ports.
 2. Companion readout kit (with fittings) for calibrated balancing valve with ranges as required by all devices on this project.

PART 3 - EXECUTION

3.1 GENERAL STARTUP DOCUMENTATION

- A. This Section outlines 'generic' or minimally acceptable Startup Documentation (which are defined to include both 'Startup Checks' and 'Startup Tests') and individual systems training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimally acceptable guideline for required Contractor development

of Startup Documentation. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized final Startup Documentation specific to the equipment and systems installed on this project.

- B. Section 019100 defines the systems and equipment Startup process in detail and provides definitions for Startup Documentation, including the generic Startup Documentation provided below.

3.2 STARTUP DOCUMENTATION COMMON TO ALL SYSTEMS

- A. The following Startup Documentation (Checklists and Tests) shall be considered common to all systems:
 1. Checkout shall proceed from lower level devices to larger components to the entire system operation.
 2. Verify labeling is affixed per specification and visible.
 3. Verify prerequisite procedures are done.
 4. Inspect for damage and ensure none is present.
 5. Verify system is installed per the manufacturer's recommendations.
 6. Verify system has undergone Startup per the manufacturer's recommendations.
 7. Verify that access is provided for inspection, operation and repair.
 8. Verify that access is provided for eventual replacement of the equipment.
 9. Verify that record drawings, submittal data and O&M documentation accurately reflect the installed systems.
 10. Verify all gauges and test ports are provided as required by contract documents and manufacturer's recommendations.
 11. Verify all recorded nameplate data is accurate.
 12. Verify that the installation ensures safe operation and maintenance.
 13. Verify specified replacement material/stock has been provided as required by the Contract Documents.
 14. Verify all rotating and moving parts are properly lubricated.
 15. Verify all monitoring and ensure all alarms are active and set per Owner's requirements.
 16. Complete all nameplate data and confirm that ratings conform to the design documents.

3.3 VALVES

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Startup Checks: Perform the following checks during startup and as specified in manufacturer's instructions:
 1. Operate all valves, manual and automatic, through their full stroke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.
 2. Verify actuators are properly installed with adequate clearance.
 3. Verify all valves are labeled per the construction documents. Confirm that concealed valves are indicated on the finished building surface.
 4. For automatic pneumatically-operated valves, verify spring range and adjust pilot positioners where applicable.
 5. For electronically operated valves, check the stroke and range.
 6. For all automated valves controlled by a program, ensure that the minimum and maximum stroke and ranges on the valves are coordinated with the limits entered in the program.

3.4 METERS AND GAUGES

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Startup Checks: Perform the following checks during startup and as specified in manufacturer's instructions:
 - 1. Adjust faces of meters and gauges to proper angle for best visibility.
 - 2. Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.
 - 3. For meters and gauges requiring temporary manual connection of read-out device such as pressure taps on a flow measuring device, ensure threads are clean and that connection can be made easily.
 - 4. Meters and gauges requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

3.5 MECHANICAL IDENTIFICATION

- A. Startup Checks: Perform the following checks:
 - 1. Verify all valve tags, piping, duct, and equipment labeling corresponds with drawings and indexes and meets requirements specified. Correct any deficiencies for all piping and duct systems.
 - 2. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
 - 3. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.6 MECHANICAL INSULATION

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Startup Checks: Examine all piping, systems and equipment specified to be insulated.
 - 1. Ensure quality of insulation. Patch and repair all insulation damaged after installation.
 - 2. Ensure the integrity of vapor barrier around all cold surfaces.

3.7 ALL PIPING

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Startup Checks: These procedures apply to all installed piping systems, including underground site utilities.
 - 1. Inspect all piping for proper installation, adequate support (with appropriate vibration isolation where applicable) and adequate isolation valves for required service.
 - 2. Submit welding certifications as required by the applicable specification section or referenced ASME specification.

3. Submit certified welding inspection results per the applicable specification section or referenced ASME specification. ASME B31.1 requires 100% inspection based on pressure class.
4. Provide notification of pipe cleaning and flushing activities.
5. Flush and clean all piping and clean all strainers. Provide documentation of all related procedures.
6. Ensure adequate drainage is provided at low points and venting is provided at high points.
7. Ensure facilities to effectively drain and fill the system are in place.
8. Ensure air is thoroughly removed from the system as applicable.
9. Ensure all piping is adequately supported and anchored to allow expansion. Bump across-the-line pumps and inspect for excessive pipe movement.
10. Provide notification of pressure testing.
11. Pressure and/or leak test all applicable systems in accordance with the requirements in the applicable sections, ASME B 31.1 and 39.1 as applicable.
12. Sterilize applicable piping systems as specified in the individual Sections and as required by regulatory authorities.
13. Submit pressure test reports that document the pressure testing results with certification of the results.
14. Verify the operation of applicable safety relief valves, operating controls, safety controls, etc. to ensure a safe installation.
15. Set and adjust fill, pressure, or level controls to the required setting.

3.8 AC MOTORS

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Startup Checks: Perform the following checks during startup and as specified in manufacturer's instructions:
 1. Verify proper alignment, installation, and rotation.
 2. Verify properly sized overloads are in place.
- C. Startup Tests: Perform the following tests, measurements, or procedures during startup and as specified in manufacturer's instructions:
 1. Measure insulation resistance, phase balance, and resistance to ground.
 2. Measure voltage available to all phases. Measure amps and RPM after motor has been placed in operation and is under load.
 3. Record all motor nameplate data.

3.9 BEARINGS

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Startup Checks: Perform the following checks during startup and as specified in manufacturer's instructions. This applies to all bearings on fans, pumps, compressors, and other equipment installed under this Division.
 1. Check alignment as applicable.

2. Lubricate all bearings per the manufacturer's instructions. When bearing is used for temporary conditioning, lubricate on manufacturer's recommended frequency and document it.
- C. Startup Tests: Perform the following tests, measurements, or procedures during startup and as specified in manufacturer's instructions:
1. Use infrared thermometer to measure temperature at peak conditions. Ensure temperature is below manufacturer's recommendations.
 2. For bearings in drives with motors over 10 HP, use a vibration meter and measure the maximum peak-to-peak acceleration. Compare it to the Vibration Severity Chart. Rectify any condition causing severity indicated as "Rough" or worse.

3.10 VARIABLE SPEED DRIVES

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. General: Provide the services of a factory authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below.
- C. Startup Checks: Perform the following checks during startup and as specified in manufacturer's instructions:
1. Check unit for shipping damage.
 2. Perform a point-to-point continuity test for all field installed wiring interconnections. Verify terminations of field-installed wiring.
 3. Check for proper torque on connections.
 4. Verify use of shielded cable where specified and check that shields have been terminated properly.
 5. Verify grounding.
 6. Check motor nameplate against drive input rating.
 7. Manually rotate motor shaft to ensure free rotation.
 8. Check that motor leads are not grounded.
- D. Startup Tests: Perform the following tests, measurements, or procedures during startup and as specified in manufacturer's instructions. Ensure device and system which drive is serving is configured to withstand the device operation specified below.
1. Adjust the 'Minimum Voltage Adjustment' to enable starting but not to draw excessive power at start.
 2. Adjust the 'Volts/Hz Adjustment' to proper setting.
 3. Adjust the 'Acceleration and Deceleration Rates' to the specified times.
 4. Adjust 'Current Limiting' to coordinate with the overcorrect device and protect the motor.
 5. Set the 'Maximum and Minimum Speed' points.
 6. Manually ramp fan speed from minimum to maximum and check for excessive noise and vibration.
 7. Determine any critical speeds to avoid and set these in the drive.
 8. Check for acceptable voltage and current distortion on the power system. Record the input and output voltages and currents showing the harmonic content as a percentage of the base frequency.
 9. Measure and record overall efficiency at 50%, 75%, and 100%.
 10. Record the motor terminal voltage.

- E. Training: Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventative maintenance. Review data in manufacturer's Operation and Maintenance Manuals.

3.11 HYDRONIC PIPING

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Startup Checks: Perform the following checks during startup:
 1. Prepare hydronic and test piping in accordance with applicable Section and ASME B 31.9 and/or B 31.1.
 2. Flush system with clean water in accordance with applicable Section.
 3. Clean strainers.
 4. Check expansion tanks to determine that they are not air-bound and that the system is completely full of water.
 5. Set automatic fill valves for required system pressure.
 6. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
 7. Set and coordinate automatic fill pressure and relief valve settings.
- C. Startup Tests: Perform the following tests, measurements, or procedures during startup:
 1. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

3.12 VAV TERMINAL UNITS

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Refer to and coordinate with Division 23 Section "Testing, Adjusting, and Balancing".
- C. Startup Checks: Perform the following inspections/checks during startup:
 1. After construction is completed, including painting if applicable, clean exposed unit surfaces.
 2. Clean factory-finished surfaces. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
 3. Ensure unit is properly supported and that integrity of vibration isolation has been maintained where applicable.
 4. Ensure that air velocity sensor is correctly installed and that inlet/outlet restrictions for accurate measurements have been met.
 5. Ensure air inlet is free of obstructions. Start fans and ensure proper rotation (as applicable). Measure and record motor amperage and voltage.
 6. Ensure the coils are undamaged, combed, and vented.
 7. Check the heating device and control to ensure functionality and proper installation. Check stroke and range on the valve and ensure it closes and seals tightly.
- D. Startup Tests: Perform the following during startup:

1. Calibrate and adjust the airflow control parameters. Set applicable min and max setpoints. Coordinate with the BAS contractor as necessary to obtain flow parameters required.
2. Install new filters where required.
3. Set all temperature and humidity setpoints to those as directed by Owner.
4. Record supply air temperature at full cooling and at full heating (compare both with current air handler temp)

3.13 CENTRAL-STATION AIR HANDLING UNITS

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. **General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below.**
- C. References: The following additional Sections shall also apply:
 1. Refer to AC Motors in this Section.
 2. Refer to Fans in this Section.
 3. Refer to Bearings in this Section.
 4. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.
 5. Refer to Section 230810 - BAS Commissioning for procedures for starting the controls related to the AHU.
- D. Startup Checks: Perform the following inspections/checks during startup:
 1. Inspect the field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
 2. Cleaning: Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face. Ensure volatile irritants are contained and kept out of occupied spaces.
 3. Adjust and lubricate dampers and linkages for proper damper operation.
 4. For field-fabricated units, ensure the sections are properly connected within acceptable tolerances.
 5. Seal all penetrations to be air-tight and ensure access doors seat tightly.
 6. Verify that unit is secure on mountings and supporting devices and connections for piping, ductwork, and electrical are complete.
 7. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
 8. Ensure vibration isolation integrity is maintained throughout the AHU installation and its connections.
 9. Tension all belts per the drive manufacturer's recommendations.
 10. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
 11. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 12. Comb coil fins for parallel orientation.
 13. Install clean filters.
 14. Ensure condensate drains properly and that trap is adequate.
 15. Stroke all valves and damper to ensure free and full travel.
- E. Startup Tests: Perform the following during startup:

1. Pressure test units as required in the AHU specification.

F. Training: **Factory-authorized representative** shall train Owner's maintenance personnel including:

1. Procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of manufacturer's Operating and Maintenance Manuals.

3.14 FANS

A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.

B. **General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below.**

C. References: The following additional Sections shall also apply:

1. Refer to AC Motors in this Section.
2. Refer to Bearings in this Section.
3. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.
4. Refer to Section 230810 - BAS Commissioning for procedures for starting the controls related to the fan.

D. Startup Checks: Perform the following inspections/checks during startup:

1. Inspect the field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
2. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face. Ensure volatile irritants are contained and kept out of occupied spaces.
3. Adjust and lubricate dampers and linkages for proper damper operation.
4. Verify that unit is secure on mountings and supporting devices and connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
5. Ensure vibration isolation integrity is maintained with the fan installation and associated connections.
6. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
7. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
8. Stroke all dampers to ensure free and full travel.

E. Training: **Factory-authorized representative** shall train Owner's maintenance personnel including:

1. Procedures and schedules related to startup and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of manufacturer's Operating and Maintenance Manuals.

3.15 AIR CLEANING AND FILTERS

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. General: Operate installed air filters to demonstrate compliance with requirements. Test for air leakage of unfiltered air while system is operating. Correct malfunctioning units at site, then retest to demonstrate compliance; otherwise remove and replace with new units, and proceed with re-testing.

3.16 METAL DUCTWORK

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure using polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.
- C. Startup Checks: Perform the following checks during startup and as specified:
 - 1. Clean ductwork internally of dust and debris, unit-by-unit as it is installed. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
 - 2. Strip protective paper from stainless ductwork surfaces if applicable, and repair finish wherever it has been damaged.
- D. Startup Tests: In addition to specifications, perform the following as a minimum:
 - 1. Leakage Tests: After each duct system is completed, test for duct leakage in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Repair leaks and repeat tests until total leakage is less than specified acceptable leakage rate.
 - 2. Balancing: Refer to Division-23 section "Testing, Adjusting, and Balancing" for air distribution balancing of metal ductwork; not work of this section. Seal any leaks in ductwork that become apparent in balancing process.

3.17 DUCTWORK ACCESSORIES

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Startup Checks: Perform the following checks during startup and as specified:
 - 1. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- C. Startup Tests: In addition to specifications, perform the following as a minimum:
 - 1. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.
 - 2. Label access doors in accordance with Division 23 Section "Mechanical Identification".

3. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
4. Final positioning of manual dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing".
5. Fire Damper Testing: For every fire damper, remove the fusible link and verify that the damper operates freely and closes tightly. Reinstall the fusible link.

3.18 AIR TERMINALS

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Startup Checks: Upon completion of installation and prior to initial operation, check that air terminals are:
 1. Properly installed with the proper airflow direction.
 2. Properly supported with vibration isolation integrity maintained where applicable.
 3. Duct connections to air terminals are leak-tight.
 4. Operable dampers travel free.
 5. Airflow measuring devices are properly installed and connected.
 6. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.
 7. Clean exposed factory-finished surfaces. Repair any marred or scratched surfaces with manufacturers touch-up paint.

3.19 BUILDING AUTOMATION SYSTEM AND CONTROL SUB-SYSTEMS

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Startup Checks: Perform the following checks during startup and as specified:
 1. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- C. Startup Tests: Refer to Section 230810 – BAS Commissioning. This requires manufacturers authorized representative to startup, test, adjust, and calibrate direct digital and other microprocessor-based control systems and demonstrate compliance with requirements. This will include verification of sequences, normal and emergency operations, calibration, interfaces, and interlocks, etc.

3.20 TESTING, ADJUSTING, AND BALANCING

- A. Reference: Perform testing, adjusting, and balancing (TAB) procedures on each system identified, in accordance with the detailed procedures outlined in the respective section and the referenced standards.
- B. Startup Checks: In addition to specifications, perform the following as a minimum:
 1. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
 2. Patch insulation, ductwork, and housings, using materials identical to those removed.

3. Seal ducts and piping, and test for and repair leaks.
4. Seal insulation to re-establish integrity of the vapor barrier.
5. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
6. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.
7. Test and adjust mechanical systems for sound and vibration in accordance with the detailed instructions of the referenced standards.

C. Training:

1. Train the Owner's maintenance personnel on troubleshooting procedures and on testing, adjusting, and balancing procedures.
2. Review for the Owner's personnel the locations of TAB reports and data.

3.21 ROOM AND ZONE CHECKOUT

- A. Include all applicable 'Startup Checks Common to All Systems'. Additional Startup Checks and Tests are as follows.
- B. Contractor shall complete a checklist acknowledging completion of Div. 23 responsibilities for all rooms. Checklist shall include items such as the following as applicable:
- C. Typical Room:
 1. Diffusers, registers, and grilles installed and cleaned.
 2. Zone controls in place and functional.
 3. All terminal equipment functional, clean, and punched out.
 4. Occupancy schedules entered with applicable control setpoints.
- D. Rooms with Plumbing Fixtures:
 1. Plumbing fixtures clean and operational.

3.22 WORK SEQUENCE ILLUSTRATION

- A. Reference Section 019100.

3.23 TRAINING

- A. System training requirements are detailed in 019100.

END OF SECTION

SECTION 23 08 10

BUILDING AUTOMATION SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Building Automation System (BAS) Startup and Functional Performance Testing.
- B. Validation of proper and thorough installation of BAS and associated equipment.
- C. Generic Start-Up Documentation for BAS.
- D. Development of final Start-Up Documentation for BAS.
- E. Functional Performance Testing of BAS.
- F. Coordination of BAS-related training.
- G. Documentation of BAS Operation and Maintenance Documentation.
- H. BAS Control Sub-Systems coordination with BAS Systems.

1.2 GENERAL DESCRIPTION

- A. This section defines responsibilities of the Building Automation System Contractors to commission the BAS and all BAS control Sub-Systems. Sub-Systems are considered to be any control system that must integrate with the BAS.
- B. Commissioning (Cx) is the process of ensuring that (i) all building systems are installed and perform interactively per the design intent; (ii) that systems are efficient and cost effective and meet the Owner's operational needs; (iii) that the installation is accurately documented; and (iv) that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.
- C. Commissioning Authority (CA) shall work with the Contractors and the design engineers to direct, oversee and execute some portions of the Cx process.
- D. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

1.3 SCOPE

- A. The scope of Commissioning on this project shall include the entire BAS system and all sub-systems connected to or integrated with the BAS.

1.4 RELATED WORK AND DOCUMENTS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents. See Division 01 for details.
- B. The Cx process references many related Sections, particularly Section 019100 - General Commissioning Requirements. It is important for all Contractors subject to the Cx process to be familiar with Section 019100.
- C. Section 019113.13 – General Commissioning Requirements for Functional Performance Testing.
- D. Section 220800 – Plumbing System Commissioning.
- E. Section 230800 – HVAC System Commissioning.
- F. Section 260800 – Electrical Systems Commissioning.

1.5 REFERENCE STANDARDS

- A. ASHRAE Standard 202 – Commissioning Process for Buildings and Systems.
- B. ASHRAE Guideline 0 – The Commissioning Process.
- C. ASHRAE Guideline 1.1 – HVAC&R Technical Requirements for the Commissioning Process.
- D. ASHRAE Guideline 1.3 – Building Operations and Maintenance Training for the HVAC&R Commissioning Process.
- E. ASHRAE Guideline 1.4 – Procedures for Preparing Facility Systems Manual.

1.6 CONTRACTOR RESPONSIBILITIES

- A. General commissioning responsibilities of the BAS Contractor are specified in Section 019100. The following indicate additional specific responsibilities of the BAS Contractor.
- B. Completely install and thoroughly inspect and document all systems and equipment.
- C. The BAS Contractor will:
 - 1. Attend Commissioning (Cx) progress and coordination meetings.
 - 2. Prepare and submit required draft forms and systems information.
 - 3. Establish trend logs of system operation as specified herein.
 - 4. Perform verification and performance testing as documented in all Startup Procedures.
 - 5. Demonstrate system operation.
 - 6. Provide instrumentation necessary for verification and performance testing.

7. Provide POTs or operator workstations in locations convenient to testing activities as specified below.
 8. Provide CA with appropriate passwords, keys, and access to control panels and workstations.
 9. Manipulate systems and equipment to facilitate Functional Performance Testing as outlined in the specifications. Typically, this will only be for initial samples of like systems.
 10. Train Owner's Representatives as specified in Part III of this section.
 11. Within six months of the acceptance test the CA will request opposite season testing for HVAC and controls work. BAS contractor will participate in this testing and remedy any deficiencies identified.
- D. Where control systems do not allow a test mode or the overriding of physical input values for testing, program an interim virtual point for all inputs that can be used to represent the point to facilitate operator selectable input values for testing.
- E. Provide a control technician to work at the direction of the CA for software optimization assistance for a minimum of 80 hours during the Acceptance Phase of the project.
- F. Controls Parameter Matrix: Contractor shall provide a form summarizing all setpoints and alarm parameters and alarming strategies for the Owner to complete. Organize a meeting to discuss the desired initial setpoints and alarm parameters. Contractor shall enter the requested setpoints and alarm parameters at completion of start-up and record the applicable settings in the Start-Up Documentation.
- G. Final Systems Operation Training: The BAS Contractor shall train the Owner and Operators on whole-building operation and/or use of the BAS. This training shall focus primarily on BAS control of building systems and operation and its impact on building performance, and shall be conducted after Functional Completion. Additional information is provided in Section 019100.

1.7 SUBMITTALS

- A. Submit the following Quality Assurance / Quality Control documentation:
1. Quality Assurance Plan.
 - a. Contractor must provide a description of their quality assurance operations for the commissioning phase of this project. The description shall include protocols for each step of commissioning listed within this section including testing, reporting, coordination with the CA and remediation of all action items.
- B. Submit the following items as required and defined within the process:
1. BAS Start-Up Report (reference Div. 01 and BAS Testing, Adjusting & Calibration Section below): Submit one (1) electronic copy prior to scheduling of Functional Performance Testing.
 2. BAS Training Plan (defined below): Submit prior to scheduling BAS Demonstration.
 3. Captured trend and alarm logs as required during the Acceptance Period and Warranty Period.
 4. Signoff certifying all startup and commissioning work described in this section has been completed. Signoff must include completion of seasonal testing work.

1.8 CX PROCESS SEQUENCING

- A. Refer to Section 019100.
- B. The following list outlines the general sequence of events for Commissioning of the BAS.
 - 1. Construction Phase:
 - a. Collaborate on construction scheduling.
 - b. Submit Product data and Shop Drawings, and receive approval.
 - c. Meet with Cx Team to coordinate with all trades.
 - d. Submit Control Logic Documentation, and receive approval.
 - e. Begin BAS installation.
 - f. Submit refinement of generic Start-Up Documents incorporating manufacture-specific start-up requirements accompanied by manufacturers pre-printed start-up forms for all equipment provided by the BAS Contractor.
 - g. Receive BAS Start-Up Documents approval from CA.
 - h. Submit Training Plan content.
 - i. Receive approval of Training Plan content.
 - j. Provide the Controls Parameter Matrix and receive approval.
 - k. Provide sample graphics and receive approval.
 - l. Complete BAS installation.
 - m. Place systems under BAS control.
 - n. Enter alarms as approved by Owner.
 - o. Complete BAS graphics.
 - p. Perform BAS system start up and complete Start-Up Documentation.
 - q. Submit completed BAS Start-Up Documentation.
 - r. Prepare and initiate trend log data storage and format trend graphs.
 - s. Train Owner on BAS operation and maintenance.
 - t. Formal BAS System Turn-Over Meeting.
 - u. Submit commissioning BAS Software/Access and provide full access or as mandated by the Owner, password access to Owner and CA.
 - v. Receive BAS Start-Up Documentation approval and approval to schedule BAS demonstration of completeness.
 - w. Demonstrate systems to CA and Owner.
 - x. Submit trend logs in format specified.
 - y. Receive FPT or BAS demonstration approval and approval to schedule Acceptance Phase.
 - 2. Acceptance Phase:
 - a. 14-day BAS Observation Period to witness stable BAS operation.
 - b. Receive Observation Period approval which enables start of Functional Performance Testing.
 - c. CA performs Functional Performance Testing and BAS Contractor participates in initial samples.
 - d. Receive Functional Completion approval from CxA for the BAS.
 - 3. Substantial Completion:
 - a. Endurance Period.
 - 4. Warranty Phase:
 - a. Provide administrator access password access to Owner.

- b. Train Owner on final sequences and modes of operation (Final Systems Operation Training).
- c. Update Systems Manual content with any changes.
- d. Revise and re-submit record drawings and O&M manuals.
- e. Install framed control drawings.
- f. Final Completion.
- g. Opposite-season operational test and Functional Performance Testing.
- h. Receive opposite-season operational test and FPT approval.
- i. Revise and re-submit record drawings and O&M manuals.
- j. Update framed control drawings.
- k. Complete owner training.
- l. End of Warranty Period.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

- A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:
 - 1. Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of +/- 0.1F.
 - 2. Pressure sensors shall have an accuracy of +/- 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.
 - 3. All equipment shall be calibrated per the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.
- B. Standard Testing Instrumentation: Standard instrumentation used for testing air and water flows, temperatures, humidity, noise levels, amperage, voltage, and pressure differential in air and water systems related to functional testing shall be provided by CA.
- C. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, per these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon project completion.

2.2 TEST KITS FOR METERS AND GAUGES

- A. Test kits for meters and gages shall be provided to the Owner new and in good condition. Previously used kits will be unacceptable. Kits shall be submitted prior to the Acceptance Phase. Kits included shall be as a minimum:
 - 1. Digital indication of temperature and pressure with associated sensors to work with the P/T test ports.
 - 2. Companion readout kit (with fittings) for calibrated balancing valve with ranges as required by all devices on this project.

2.3 TAB & COMMISSIONING PORTABLE OPERATOR TERMINALS

- A. Provide the CA with all software, connection devices, licenses, passwords, etc. to facilitate connection to the BAS throughout the building. Provide a license to graphic software, and all operating software necessary for testing and configuration of all control elements at all levels. License may be a temporary license that will expire after the completion of the Warranty Period. Options include:
 - 1. A laptop computer provided by BAS Contractor for dedicated use by the CA throughout the Construction and Acceptance Phases. This would be turned over to the Owner at the end of the Acceptance Phase.
 - 2. Browser access to the full graphic software: CA will provide laptop, however BAS Contractor shall set up the laptop to successfully connect.
 - 3. Licensed client software to be installed on CA computer: BAS Contractor shall install the software and ensure it is functional.
 - 4. Terminal Services session access to a graphic server with licensing to allow use of all required software. BAS Contractor shall configure the CA computer to connect to the terminal session.
- B. Access to the BAS must be provided throughout the building as more fully defined as follows:
 - 1. Full wireless connection to the graphic server throughout the building will be adequate.
 - 2. Network connection for full access to the graphic server within 50' of any point in the building.
 - 3. Exception to 1 and 2 above: An acceptable alternative to full building access to the graphic server relating to terminal unit controls shall be providing to the CA the devices and software required to connect to local terminal unit controllers through a connection port in the space such as connection to a jack on the temperature sensor (basically what is required by TAB specified below). This does not apply to mechanical rooms as full graphic access is required in mechanical rooms.
- C. Provide software required by TAB to calibrate all flow sensors. TAB will provide computer to be used as a portable operator's terminal. Any manufacturer specific hardware such as connection cables, converters, handheld devices, etc. shall be provided by the BAS Contractor.
- D. 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 as well as at the box. Otherwise a wireless system shall be provided to facilitate this local functionality.

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.

3.2 BAS STARTUP TESTING, ADJUSTING, CALIBRATION

- A. BAS work and/or systems shall be fully functioning prior to Demonstration and Acceptance Phase. Contractor shall start, test, adjust, and calibrate all work and/or systems under this contract, as described below:

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. For the following control settings, initially use the control setting that was used by the existing BAS unless otherwise indicated. For AHUs that use a throttled outside air damper position when minimum outside air is required, Contractor shall mark existing minimum outside air damper position to allow replication by new BAS installation.
5. Coordinate with TAB Contractor to obtain and, with CA, fine tune control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB Contractor, and note any TAB deficiencies in the BAS Start-Up Documentation:
 - a. Optimum duct static pressure setpoints for VAV air handling units.
 - b. Minimum outside air damper settings for air handling units.
 - c. Optimum differential pressure setpoints for variable speed pumping systems.
 - d. Calibration parameters for flow control devices such as VAV boxes and flow measuring stations. BAS Contractor shall provide hand held device as a minimum to the TAB and CA to facilitate calibration. Connection for any given device shall be local to the device (i.e., at the VAV box or at the thermostat). HHD or POT shall allow querying and editing of parameters required for proper calibration and Start-Up.
6. Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/- 0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the BAS Start-Up Documentation.
7. Check and set zero and span adjustments for all transducers and transmitters.
8. For dampers and valves:
 - a. Check for adequate installation including free travel throughout range and adequate seal.
 - b. Where control loops are sequenced, check for proper control without overlap of controlled devices.
9. For actuators:
 - a. Check to ensure that device seals tightly when the appropriate signal is applied to the operator.

- b. Check for appropriate fail position, and that the stroke and range is as required and coordinated with the programmed ranges when it is operating under normal conditions.
 - c. For pneumatic operators, adjust the operator spring compression as required to achieve close off. If positioner or volume booster is installed on the operator, calibrate per manufacturer's procedure to achieve spring range indicated. Check split range positioners to verify proper operation. Record settings for each device.
 - d. Check the stroke and range under actual loading conditions and validate that they correlate with programmed values.
 - e. For sequenced electronic actuators, calibrate per manufacturer's instructions to required ranges.
10. Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the OI display. Record the results for each device.
 11. For outputs to reset other manufacturers devices (such as VSDs) and feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.
 12. Verify proper sequences by using the approved Start-Up Documentation to record results. Verify proper sequence and operation of all specified functions.
 13. Verify that all safety devices trip at appropriate conditions. Adjust setpoints accordingly.
 14. 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 BAS Start-Up Documentation. Except from a start-up, maximum allowable variance from setpoint for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any step-change (for which the system has the capability to respond) in the control loop, the following tolerances shall be maintained (exceptions noted):
 - a. Duct air temperature: $\pm 1^{\circ}\text{F}$.
 - b. Zone temperature: $\pm 3^{\circ}\text{F}$ within 3 minutes and control within $\pm 2^{\circ}\text{F}$.
 - c. Chilled water temperatures: $\pm 1^{\circ}\text{F}$.
 - d. Hot water temperatures: $\pm 2^{\circ}\text{F}$.
 - e. Duct air pressure: $\pm 0.25''$ w.g.
 - f. Water pressure: ± 1 psid.
 - g. Duct relative humidity: $\pm 3\%$ when adding humidity.
 - h. Zone relative humidity: $\pm 5\%$ when adding humidity.
 - i. Terminal air flow control: $\pm 5\%$ of setpoint. This includes all VAV terminal control and exhausted BSCs, canopy hoods, ventilated cage racks, necropsy tables, and other scientific equipment with supply or exhaust ventilation.
 - j. Building and relief pressure: $\pm 0.01''$ w.g.
 15. For communication interfaces and BAS control panels:
 - a. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
 - b. Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
 - c. Check power supplies for proper voltage ranges and loading.
 - d. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
 - e. Check for adequate signal strength and acceptable bandwidth utilization on communication networks.

- f. Check for stand-alone 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.
 - g. Ensure that all outputs and devices fail to their proper positions/states.
 - h. Ensure that buffered and/or volatile information is retained through power outage.
 - i. With all system and communications operating normally and all trends functioning, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.
 - j. Check for adequate grounding of all BAS panels and devices.
 - k. Run self-diagnostic routines and ensure they are functional.
 - l. Check the memory allocation and loading to ensure adequate and excess capacity is available and that it will not affect control functionality.
16. Coordinate desired initial alarm strategies with Owner's Operators. Set all required alarms and document the initial settings in the Start-Up Documentation.
17. Coordinate all initial setpoints with Owner's Operators. Ensure those setpoints are active.
18. For Operator Interfaces:
- a. 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.
 - b. Output all specified BAS reports for review and approval.
 - c. Verify that the alarm printing and logging is functional and per requirements.
 - d. Verify that trend archiving to disk and provide a sample to the CA for review.
 - e. Verify alarm enunciation functionality. Time delay from actual occurrence to the time updated or enunciated on the screen. Ensure it is per the specified requirements.
 - f. Verify that real time and historical trends are accessible and viewable in graph format.
 - g. Verify that paging/dial out alarm annunciation is functional.
 - h. Verify the functionality of remote OIs and that a robust connection can be established consistently.
 - i. Verify that required third party software applications required with the bid are installed and are functional.
 - j. Demonstrate open protocol and custom third party interfaces reliably communicate and check response time.
 - k. Verify response times and screen update and refresh times are per the requirements.
 - l. Verify that all custom programs are editable from the OI. Check upload, download, backup and restore capabilities of system configuration information as well as custom programs.
 - m. Verify schedules are set up and working.
 - n. Verify Owner stipulated security and permissions is set up and functional.
 - o. In concert with the Building Power Outage test, validate that critical GUI installations are properly powered by UPS and emergency outlets to keep it functional during a power outage. Validate that the space has adequate lighting to manage the building in the event of an outage.
19. Start-up and check out control air compressors and air drying and filtering systems in accordance with the appropriate section and with manufacturer's instructions.
- a. Validate adequate deliver and pressures.
 - b. Validate adequate redundancy.
 - c. Validate max run time and cycle time vs manufacturer's recommendations.

- d. Validate that routing of the compressed air does not result in condensation at any point in the system when used with the specified drier.
 - e. Check all PRVs both primary and back up to ensure adequate functionality and maintenance of downstream pressure
- 20. Verify proper interface with Fire Alarm System.
- 21. Verify proper interface with control panels of equipment with self-contained controls that are being monitored by the BAS.
- B. Submit Start-Up Documentation. This shall be completed, submitted, and approved prior to demonstration and Acceptance Phase.

3.3 SENSOR CHECKOUT AND CALIBRATION

- A. General Checkout: Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading of each other for pressure. Tolerances for critical applications may be tighter.
- B. Calibration: Calibrate all sensors using one of the following procedures:
 - 1. Sensors Without Transmitters--Standard Application. Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20% of the expected range.
 - 2. Sensors With Transmitters--Standard Application. Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the OI. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.
- C. Sensor Tolerance: Sensors shall be within the tolerances specified for the device.

3.4 COIL VAVE LEAK CHECK

- A. Verify proper close off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit. Calibrate air temperature sensors on each side of coil to be within 0.5°F of each other. Via the OI, command the valve to close. Energize fans. After 5 minutes, observe air temperature difference across coil. If a temperature difference is indicated, and the piping surface temperature entering the coil is within 3°F of the water supply temp, leakage is probably occurring. If it appears that it is occurring, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

3.5 VALVE STROKE SETUP AND CHECK

- A. For all valve and actuator positions checked, verify the actual position against the OI readout.
- B. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command valve to a few intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

3.6 ALARM SETPOINT COORDINATION

- A. The Contractor shall prepare a Controls Parameter Matrix of all conceptual point types and recommend the types and recommended alarming strategies and setpoint for review of CA and Owner. Owner shall use this alarm list to provide direction to Contractor for alarm strategies and setpoints. Alarm list shall be provided at least two months prior to the first functional test. Contractor shall have alarm setpoints entered prior to functional testing. Omitting an alarm setting, using the wrong strategy, or entering the wrong setpoints will be considered a failure from the perspective of the functional test.

3.7 GRAPHIC COORDINATION

- A. The Contractor shall prepare all graphics (only one example graphic is required for typical systems like terminal units) with points embedded for review of CA and Owner. Owner shall use these graphics to provide direction to Contractor for the required final graphic. All final graphics must be complete and active before functional testing. Any deviation from the approved graphics will be considered a failure from the perspective of the functional test.

3.8 BAS DEMONSTRATION

- A. Demonstration will occur while the project BAS is connected to the QA Construction BAS.
- B. Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the CA and Owner. Schedule the demonstration with the Owner's representative 1 week in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the Work fails to be demonstrated to conform with Contract specifications, so as to require scheduling of additional site visits by the CA for re-demonstration, Contractor shall reimburse Owner for costs of subsequent CA site visits.
- C. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etc. Contractor supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the job site.
- D. Demonstration shall typically involve small representative samples of systems/equipment randomly selected by the Owner and CA.
- E. The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved Commissioning Checklists. Demonstration shall include, but not necessarily be limited to, the following:

1. Demonstrate that required software is installed on BAS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.
 2. Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.
 3. Demonstrate that remote dial-up communication abilities are in accordance with these Specifications.
 4. Demonstrate correct calibration of input/output devices using the same methods specified for the start-Up tests. A maximum of 10 percent of I/O points shall be selected at random by CA and/or Owner for demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random by CA for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.
 5. Demonstrate that all BAS and other software programs exist at respective field panels. The BAS programming and point database shall be as submitted and approved.
 6. Demonstrate that all BAS programs accomplish the specified sequences of operation.
 7. Demonstrate that the panels automatically recover from power failures, as specified.
 8. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements of these Specifications.
 9. Identify access to equipment selected by CA. Demonstrate that access is sufficient to perform required maintenance.
 10. Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.
- F. BAS Demonstration shall be completed and approved prior to Functional Performance Testing. CA shall determine if the system is ready for Functional Performance Testing and document any problems requiring Contractor attention.
1. If the systems are not ready for Functional Performance Testing, Contractor shall correct problems and provide notification to the Owner's representative that all problems have been corrected. The Acceptance Period shall be restarted at a mutually scheduled time for an additional one week period. This process shall be repeated until CA issues notice that the BAS is ready for Functional Performance Testing.
- G. Any tests successfully completed during the BAS Demonstration will be recorded as 'Passed' for the Functional Performance Testing and will not have to be re-accomplished.

3.9 BAS ACCEPTANCE PHASE AND OBSERVATION PERIOD

- A. BAS Acceptance Phase: BAS Acceptance Phase consists of the Functional Performance Testing process of the BAS by the CA and shall begin after approval of the BAS Demonstration and prior to issuance of Substantial Completion. Acceptance Phase for the BAS shall not be scheduled until all HVAC systems are in operation, the Start-Up Documentation has been reviewed, all required cleaning and lubrication has been completed (i.e., filters changed, piping flushed, strainers cleaned, etc.), and TAB report has been submitted and approved. Acceptance Phase and its approval to begin will be performed on a system-by-system basis if mutually agreed upon by Contractor and Owner.
- B. BAS Observation Period: After Functional Performance Testing, the BAS shall be shown to operate properly for 2 weeks 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. At the end of the two weeks, BAS Contractor shall forward the trend logs to the CA for review.

- C. During the Acceptance Phase, the Contractor shall maintain a hard copy log of all alarms generated by the BAS. For each alarm received, Contractor shall diagnose the cause of the alarm, and shall list on the log for each alarm, the diagnosed cause of the alarm, and the corrective action taken. If in the Contractor's opinion, the cause of the alarm is not the responsibility of the Contractor, Contractor shall immediately notify the Owner's representative.
- D. During the Acceptance Phase, the Contractor shall maintain all controller network and workstation hardware and software in a state that will allow remote access by CA to trend logs as specified below.

3.10 BAS TREND COMMISSIONING REQUIREMENTS

- A. CA will analyze trend logs of the system operating parameters to evaluate normal system functionality. The requirements of the trending are specified below. Contractor shall establish these trends, ensure they are being stored properly, and forward the data in electronic format to the CA.
- B. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field. Recorded parameters for a given piece of equipment or component shall be trended at the same time intervals and be presented in a maximum of two separate two dimensional formats with time being the vertical axis and field name being the horizontal axis. Data shall be forwarded in one of the following formats.
 1. Microsoft Excel Spreadsheet (.xls).
 2. Comma Separated Value (.csv).
- C. Sample times indicated as COV mean that the changed parameter only needs to be recorded whenever the value changes by the amount listed. When output to the trend file, the latest recorded value shall be listed along with the time increment record. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the time interval common to other point trends for the system.
- D. Contractor shall provide the CA with required passwords, phone numbers, etc. to allow the CA access to the trend log data and allow downloading to a remote location. Contractor shall also provide step-by-step written instructions for accessing the data.
- E. Trending used to document ongoing FPTs may occur and be at a more frequent interval. Consult with the CA to determine the required intervals for functional testing and modify intervals as required.

3.11 TREND GRAPHS

- A. Trend graphs shall be used during Functional Performance Testing to facilitate and document testing. Contractor shall prepare controller and workstation software to display graphical format trends throughout the Acceptance Phase. Trend graphs shall demonstrate compliance with contract documents. Trended values and intervals shall be the same as those specified for the Functional Performance Tests.
- B. Lines shall be labeled and shall be distinguishable from each other by using either different line types or different line colors.

- C. Indicate engineering units of the y-axis values; e.g. degrees F., inches w.c., Btu/lb, percent wide open, etc.
- D. The y-axis scale shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.
- E. Trend outside air temperature, humidity, dew point and enthalpy during each period in which any other points are trended.
- F. All points trended for one HVAC subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended simultaneously and on a common trend period.
- G. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

3.12 NETWORK TESTING AND VALIDATION

- A. Per Division 23 specifications, the BAS Contractor will perform the required Network Bandwidth and BACNET Analysis reports. Any issues discovered shall be reported and remediated prior to connection to the Production BAS.
- B. 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.

3.13 WARRANTY PHASE – OPPOSITE SEASON TRENDING AND TESTING

- A. Warranty Period shall not commence until successful completion of the BAS Demonstration.
- B. Trending: Throughout the Warranty Phase, trend logs shall be maintained as required for the Acceptance Phase. BAS Contractor shall forward archived trend logs to the CA for review upon CA request. CA will review these and notify BAS Contractor of any warranty work required.

- C. Opposite Season Testing: Within 6 months of completion of the Acceptance Phase, CA shall schedule and conduct Opposite Season Functional Performance Testing. The BAS Contractor shall support this testing and remedy any deficiencies identified.
- D. End of Warranty Visit: CA/PU will conduct an End of Warranty walkthrough a minimum of one month prior to the end of the Warranty Period. Contractor shall participate in this walkthrough and remedy any deficiencies identified.

3.14 SOFTWARE OPTIMIZATION ASSISTANCE

- A. The Contractor shall provide the services of a BAS technician as specified above at the project site to be at the disposal of the CA. The purpose of this requirement is to make changes, enhancements and additions to control unit and/or workstation software that have been identified by the CA during the construction and commissioning of the project and that are beyond the specified Contract requirements. The cost for this service shall be included with the bid as noted above. Requests for assistance shall be for contiguous or non-contiguous 8-hour days, unless otherwise mutually agreed upon by Contractor, CA, and Owner. The Owner's representative shall notify Contractor 2 days in advance of each day of requested assistance.
- B. The BAS technician provided shall be thoroughly trained in the programming and operation of the controller and workstation software. If the BAS technician provided cannot perform every software task requested by the CA in a timely fashion, Contractor shall provide additional qualified personnel at the project site as requested by the CA to meet the total specified requirement on-site.

3.15 BAS OPERATOR TRAINING

- A. Provide up to 6 complete sets of User Manuals (hard copy and one electronic copy) to be used for training.
- B. BAS Contractor shall submit a Training Plan per the requirements of Div 01 to the GC who will forward it to the A/E and CA for review.
- C. On Site Training: Provide services of BAS Contractor's qualified technical personnel for [five] 8-hour days to instruct Owners personnel in operation and maintenance of the BAS. Instruction shall be in classroom setting at the project site for appropriate portions of the training. Training may be in non-contiguous days at the request of the Owner. The Owner's representative shall notify Contractor 1-week in advance of each day of requested training. The Contractor's designated training personnel shall meet with the A/E, CA and Owner's representative for the purpose of discussing and fine-tuning the training agenda prior to the first training session. Training agenda shall be as follows:
 - 1. Basic Operator Workstation Training – 8 hours for all potential users of the OWS in 4-hour non-contiguous segments:
 - a. Brief walk-through of building, including identification of all controlled equipment and condensed demonstration of controller portable and built-in operator interface device display capabilities.
 - b. Brief overview of the various parts of the BAS O&M manuals, including hardware and software programming and operating publications, catalog data, controls installation drawings, and BAS programming documentation.

- c. Demonstration of workstation login/logout procedures, password setup, and exception reporting.
 - d. Demonstration of workstation menu penetration and broad overview of the various workstation features.
 - e. Overview of systems installed.
 - f. Present all site-specific naming conventions and points lists, open protocol information, configuration databases, back up sequences, upload/download procedures, etc.
 - g. Overview of scheduling procedures.
 - h. Overview of alarm features, including how to acknowledge, respond to, and archive alarms, and how to access further information from them.
 - i. Overview of trend features, including how to set up and view trends.
 - j. Overview of workstation reporting features and introductory level report generation and scheduling.
2. BAS Technician Training: Two 24-hour training sessions that can be in 4-hour non-contiguous segments for individuals who will troubleshoot the system hardware, I/O devices, and the systems in general.
- a. General review of sequence of operation and control logic for the project site, including standalone and fail safe modes of operation.
 - b. Uploading/downloading and backing up controller configuration and application programs.
 - c. Review of installed components including all communication devices, controllers, I/O, etc., and how to install/replace, maintain, commission, and diagnose them.
 - d. Introduction to controller programming and overview of the programming application interface.
 - e. Defining trends, generating graphs in real time; archiving trends, accessing historical archive and generating reports from them.
 - f. Introductory network administration.
 - g. Introduction to creating and editing graphics.
 - h. Review of setpoint optimization and fine-tuning concepts.
 - i. OI use and maintenance.
 - j. Web page creation as applicable.
3. System Administrator Training: One 8-hour session that may be done in two 4-hour segments on non-contiguous days. Target audience is the person who will be maintaining the system from an IT perspective as well as Owners IT personnel. Agenda shall be as follows:
- a. Overview of system architecture including all routers, bridges, repeaters, gateways, communications protocols, servers, controllers, etc.
 - b. Overview of and recommendations for backing up and restoring the system configuration database.
 - c. Server maintenance.
 - d. Security Management: Assigning passwords and rights for various users on the server, workstations and GUI software.
4. Final Systems Operation Training.
- a. The BAS Contractor shall conduct Final Systems Operation Training in accordance with all specifications.
 - b. Final Systems Operation Training provides the Owner and Operators a training session on whole-building operation. It shall focus primarily on BAS control of building systems and operation and its impact on building performance. System

interactions shall be presented and discussed (such as a combined air handler, chiller, boiler, and terminal unit system), along with a detailed presentation of the sequences of operation and their relationship to the BAS. This training shall be conducted by the BAC with assistance from the CA, and shall be attended by the Owner, Operators, Contractor, Design Team, and by any other Cx Team members deemed necessary by the CA or the Owner.

- c. The Record BAS Shop Drawings shall be provided as a handout for the training.
- d. Scheduling, attendees, and training methods shall be as specified in Division 23 and any general commissioning requirements.

3.16 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 CA on a time and material basis at standard billing rates for any additional time required to witness additional demonstration tests or to review additional BAS trends beyond the initial tests, at no additional cost to the Owner.

END OF SECTION

SECTION 23 09 00

BUILDING AUTOMATION 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 (BAS).
- 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. Other BAS Sections:
 - 1. Section 230913 BAS Basic Materials and Devices
 - 2. Section 230916 BAS Operator Interfaces
 - 3. Section 230919 BAS Field Panels
 - 4. Section 230923 BAS Communication Devices
 - 5. Section 230926 BAS Software and Programming
 - 6. Section 230810 BAS Commissioning
- B. Coordination with other Divisions. The table in specification 230010 paragraph 1.2-B shall be used to determine scope of work between Division 23 and other Divisions including Divisions 23 and 26. All work not specified to be a part of the BAS scope of work shall be provided by General Contractor and associated subcontractors for each building and the infrastructure.
- C. Testing and Commissioning.
 - 1. Section 230593 Testing, Adjusting and Balancing for HVAC
 - 2. Section 230810 BAS Commissioning
- D. Communications.
 - 1. Connection to Owner's IT WAN/LAN and terminations to wall jack shall be by Division 23C Contractor. Coordinate connection location of IT WAN/LAN and terminations with Division 26. 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 BAS location(s) specified under Division 26. It shall be the responsibility of the Division 23C contractor to communicate required IT WAN/LAN drop location(s) with Division 26.

E. Modifications to the Existing BAS.

1. The existing BAS is a Trane Tracer Summit system.
2. All of the existing BAS (not removed as part of the 3rd Floor Renovation Project) shall remain fully functional and operational.
3. The BAS Contractor shall be responsible for any required modifications to the existing BAS including modifications to controllers, wiring, sensors, programming, graphics, schedules, alarms, etc.
4. If a BAS communication outage is required, the outage shall be performed over a weekend beginning at 5pm on a Friday afternoon and shall be fully restored and operational by 8am the following Monday. The outage shall be requested and scheduled with the Owner per Section 019100 – General Commissioning Requirements.
5. The existing BAS has a smoke control system including a fire floor sequence of operation. The smoke control system and fire floor sequence shall remain. BAS Contractor shall be responsible for modifications to the existing smoke control system. Modifications shall comply with NFPA 92-2018.

1.4 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 23 (Indicated as 23 in table), Section 230900 Energy Management & Control System (indicated as 23C), 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]		
FIRE & LIFE SAFETY SYSTEMS						
	Fire alarm systems	26	26	26	26	
	Duct mounted & in-direct mounted smoke detectors	26	23	26	26/23C	[2]

INTERFACE/RESPONSIBILITY MATRIX						
System	Division under which the following is specified				Remarks	
	Equipment	Installation	Power Wiring [1]	Control & Interlock Wiring [1]		
Other smoke detectors	26	26	26	26		
ENERGY MANAGEMENT & CONTROL SYSTEM						
Central control workstations & servers	23C	23C	26	23C		
Control system network backbone	23C	23C	23C	23C		
Control panels	23C	23C	23C	23C	[3]	
Control devices	23C	23C	23C	23C		
Network IT WAN/LAN drop	-	23C	23C	23C	[4]	
Lighting controls	26	26	26	26		
Lighting occupancy sensors	26	26	26	26		
Variable frequency drives	23	26	26	23C		
HVAC HYDRONIC SYSTEMS						
Pipe gauges, thermometers, test plugs	23	23	-	-		
Automatic isolation and control valves	23C	23	23C	23C		
Sensor wells, meters and other pipe-mounted control devices	23C	23	23C	23C		
Test plugs	23	23			[5]	
HVAC SHEET METAL						
Duct mounted sensors	23C	23	23C	23C		
Control dampers	23C	23	23C	23C	[6]	
Control damper actuators	23C	23C	23C	23C	[6]	
HVAC TERMINAL BOXES						
Terminal box control transformer panel	23C	23C	23C	23C	[3]	
Terminal box with damper	23	23	-	-		
Digital controller and damper actuator	23C	23	23C	23C		
Air-flow measurement pickup and piping	23	23	-	-		
Air-flow measurement transducer and wiring	23C	23C	23C	23C		
Wall sensor module	23C	23C	23C	23C		
HW control valve and actuator	23C	23	23C	23C		
NUMBERED REMARKS:						
[1] Wiring includes raceway, fittings, wire, boxes and related items, all voltages [2] Wiring of interlock of duct smoke detectors to shut off supply fans upon detection of smoke is specified under Section 230900 Energy Management & Control System. All other smoke control/fire alarm related control wiring is specified under Division 26 Electrical. [3] Power to all EMCS control panels is specified under Section 230900 Energy Management & Control Systems, coordinate with Division 26 contractor for available circuits. [4] Network IT LAN drop at required EMCS location(s) specified under Section 230900 Energy Management & Control Systems. It shall be the responsibility of the Division 23C contractor to coordinate required IT LAN network connection location(s) with the Divi-						

INTERFACE/RESPONSIBILITY MATRIX					
System	Division under which the following is specified				Remarks
	Equipment	Installation	Power Wiring [1]	Control & Interlock Wiring [1]	
sion 26 contractor or Owner's IT Department. Connection(s) to Owner's IT LAN and termination to wall jack specified under Section 230900 Energy Management and Control System.					
[5]	Test plugs mounted adjacent to all temperature well (for calibration) specified under Division 23				
[6]	Duct access doors required for access to control devices where required specified under Division 23 HVAC.				

1.5 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, BAS 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 BAS 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.

1.6 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 Inter-change
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
BAS	Building Automation System
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
EMT	Electrical Metallic Tubing
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
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 Controller	A device with limited resources relative to the Advanced 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 Automation System	The entire integrated management and control system
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, BAS Contractor, or Division 23C Contractor	The Contractor retained by Owner to execute the work defined in Division 23C 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 BAS control panels
Direct Digital Control	Microprocessor-based control including Analog/Digital conversion and program logic
Equal	Approximately equal in material types, weight, size, design, quality, and efficiency of specified product.
Exposed	Not installed underground or concealed.
Extensible Markup Lan-	A specification developed by the World Wide Web Consortium.

guage	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 a 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
Hand Held 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 BAS
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 and CSS. 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 BAS including OWSs, POTs, and HDDs.
Operator Workstation	The user's interface with the BAS system. As the BAS 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.

1.7 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 compliant with BACnet through the BACnet Manufacturers Association or the vendor must supply proof of having submitted the device for testing by BMA.
5. The BAS and components shall be listed by Underwriters Laboratories UL 916 as an Energy Management System.

B. Installer

1. BAS 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. BAS 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. BAS 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.

1.8 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 230900-01.
2. Each resubmittal shall have the original unique serial number plus unique revision number such as SUBMITTAL 230900-01 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 BAS Contractor's schematics with respect to control points, but BAS 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 230926 - 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 Section 230926 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. Complete and submit pre-functional test forms as provided by the CxA.
 - b. Complete and submit functional test forms as provided by the CxA.
 - c. Format: Word-searchable format.
 - 4. Submittal Package 4 (Training Materials).
 - a. Provide training materials as required by Section 230810.
 - 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.
 - c. Format: See Section 230926.

1.9 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 BAS 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 BAS 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., per Section 230810.
 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 as required by Section 230810.
 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. Electronic media shall be readable on Control System Servers and Operator Workstations.

	Document	Paper (binder or bound)	Electronic	
			USB Flash Drive	Loaded onto CSSs and POTs
1.	O&M Manual	5	1	1
2.	Original issue software	–	1 per	1

	Document	Paper (binder or bound)	Electronic	
			USB Flash Drive workstation	Loaded onto CSSs and POTs
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.

1.10 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 to serve as the entire MDOT Administration Building's BAS.
 - a. Within the building, the BAS shall be standalone and not rely on any 3rd party networks, such as the Owner's IT LAN.
3. The system shall consist of a control system server and operator workstation location to be coordinated with the Owner. They will connect via a high-speed network to BC's and other control devices located throughout the building. The CSS and OWS shall provide for overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation.
4. The system shall support web browser access to the building data. A remote user using a standard web browser shall be able to access the control system graphics and change adjustable setpoints with the proper password.
5. Performance Monitoring. The BAS 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 BAS 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. BAS 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.
 - a. Supervisory LAN shall be extended to one of the 3rd floor mechanical rooms (to allow POTs to connect to system using browser and to improve throughput of trend data).
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. It shall also store trend data uploaded from controllers.
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.

1. This project shall include at least one BC.

E. Gateways.

1. Gateways shall be provided only as required for connection to the following:
 - a. Variable Speed Drive Controls.
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.

1.11 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. (See Section 230810 and Construction Drawings.) 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-BAS-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 BAS 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.

1.12 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.

1.13 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 BAS 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 BAS Contractor shall be provided at no charge during the warranty period.
- G. Sequence of operation and 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.

1.14 WARRANTY MAINTENANCE

- A. The Owner reserves the right to make changes to the BAS 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 BAS.
- 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 23C. 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 (ENTERPRISE / SERVER CLASS APPLICATIONS)

- A. Johnson Controls (Metasys)
- B. Johnson Controls (Facilities Explorer)
- C. Trane (Tracer SC)
- D. Siemens (Desigo)
- E. Schneider (SmartStruxture)
- F. Or equal.

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 230919 - BAS 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 23C Contractor shall extend power to all BAS devices, including 120V power to panels, from an acceptable power panel.
 - 1. See Division 26 Electrical drawings for power locations pre-allocated for BAS 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 26 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.
 4. Standalone Functionality: Refer to Section 230919.
- 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 BAS 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 BAS Contractor shall be responsible for all cutting, coring, and patching that may be required for Division 23C 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 fire-stop.
- C. All damage to and openings in ductwork, piping insulation, and other materials and equipment resulting from Division 23C 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 BAS Contractor shall clean up all debris resulting from its activities daily. The BAS 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 BAS Contractor.
- B. At the completion of work in any area, the BAS Contractor shall clean all of its work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. The BAS 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 Division 1 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 23C pre-functional, functional, and demonstration tests.

2. Division 23C work related to Section 230593 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 23 09 13

BAS 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 230900 for general requirements.
- C. Refer to drawings for points list and specific device requirements.

1.3 RELATED WORK AND REQUIREMENTS

- A. Other BAS Sections:
 - 1. Section 230900 Building Automation System (BAS) - General
 - 2. Section 230916 BAS Operator Interfaces
 - 3. Section 230919 BAS Field Panels
 - 4. Section 230923 BAS Communication Devices
 - 5. Section 230926 BAS Software and Programming
 - 6. Section 230810 BAS 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	±1°F
Ducted air dry bulb temperature	±0.5°F
Mixed air dry bulb temperature	±1°F
Outside air dry bulb temperature	±0.5°F
Relative humidity – general	±5% RH
Relative humidity – outdoor air	±3% RH
Airflow (terminal)	±10% of reading

Measured Variable	Reported Accuracy
Airflow (measuring stations)	±5% of full scale
Air pressure (ducts)	±0.05 inches
Air pressure (space)	±0.01 inches

- 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 on 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 26.
- B. Power Wiring.
- Power wiring and wiring connections required for BAS shall be provided under this section unless specifically shown on drawings or specified to be under Division 26. See Coordination section in Section 230900.
 - See Control Power section of 230900.
- C. Communication Wiring.
- 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).
 - 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.
 - 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. Valve Teck
 5. Or equal
- B. 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 dead-band 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

C. Modulating 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: 6 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. Close off rating: 200 psid.
7. Ball: stainless steel.
8. Stem: stainless steel.
9. Port: Segmented design with characterizing disk held securely by a keyed ring.

D. Valve assembly pressure ratings:

1. Chilled water: 125 psi at 60°F.
2. Hot water: 125 psi at 200°F.

E. Valve Selection:

1. Valve type:
 - a. Modulating 2-way or 3-way valves: characterized ball type. Valves (in conjunction with actuator) shall have minimum rangeability of 100 to 1.
 - 1) 6 inch and less: characterized ball 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 heating coils: equal percentage or modified equal percentage.
- c. 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 water at coils: 2 psi.
 - b) Chilled water at coils: 5 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).
 - 5) Valve size shall match as close as possible the pipe size where C_v is available in that size.
- b. Two-position valves: Line size unless otherwise indicated.

2.5 CONTROL DAMPERS

A. Manufacturers:

- 1. Ruskin.
- 2. Greenheck.
- 3. Pottorff.
- 4. Or equal.

B. Automatic Dampers:

- 1. Actuators: See hereinafter.
- 2. Construction:
 - a. Return and outdoor air dampers (AHUs):
 - 1) Class 2 smoke-rated Ruskin Model SD-36 or equal.
 - 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.

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 and 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	Fail Safe Position
Outside air damper	CLOSED	YES	CLOSED
Return air damper	OPEN	YES	OPEN
Exhaust/relief air damper	CLOSED	YES	CLOSED
AHU heating coil valves	OPEN	YES	OPEN
AHU cooling coil valves	CLOSED		LAST
Hot water reheat coil valves	CLOSED		LAST
VAV box dampers	OPEN		LAST

- 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). Sensor probe shall be 304 stainless steel.
 - 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-3C.
 - b. Equipment rooms: TS-3C,
 - c. Offices and other spaces not listed above: TS-3C.
 - d. Others not listed: Confirm with Architect through RFI.
 5. For room sensors connected to terminal box controllers (such as at VAV boxes) that require calibration: Include a USB port or some other means for connection of POT for terminal box calibration. Alternative means of terminal calibration are acceptable provided they result in no cost to Testing, Adjusting, and Balancing work performed under Section 230990 Testing, Adjusting and Balancing.
- E. 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 CO₂ 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

2.10 DIFFERENTIAL PRESSURE TRANSMITTERS (DPT)

A. DPT-1. Not used.

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: $\pm 1\%$ 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 $\pm 1\%$ FS.
 - b. Minimum outdoor air damper DP used for minimum outdoor airflow: $\pm 0.25\%$ 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

2.11 DIFFERENTIAL PRESSURE SWITCHES (DPS)

- A. DPS-1. Not used.

- 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.

2.12 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 BAS panel. Battery not acceptable.
5. 5-year warranty minimum.
6. Manufacturer:
 - a. Dorlen Water Alert SS-4'
 - b. Or equal

2.13 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

2.14 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: $\pm 0.2\%$ from 20 to 100 Hz.
5. Manufacturers:

- a. Kele SC100
- b. Veris 722
- c. Or equal

2.15 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 $\pm 3\%$ 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. Air Monitor Electra-Flo
- d. Or equal

2.16 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. 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.
- C. 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 plugs.
 - 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.
- D. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA type 1 enclosure. Manufacturer shall be Square 'D', Cutler-Hammer, or equal.
- E. 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.

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 26.
 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 BAS 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 1/2" 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 BAS 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.
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(s).
- 2) High discharge static pressure.
- 3) Freeze-stats.

B. Communication Wiring.

1. The BAS 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. BAS 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, CO₂ 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. Current Switches for Motor Status Monitoring: Adjust so that setpoint is below minimum operating current and above motor no load current.
 - G. 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.

3.5 AUTOMATIC CONTROL DAMPERS

- A. Install dampers according to the manufacturer's instructions and applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
- B. Field mounted control dampers installed with concealed linkage shaft accessible on side of damper with space for direct-coupled actuator.

3.6 ACTUATORS

- A. Type.
 1. 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 23 09 16

BAS 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
 - 2. Control System Server
 - 3. Portable Operator Terminal
 - 4. Uninterruptible Power Supply
- B. Refer to Section 230900 for general requirements.

1.3 RELATED WORK AND REQUIREMENTS

- A. Other BAS Sections:
 - 1. Section 230900 Building Automation System (BAS) - General
 - 2. Section 230913 BAS Basic Materials and Devices
 - 3. Section 230919 BAS Field Panels
 - 4. Section 230923 BAS Communication Devices
 - 5. Section 230926 BAS Software and Programming
 - 6. Section 230810 BAS Commissioning

PART 2 - PRODUCTS

2.1 OPERATOR WORKSTATION (OWS)

- A. Hardware: Minimum Requirements. OWS shall be provided to meet the more stringent performance of the minimum requirements below or as specified by the BAS manufacturer.
 - 1. 3.2 GHz (minimum)
 - 2. 8 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 BAS Contractor:
 - a. See Section 230926.

2.2 CONTROL SYSTEM SERVER (CSS)

A. Hardware: CSS shall be provided to meet the more stringent performance of the minimum requirements below or as specified by the BAS manufacturer.

1. Dual Processor 3.2 GHz (minimum)
2. 8 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. 24" 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 BAS Contractor:

- a. See Section 230926.

- 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. POT shall be provided to meet the more stringent performance of the minimum requirements below or as specified by the BAS manufacturer.

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 230923).
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 BAS Contractor

- a. See Section 230926.

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 the CSS at full load for 10 minutes after power failure.

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	1
Interruptible Power Supply	As required

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 230900.
 - 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. Anti-virus software and installation shall be by the Owner.

END OF SECTION

SECTION 23 09 19

BAS 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 230900 for general requirements.

1.3 RELATED WORK AND REQUIREMENTS

- A. Other BAS Sections:
 1. Section 230900 Building Automation System (BAS) - General
 2. Section 230913 BAS Basic Materials and Devices
 3. Section 230916 BAS Operator Interfaces
 4. Section 230923 BAS Communication Devices
 5. Section 230926 BAS Software and Programming
 6. Section 230810 BAS System 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 an 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 NOVRAM 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 23 09 26. 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: Provide an adequate number of building controllers (a minimum of one) to achieve the performance specified. Each of these panels shall meet the following 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 230926 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 230923 - BAS 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 herein.

3.3 CONTROL POWER

- A. Refer to Section 230900 for power to control panels.

END OF SECTION

SECTION 23 09 23

BAS 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 230900 for general requirements.

1.3 RELATED WORK AND REQUIREMENTS

- A. Other BAS Sections:
 - 1. Section 230900 Building Automation System (BAS) - General
 - 2. Section 230913 BAS Basic Materials and Devices
 - 3. Section 230916 BAS Operator Interfaces
 - 4. Section 230919 BAS Field Panels
 - 5. Section 230926 BAS Software and Programming
 - 6. Section 230810 BAS 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 230919. 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 BAS vendor's scope is 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 shall 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 230900 for device power options and requirements.

3.2 LANID AND LAN ROUTERS

- A. Provide as required. See System Architecture in Section 230900.
- B. At each building, connect Supervisory LAN to Owner's IT/LAN or dedicated BAS 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 on drawings.
 - 3. Thoroughly test each point to ensure that mapping is accurate.
 - 4. Initiate trends of points as indicated on drawings.

END OF SECTION

SECTION 23 09 26

BAS 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 230900 for general requirements.

1.3 RELATED WORK AND REQUIREMENTS

- A. Other EMCS Sections:
 - 1. Section 230900 Energy Management and Control System (EMCS) - General
 - 2. Section 230913 EMCS Basic Materials and Devices
 - 3. Section 230916 EMCS Operator Interfaces
 - 4. Section 230919 EMCS Field Panels
 - 5. Section 230923 EMCS Communication Devices
 - 6. Section 230810 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 230923) with the restrictions/exceptions per application provided in Section 230919:
 - 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 230919 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 230919 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 online 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 dead-band 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 230916) 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 floorplans, 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 drawings.
 - b) O&M and submittal information for the devices on the graphic. See Section 230900 and Section 230010.
 - 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 230919 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 23C 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 230916) 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 230810.
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 230919). If historical trending is enabled for the BACnet object, trend data shall be uploaded from control panels to the 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 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 username 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. See Utility cost calculation on drawings.
 - 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 on 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 (wet-bulb, 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 be 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 230900).

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 identify.

- 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.Equipment Tag.Component.Property.
 - b. Example: 001LIB.HVAC.Heatplant.B-1.HWS.Temperature.

Building	Category	System	Equipment 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 Footcandles Watts
	HVAC	Air handling Exhaust Heatplant Coolplant Misc		CWS CWR HWS HWR CHWS CHWR	Voltage Current ValvePos DamperPos Temperature	Volts Amps %open %open °F
	PLMB	Dom water Air Nat gas N2 O2 Irrigation Waste Misc		OA SA RA EA GAS FLUID	Humidity Pressure Flow Energy Speed Signal	%RH Psig, " H ₂ O 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, CO₂, 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. Message 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 230900.)
2. At the completion of functional performance testing, and.

3. At the end of the warranty period (see Warranty Maintenance in Section 230900).

- 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 and 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 Administration 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).

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 230593 Testing, Adjusting, and Balancing for HVAC.
 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 23 09 60

ENERGY MANAGEMENT SYSTEM

1.01 SCOPE

- A. General: The control system shall be as indicated on the Drawings and described in the Specifications.
- B. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems on this project.
- C. The control system shall accommodate simultaneous multiple user operation. Access to the control system data should be limited only by operator password. Multiple users shall have access to all valid system data. An operator shall be able to log onto any work-station on the control system and have access to all appropriate data.
- D. The control system shall be designed such that each mechanical system will be able to operate under stand-alone control. As such, in the event of a network communication failure, or the loss of any other controller, the control system shall continue to independently operate under control.
- E. Communication between the control panels and all work-stations shall be over a high speed network. All nodes on this network shall be peers. The operator shall not have to know the panel identifier or location to view or control an object. Application Specific Controllers shall be constantly scanned by the network controllers to update point information and alarm information.
- F. The documentation is schematic in nature. The Contractor shall provide hardware and software necessary to implement the functions and sequences shown.

1.02 QUALITY ASSURANCE

- A. System Installer Qualifications
 - 1. The Installer shall have an established working relationship with the Control System Manufacturer of not less than three years.
 - 2. The Installer shall have successfully completed Control System Manufacturer's classes on the control system. The Installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.
 - 3. The installer shall have an office within 100 miles of the project site and provide 24 hour response in the event of a customer call.
- B. Codes and Standards: Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:
 - 1. ASHRAE/ANSI Standard 135 (latest edition)
 - 2. NFPA 101 - Life Safety Code
 - 3. ASHRAE Standard 62 (latest edition) with all addenda and interpretations
 - 4. ASHRAE Standard 170 (latest edition) with all addenda and interpretations
- C. All products used in this installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of 2 years.

- D. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing prior to bid date.
- E. Spare parts shall be available for at least 5 years after completion of this contract.

1.03 SUBMITTALS

- A. See also Section Mechanical Submittals and Shop Drawings for more information.
- B. Communications/open protocol certification per PART 2, Paragraph NETWORKING/COMMUNICATIONS hereafter.
- C. Contractor shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software to be provided. No work may begin on any segment of this project until submittals have been reviewed for conformity with the plan and specifications. All shop drawings shall be done on AutoCAD, and provided to the Owner electronically. These same drawings shall indicate location of all panels, controllers, relays, etc., including locations for all required electrical power connections.
- D. Provide any additional information or data which is deemed necessary to determine compliance with these specifications or which is deemed valuable in documenting the system to be installed.
- E. Submit the following:
 - 1. A complete bill of materials of equipment to be used indicating quantity, manufacturer and model number.
 - 2. A schedule of all control dampers. This shall include the damper size, pressure drop, manufacturer and model number.
 - 3. Provide manufacturers cut sheets for major system components. 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 being submitted to cover. Include:
 - a. Building Controllers
 - b. Custom Application Controllers
 - c. Application Specific Controllers
 - d. Operator Interface Computer
 - e. Auxiliary Control Devices
 - f. Proposed control system riser diagram showing system configuration, device locations, addresses, and cabling.
 - g. Detailed termination drawings showing all required field and factory terminations. Terminal numbers shall be clearly labeled.
 - h. Points list showing all system objects, and the proposed English language object names
 - i. Sequence of operations for each system under control. This sequence shall be specific for the use of the Control System being provided for this project.
 - j. Provide a BACnet Product Implementation Conformance Statement (PICS) for each BACnet device type in the submittal.
 - k. Color prints of proposed graphics with a list of points for display.
- F. Project Record Documents: The documents shall be submitted for approval prior to final completion and include:

1. Project Record Drawings - These shall be as-built versions of the submittal shop drawings. One set of electronic files including CAD .DWG or .DXF drawing files shall also be provided.
 2. Testing and Commissioning Reports and Checklists.
 3. Operating and Maintenance (O & M) Manual - These shall be as-built versions of the submittal product data. In addition to that required for the submittals, the O & M manual shall include:
 - a. Names, address and 24-hour telephone numbers of Contractors installing equipment, and the control systems and service representative of each.
 - b. Operators Manual with procedures of 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.
 - c. Programming Manual with a description of the programming language including syntax, statement descriptions including algorithms and calculations used, point database creation and modification, program creation and modification, and use of the editor.
 - d. Engineering, Installation and Maintenance Manual(s) that explains how to design and install new points, panels, and other hardware; preventative maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.
 - e. A listing and documentation of all custom software created using the programming language including the point database. One set of electronic media containing files of the software and database shall also be provided.
 - f. One set of electronic media containing files of all color-graphic screens created for the project.
 - g. A list of recommended spare parts with part numbers and supplier.
 - h. Complete original issue documentation, installation and maintenance information for all third party hardware provided including computer equipment and sensors.
 - i. Complete original issue diskettes for all software provided including operating systems, programming language, operator work-station software, and graphics software.
 - j. Licenses, Guarantee, and Warranty documents for all equipment and systems.
 - k. Recommended preventive maintenance procedures for all system components including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.
- G. Trend Logs: Submit trend logs for specified mechanical equipment, as hereafter identified. Trend logs shall be started a minimum of fourteen (14) days prior to initially scheduled total project (or any scheduled phase thereafter) comprehensive substantial completion. Submit this trend data weekly to ENGINEER until total project has been accepted by OWNER and thereafter if the building systems are not yet proven reliable for off-season monitoring, and as requested by the PROFESSIONAL during the warranty period.
- H. Training Manuals: The Contractor shall provide a course outline and training manuals for all training classes at least six weeks prior to the first class. The Owner reserves the right to modify any or all of the training course outline and training materials. Review and approval by Owner and Engineer and shall be completed at least 3 weeks prior to first class.

1.04 SYSTEM PERFORMANCE

- A. Performance Standards. System shall conform to the following minimum standards over network connections:

1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 seconds.
2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 seconds.
3. Object Command. Devices shall react to command of a binary object within 2 seconds. Devices shall begin reacting to command of an analog object within 2 seconds.
4. Object Scan. Data used or displayed at a controller or workstation shall have been current within the previous 6 seconds.
5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 45 seconds.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. Select execution times consistent with the mechanical process under control.
7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per second. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 seconds of other workstations.

1.05 WORK BY OTHERS

- A. The CONTRACTOR shall provide and install all wells and taps in pipe lines for the temperature and pressure sensing devices, coordination by FMC.
- B. The CONTRACTOR shall provide all necessary wiring diagrams from equipment data sheets as required for the FMC to prepare accurate control diagrams.
- C. The CONTRACTOR shall provide a dedicated 120-volt A.C. circuit to each Unitary Temperature Control Panel (one per air handling unit) and one per floor for ATU's (minimum 4 total). CONTRACTOR to verify locations and connections with FMC.
- D. All communication cards required to connect to BMS shall be provided with equipment by equipment manufacturer.
- E.

BMS RESPONSIBILITY MATRIX WORK

	FURNISH	INSTALL	LOW VOLTAGE WIRING/ CONDUIT	LINE POWER
BMS low voltage and communication wiring	BMS	BMS	BMS	N/A
BMS conduits and raceway	BMS	BMS	BMS	BMS
Manual valves	23	23	N/A	N/A
Automatic valves	BMS	23	BMS	N/A
Pipe insertion devices and taps including thermowells, flow and pressure stations	BMS	23	BMS	BMS
BMS current switches	BMS	BMS	BMS	N/A
BMS control relays	BMS	BMS	BMS	N/A
Power distribution system monitoring interfaces	26	26	BMS	26
All BMS nodes, equipment, housings, enclosures, and panels	BMS	BMS	BMS	BMS
Fire dampers	23	23	N/A	N/A

Fire alarm shutdown relay interlock wiring	26	26	26	26
Fire alarm smoke control relay interlock wiring	26	26	BMS	26
Fireman's smoke control override panel	26	26	26	26
Unit heater controls	BMS	BMS	BMS	26
Air conditioning units	23	23	BMS	26
Starters, HOA switches	26	26	N/A	26
Control damper actuators	BMS	BMS	BMS	26
VAV box nodes	BMS	23	BMS	26
VAV boxes	23	23	N/A	N/A
Lighting control interface	26	26	BMS	26
Air compressor controls	BMS	BMS	N/A	26
Concrete and/or inertia equipment pads and seismic bracing	23	23	N/A	N/A
BMS interface with HVAC equipment controls	BMS	BMS	BMS	26
BMS gas and water meter interface	22	22	BMS	N/A
BMS electric meter interface	23	26	BMS	26
Smoke/Fire dampers	23	26	BMS	26
Smoke detectors	26	26	26	26
VFD's	23	26	BMS	26
Water heater controls interface	22	22	BMS	26
Water heater recirculating pump controls interface	22	22	BMS	26

1.06 INSTALLATION (DDC WIRING)

- A. Control wiring specified in Divisions 23 shall be done in accordance with the following:
 1. Where the voltage exceeds 30 volts AC installation shall be done in accordance with Division 26 requirements.
 2. Where the voltage is 30 volts AC or less installation shall be done in accordance with Paragraph 1.06.C herein.
- B. A complete wiring system shall be provided for all direct digital control (DDC) and electric controlled apparatus. All wiring shall be installed in a neat, workmanlike manner, of sufficient size and tested to be continuous and without unnecessary "short".
- C. Control Wiring shall be as follows:
 1. Exposed Areas and Mechanical Equipment Rooms: Wiring shall be routed in metallic conduit per Division 26 requirements. Provide flexible conduit connections to rotating equipment.
 2. Concealed, Accessible Areas: Wiring may be routed outside conduit in above ceiling accessible spaces, however wiring outside conduit shall be sheathed with plenum rated jacket with maximum rating of 50/25 smoke developed/fire rated per NFPA 90A.

- a. All wiring will be routed as high as possible held tight to floor/roof structure supported with tie-straps at maximum 5'-0" on center.
- b. All drops and risers to HVAC equipment, fans, sensors, etc., will have a tie-strap installed directly above each device to insure a vertical support to the device.
- c. Any open wiring that enters a conduit in the walls or drop/rise to connect equipment will have a minimum of 60 inches of wire looped outside the conduit above the ceiling and will be attached utilizing a tie-strap within 12 inches of the conduit end or connection.
- 3. Inaccessible Areas: Same as number 1 above - includes wiring in walls, above hard ceilings, in chases, etc.
- 4. Inside Panels or Unit Enclosures: Wiring may be run outside conduit and neatly tied in bundles for neatness and function.
- 5. Wiring in exterior and moist environments shall be routed in weatherproof liquid tight conduit with matching fittings and connections.
- 6. Minimum gauge for low voltage (24VAC or less) control wiring shall be 18 AWG copper solid conductor(s).
- 7. All wiring to have color coded exterior jacket. Coordinate color with Owner prior beginning installation.
- D. All HVAC and pump control and interlock wiring shall be furnished and installed by the FMC. Control and interlock wiring shall not exceed 120 volts. The FMC shall furnish and install any transformers and relays necessary for his control and interlock circuits.
- E. Any power connections required by the FMC for his field-mounted devices which are not shown or specified elsewhere shall be the coordination responsibility of the FMC.
- F. Provide wiring for control devices furnished under this Section, HVAC motor control conduits and interlocks. Color code or number all wires, whether individual or in cables, for identification. All panels and such shall include terminal block, with individual connections adequately identified and with a wiring diagram indicating each termination point, connection, and function. Wiring Diagram shall be:
 - 1. In Finished Spaces: Neatly folded and concealed loose in panel.
 - 2. In Equipment Rooms: Mounted in glass front framed enclosure.

1.7 WARRANTY SERVICES

- A. The adjustment, required testing, and repair of the system includes all computer equipment, transmission, equipment and all sensors and control devices.
- B. The on-line support services shall allow the Contractor/Vendor to remotely connect to utilizing telephone lines to monitor and control the facility's building automation system. This remote connection to the facility shall be within two (2) hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays. If the problem cannot be resolved on-line by the local office, the national office of the building automation system manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on-line support services, the CONTRACTOR shall dispatch the appropriate personnel to the jobsite to resolve the problem within eight (8) hours of the time that the problem is reported.
- C. During the warranty period, the CONTRACTOR shall provide scheduled warranty service and training visits on a quarterly basis. These quarterly, scheduled service visits shall include calibration of pertinent sensors and controllers, verification and adjustment of system points, schedules, and optimization of sequences as required to maintain the system in peak operating condition for occupant comfort, safety and

energy conservation. These visits shall be scheduled with the appropriate OWNER'S representative. Provide up to four (4) hours of additional system training and instruction per visit to the OWNER'S facility operators.

- D. Sixty (60) days prior to the end of the initial warranty period, the CONTRACTOR shall present to the OWNER a proposal for continuing service on the FMS system. This service shall include as a minimum, quarterly system inspections, an annual calibration of all system analog points (outputs and inputs) eight (8) hours of additional training, and unlimited on-line service. The contract shall include all terms and conditions applicable.
- E. Operator work-station software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by Owner must, however, be granted prior to the installation of such changes.

1.08 OWNERSHIP OF PROPRIETARY MATERIAL

- A. All project developed hardware and software 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. Job-specific application programming code
 - 5. All documentation.

PART 2 - PRODUCTS

2.01 CONTROL EQUIPMENT & FMS FIELD DEVICES:

- A. Control Valves: (DDC Electronic Modulating Type)
 - 1. All water circulation control valves shall be full proportioning ball type with cage trim inner valve to facilitate modulation of flow as well as provide for replacing the inner valve without removing from the piping. Valve actuators shall be sized to ensure tight seating against the specified working pressure (all control valves for this project must be capable of seating against minimum 150 p.s.i.g.). Each valve shall be sized by the FMC and guaranteed to be of sufficient size to meet the heating and cooling requirements. Valves 3 inches and larger shall have flanged connections. Valves 1 1/2 inch thru 2 1/2 inches shall have screwed connections. Smaller valves may be solder connection. Mixing valves shall have true mixing pattern bodies with 2 inlets and 1 outlet. Provide positive positioning devices where required for adequate seating pressure or for sequencing. Provide valves with turndown, flow characteristics and close-off pressure to suit specified range of use to yield stable and consistent operation.
 - 2. All valves outdoors shall be equal to
 - 3. Maximum Pressure Drop Through Valves:
 - a. Modulating Water Control: The lesser of 5 feet of water or 50 percent of the drop through the apparatus.
- B. DDC Space Temperature Sensors: Shall be fully proportional relay electronic controllers with adjustable sensitivity and feedback for control stability. Sensors shall be provided with exposed thermometer or LCD temperature readout, set point indication in degrees Fahrenheit and adjustment wheel for all areas. Sensors for air terminal units shall also be provided with push button override of after-hours

setup/setback unoccupied control by remote FMS workstation control. Sensors shall have an adjustable dead band wherein there shall be no action to add heat or cooling when space temperature is within the dead band setting. All space sensors shall be provided with tamper-resistant locking covers. Space sensors shall be mounted 48 inches above finished floor unless otherwise indicated.

- C. Duct Mounted Sensors and Controllers (Temperature Only): Shall have averaging elements of at least 8 feet in length. Duct flanges shall be provided to protect the element and capillary from mechanical damage. Sensors shall be RTD or silicon type with minimum accuracy of 1 percent. Silicon sensors shall have minimum insertion length of 18 inches. The assembly shall be complete with "handy box" for wiring connection.
- D. Provide temperature sensor within AHU's just upstream/downstream of mixing boxes, coil(s) and sufficiently downstream of all coils in mixed air stream for consistent well mixed monitoring.
- E. Pipe Mounted Sensors and Controllers (Temperature Only): Shall be bulb type and mounted in brass separable wells. Sensors shall be RTD type with minimum accuracy of 1 percent. Assembly shall be complete with "handy box" for wiring connection.
- F. Duct Humidity Sensors and Controllers: Shall be combination temperature and humidity transmitters, installed with appropriate duct mounting flanges. The transmitter shall provide signal for the DDC controller. Temperature sensor shall be RTD type with minimum accuracy of 1 percent. Humidity sensor shall be Polymer element with minimum accuracy of 2 percent RH for 5-95 percent RH range, non-condensing.
- G. Low Limit Thermostat: A series of low limit, manual reset thermostat shall be provided for each air handling unit mixed air. The thermostat(s) shall have a 20-foot long sensing element, which shall respond to the lowest temperature over any one-foot section of the element. The thermostat shall stop the air handling unit fan(s) whenever the temperature falls below its set point, with manual reset capability.
- H. Duct Smoke Detectors: Shall be type as specified and furnished by Division 26, with manual reset and sampling tubes to fit duct width. The smoke detectors shall stop the air handling unit fan(s) and provide alarm input to the Fire Alarm System. Interlock to the air handling unit fans shall be by FMC and shall be by hardwire directly to fan(s). Shut-down of unit by fans software not acceptable. Connection to Fire Alarm System and power wiring connections shall be by Division 26, except as noted and hereafter specified.
- I. Damper and Valve Actuators: Shall be DDC type, heavy duty, 80:1 turndown for modulating applications, spring opposed, piston type. Actuators shall be sized to reposition in response to less than 0.25 ma change in control voltage. Provide positive positioners or end switches for the required repositioning response or when sequenced with other actuators or to verify position. Damper actuators shall be provided to have sufficient torque to accomplish damper repositioning with a minimum factor of safety of five (5). Outdoor actuators shall have NEMA 4 housing protection equal to Electra Actuator. Provide fabric weatherproof cover equal to Kele KOV for all valves outdoors.
- J. Relays, switches, transformers, and other auxiliary control devices and local control panels:
 - 1. All auxiliary control devices not required to be mounted directly upon the equipment shall be mounted within or upon a local FMS control panels.

2. Local control panels shall be aluminum, Formica, painted steel, or Lexan constructed to meet NEMA 5 standards. Panels shall have appropriate terminal strips, back plates, and piano hinged covers. Each panel shall be provided with a cover lock. All panels for the project shall be keyed alike. Any wiring or tubing for devices mounted on the panel cover shall be installed with a hinge loop. Provide laminated nameplates for cover mounted devices and permanent labels for interior mounted devices.
- K. Static Pressure Sensors: Shall have stainless steel diaphragm. Each sensor range shall be selected to match the range, which it is to sense so that the normal static pressure is at approximately the midpoint of the sensor's range. Accuracy shall be plus or minus 1% full range regardless of the range selected. Provide a static pressure sensor on each floor served by an AHU for control of each new medium pressure AHU.
 - L. Fan and Pump Status Sensors: Shall be differential pressure switch or current switch at FMC's option. In either case, switch shall be selected with range to suit the measured medium with at least 100 percent over range capability to avoid damage from pressure or current surges. There shall be no auxiliary contacts or relay contacts used for Fan or Pump status sensing. Provide status sensors and FMS monitoring/alarm for all new pumps, drives, AHU's, fans, etc.
 - M. Other Equipment Status Sensors: Shall be by status relay or may be connected directly to "status" contacts if provided with the item of equipment.
 - N. Air Flow Monitor Stations: Airflow stations capable of continuously measuring the air volume in the duct system shall be provided where indicated. Each air flow station shall consist of 14 gage galvanized steel casing with 90° connecting flanges, fabricated to the size indicated on plans. Each air flow traverse probe mounted within the station shall contain multiple total and static pressure sensors placed at equal distances along the probe length. The number of these sensors provided shall comply with ASHRAE standards for duct traversing. The airflow traverse station shall produce a steady, non-pulsing flow signal without need for correction factor or special calibration. Accuracy shall be plus or minus 2 percent of actual flow from 0 to 5,000 fpm airflow velocity. Sensors shall be equal to "Gold Series" by Ebtron.
 - O. Water Flow/Energy Measuring Stations:
 1. Devices shall capable of continuously measuring the water volumetric flow rate in the pipe system where indicated.
 2. Devices shall be bi-directional transit time ultrasonic non-insertion style powered from a 24 VAC power feed provided by CONTRACTOR.
 3. Devices shall be provided with keypad and BACnet communication protocol.
 4. Where indicated as Water Flow/Energy measuring stations, additional clamp-on RTD's for installing on the supply and return piping. RTD temperature range shall be 32-212 Deg F.
 5. Basis of Design: Dynasonics Model DTFX.

2.02 FACILITY MANAGEMENT (FMS) OR ENERGY MANAGEMENT SYSTEM (EMS) EQUIPMENT

- A. The Facility Management System (FMS) shall be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection.
- B. The FMC shall provide new computer station equipment and software as follows:

1. Custom Color Graphic software and programming utilizing new computer workstation to be located at Central Plant. New computer workstation and printer of current technology not to exceed a value of \$4,000.00. Submit to Engineer for approval
 2. Stand alone Application Specific Controllers (ASCs).
 3. Remote login and control for communication to remote operator terminals, particularly a remote terminal in the FMC's office for on line help, preliminary troubleshooting, and long-term monitoring or service contract.
- C. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

2.03 NETWORKING/COMMUNICATIONS

- A. It is the intent of the specifications that the complete controls system be open for modification of all programming to any control vendor in the future. This shall include furnishing any engineering tools, programming tools, database software, etc. (supervisory and unitary level) required for the owner's and/or future separate control vendor use in modifying the installation without involvement from the initial installing Contractor/Vendor. i.e. - an initial Johnson Controls system shall be capable of being modified by Trane in the future without the need for a Johnson Controls representative to be involved provided that the warranty on the initial installation has expired.
- B. The installing Contractor shall provide a certification letter indicating above in both the submittal phase of the project and during the close-out phase of the project. Certification shall include statement that the installation meets all of the interoperability and communication protocol requirements of this specification and that all engineering tools, programming tools, database software, etc. (supervisory and unitary level) has been provided such that other Control Vendors, specifically Trane, Johnson, Siemens and Honeywell are capable of modifying all programming, setpoints, sequences, etc. Additionally, certification shall guarantee that if in the future, it is discovered that these requirements were not provided with this project, this installing Contractor/Vendor shall pay any and all cost associated with meeting the requirements as specified herein, including total system replacement if required. This does not include any licensing fees associated with integration/additions which may be required as a function of future work associated with the initial installation.
- C. The design of the FMS shall network operator workstations and stand alone DDC Controllers. The network shall be open architecture and be dedicated to FMS devices. Utilizing Owner provided computer/data network cabling is prohibited.
- D. The design of FMS shall allow the co-existence of new DDC Controllers with existing DDC Controllers in the same network without the use of gateways or protocol converters.
- E. System shall have the capability to be an OPC Server for dynamic communication with OPC Clients over an Ethernet network. At a minimum, the following must be supported:
- F. Peer-to-Peer Building Level Network:
1. All Operator devices shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the peer-to-peer network. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time.
 2. The peer-to-peer network shall support a minimum of 100 DDC controllers and PC workstations.

3. Each PC workstation shall support a minimum of 4 peer-to-peer networks hardwired or dial up.
4. Field panels must be fully capable of integration with the open standard BACnet, as well as with third party devices via existing vendor protocols.

2.04 SYSTEM SOFTWARE FEATURES

A. System Software:

1. Operating System - Furnish a commercially available, concurrent multi-tasking operating system. Acceptable operating systems are Microsoft Windows XP Professional.
2. System Graphics - The Operator Workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while the system is on line. An operator with the proper password level shall be able to add, delete, or change dynamic points on a graphic. Dynamic points shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation of equipment. Animation capabilities shall include the ability to show a sequence of images reflecting the position of analog outputs, such as valve or damper positions (V17). Graphics shall be capable of launching other PC applications.
3. Custom Graphics - Custom graphic files shall be created with the use of commonly available graphics packages such as Corel Paint Shop Pro. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as BMP, GIF and JPEG.
4. Graphics Library - Furnish a complete library of standard HVAC equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators, including 2-dimensional and 3-dimensional graphic depictions. The library shall include a minimum of 300 such files available for use by the Owner. This library shall also include standard graphical representations of equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
5. Engineering Units - Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system. Unit selection shall be able to be customized by locality to select the desired units for each measurement. Engineering units on this project shall be [Inch Pound] [SI].

B. System Applications - Each workstation shall provide operator interface and off-line storage of system information. Provide the following applications at each workstation.

1. Automatic System Database Save and Restore - Each workstation shall store on the hard disk a copy of the current database of each building controller. This database shall be updated whenever a change is made in any panel in the

system. The storage of this data shall be automatic and not require operator intervention. In the event of a database loss in a building management panel, the first workstation to detect the loss shall automatically restore the database for that panel.

2. Manual Database Save and Restore - A system operator with the proper password clearance shall be able to archive the database from any system panel and store on electronic media. The operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
3. System Configuration - The workstation software shall provide a graphical method of configuring the system. The user with proper security shall be able to add new devices, and assign modems to devices. This shall allow for future system changes or additions.
4. On-Line Help and Training - Provide a context sensitive, on line help system to assist the operator in operation and editing of the system. On-line help shall be available for all system functions and shall provide the relevant data for that particular screen. Additional help shall be available through the use of hypertext links onscreen.
5. Security - Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set security levels for all other operators. Each operator password shall be able to restrict the operator's access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto logoff time shall be set per operator password. All system security data shall be stored in an encrypted format.
6. System Diagnostics - The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
7. Alarm Notification - Alarm messages shall use full language, easily recognized descriptors for alarm. System shall allow the user to have up to 10 popup windows appear for incoming alarms. The popup dialog shall allow the user to silence and acknowledge alarms, view an expanded message or graphic, and add and save comments for the alarm.
8. Alarm Processing - Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.
9. Alarm Reactions - The operator shall be able to determine what actions, if any are to be taken, by object, during an alarm. Actions shall include logging, printing, start a custom control program, displaying messages, dialing out to remote workstations, paging or text message to a cell phone, forwarding to an e-mail address, providing audible annunciation or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day. An object in alarm that has not been acknowledged within an operator specified time period shall be re-routed to an alternate operator specified alarm receipt device. For text messaging, the system shall support TAP protocol including parities 7-E-1 and 8-n-1, such that if the system fails to dial out/connect with one parity it will automatically try the other one.
10. Alarm and Event Log - The operator shall be able to view all logged system alarms and events from any location in the system. The operator shall be able to sort and filter alarms from events. Alarms shall be sorted in up to 5 color-coded categories based on Owner preference (V17). Include an alarm count summary for each alarm category on the system toolbar. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared

by the operator shall be archived to the hard disk on the workstation. Provide a comment field in the event log that allows a user to add specific comments associated with any alarm.

11. Trend Logs - The operator shall be able to define a trend log for any data in the system. This definition shall include interval, start-time, and stop-time. Trend intervals of 30 seconds, 1, 5, 15, 30, and 60 minutes as well as once a shift (8 hours), once a day, once a week, and once a month shall be selectable. Each trend shall accommodate up to 64 system objects. The system operator shall be able to determine how many samples are stored in each trend. Trend data shall be sampled and stored on the Building Controller panel and be archived on the workstation hard disk. Trend data shall be able to be viewed and printed from the operator interface software. Trends must be viewable in a text-based format or graphically. Trends shall also be storable in a tab delimited ASCII format for use by other industry standard word processing and spreadsheet packages.
12. Dynamic Graphical Trending - The system shall have the ability to save the data collected by a trend object and display that collected data in a graphical chart. Trend viewing capabilities shall include the ability to show up to 10 points on a chart, to include live and/or historical data. Each data point trend line shall be an individual color, and include on-graph icons that represent associated events/alarms, manual overrides, and automated changes that have occurred over the time frame represented on the chart. Navigation and viewing functions shall include scrolling and zooming of x and y-axes, and a trace display of the associated time stamp, and values for any selected point along the x-axis. Trend data shall be able to be stored for up to 10 years on the PC workstation.
13. Object and Property Status and Control - Provide a method for the operator to view, and edit if applicable, the status of any object and property in the system. These statuses shall be available by menu, on graphics or through custom programs.
14. Clock Synchronization - The real time clocks in all building controllers and workstations shall be synchronized on command of an operator. The system shall also be able to automatically synchronize all system clocks; daily from any operator designated device in the system. The system shall automatically adjust for daylight savings time if applicable.
15. Reports and Logs - Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archived on the hard disk for historical reporting. Provide the ability for the operator to obtain real time logs of designated lists of objects. Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer. The operator shall be able to designate reports that shall be printed or stored to disk at selectable intervals. Provide a means to list and access the last 10 reports viewed by the user.
 - a. Custom Reports - Provide the capability for the operator to define any system data into a daily, weekly, monthly, or annual report. These reports shall be time and date stamped and shall contain a report title.
 - b. Standard Reports - The following standard system reports shall be provided for this project. These reports shall be readily customized to the project.
 - 1) All Points in Alarm Report: Provide an on demand report showing all current alarms.
 - 2) All Points in Override Report: Provide an on demand report showing all overrides in effect.
 - 3) Schedule Report: Provide a summary of all schedules including Holiday and Exception schedules.
 - 4) Commissioning Report: Provide a one-time report that lists all equipment with the unit configuration and present operation.

- 5) Weather Data Report: Provide a monthly report showing the daily minimum, maximum and average outdoor air temperature and the number of heating and cooling degree days for each day. Provide an annual (12 month) report showing the minimum, maximum and average outdoor air temperature for the month and the number of heating and cooling degree days for the month.
- C. Workstation Applications Editors - Each PC workstation shall support dedicated screens for editing of all system applications. Provide editors for each application at the PC workstation. The applications shall be downloaded and executed at the appropriate controller panels.
1. Controller - Provide a full screen editor for each type custom application, and application specific controller that shall allow the operator to view and change the configuration, name, control parameters, and system set points.
 2. Scheduling - An editor for the scheduling application shall be provided at each workstation. Provide a monthly calendar for each schedule. Exception schedules and holidays shall be shown clearly on the calendar. Provide a method for allowing several related objects to follow a schedule. An advance and delay time for each object shall be adjustable from this master schedule. An operator shall be able to modify the schedule. Schedules shall be able to be easily copied between objects and/or dates.
 3. Manual Control and Override - Provide a means of manually controlling analog and binary output points. Control overrides shall be performed through a simple, graphical on-off-auto editor for binary points, and auto-manual selector for analog control. Provide an icon indicator of override status when a point, unit controller or application has been overridden manually.
 4. Air System Equipment Coordination - Provide editor screens with monitoring and control functions that group together and coordinates the operation of air handling equipment and associated VAV boxes as specified in the sequence of operations. For each air system, the editor pages shall include:
 - a. System mode of the air handling system
 - b. Listing and assignment of the associated air handler and VAV boxes
 - c. AHU supply air cooling and heating setpoints
 - d. AHU minimum, maximum and nominal static pressure setpoints
 - e. VAV box minimum and maximum flow, and drive open and close overrides
- D. Custom Application Programming - Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded.

2.05 BUILDING CONTROLLERS

- A. General. Provide Building Controllers to provide the performance specified in this specification section. Each of these panels shall meet the following requirements.

1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Building Controllers to manage the global strategies described in System software section.
 2. The controller shall have an integral LCD display mounted either directly on the controller or on the front face of the panel enclosure containing the controller.
 3. The Building Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 4. The controller shall provide a communications port for connection of the Portable Operators Terminal using Point to Point BACnet physical/data link layer protocol or a connection to the inter-network.
 5. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 6. Controllers that perform scheduling shall have a real time clock.
 7. Data shall be shared between networked Building Controllers.
 8. The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - a. Assume a predetermined failure mode.
 - b. Generate an alarm notification.
 9. BACnet. The Building Controller shall use the Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135-95, to communicate with BACnet objects in the internetwork. Objects supported shall include: Analog input, analog output, binary input, binary output, device.
- B. Communications. Each Building Controller shall reside on a BACnet inter-network using the ISO 8802-3 (Ethernet) or ARCNET (ASTM 878.1) Physical/Data Link layer protocol. Each Building Controller shall also perform routing to a network of Custom Application and Application Specific Controllers.
- C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at 0 C to 50 C (32 F to 120 F).
- D. Serviceability. Provide diagnostic LED's for power, communications, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.
- E. Memory. The Building Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
- F. Immunity to power and noise. Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform an orderly shut-down below 80 percent nominal voltage.

2.06 CUSTOM APPLICATION CONTROLLERS

- A. General. Provide Custom Application Controllers to provide the performance specified in section 1 of this division. Each of these panels shall meet the following requirements.

1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Building Controllers to manage the local strategies described in System software section.
 2. The controller shall have an integral LCD display mounted either directly on the controller or on the front face of the panel enclosure containing the controller.
 3. The Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 4. Controllers that perform scheduling shall have a real time clock.
 5. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 6. Data shall be shared between networked Controllers.
 7. The Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - a. Assume a predetermined failure mode.
 - b. Generate an alarm notification.
- B. Controller hardware shall be suitable for the anticipated ambient conditions.
1. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 Type waterproof enclosures, and shall be rated for operation at minus 40 Deg C to 65 Deg C (minus 40 Deg F to 150 Deg F).
 2. Controller used in conditioned ambient shall be mounted in NEMA 1 Type rated enclosures, and shall be rated for operation at 0 Deg C to 50 Deg C (32 Deg F to 120 Deg F).
- C. A local keypad and display shall be provided where specified in the sequence of operations or points list. Keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display.
- D. Serviceability. Provide diagnostic LEDs for power, communications, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.
- E. Memory. The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
- F. Immunity to power and noise. Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform an orderly shut-down below 80 percent nominal voltage.

2.07 APPLICATION SPECIFIC CONTROLLERS

- A. General. Application specific controllers (ASC) are microprocessor-based DDC controllers which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user programmable, but are customized for operation within the confines of the equipment they are designed to serve.
1. The controller shall have an integral LCD display mounted either directly on the controller or on the front face of the panel enclosure containing the controller.
 2. Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
 3. Each ASC will contain sufficient I/O capacity to control the target system.
- B. Environment. The hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 Type waterproof enclosures, and shall be rated for operation at minus 40 Deg C to 65 Deg C (minus 40 Deg F to 150 Deg F).
 2. Controller used in conditioned ambient shall be mounted in NEMA 1 Type rated enclosures, and shall be rated for operation at 0 Deg C to 50 Deg C (32 Deg F to 120 Deg F).
- C. Serviceability. Provide diagnostic LED's for power, and communications. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.
- D. Memory. The Application Specific Controller shall maintain all BIOS and programming information in the event of a power loss for at least 90 days.
- E. Immunity to Power and noise. Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform an orderly shut-down below 80 percent.
- F. Transformer. Power supply for the ASC must be rated at minimum of 125 percent of ASC power consumption, and shall be fused or current limiting type.

2.08 COMMUNICATIONS

- A. This project shall comprise a BACnet inter-network. All PC Workstations and Building Controller components shall meet ASHRAE / ANSI Standard 135-1995, BACnet.
- B. Each BACnet device shall operate on the BACnet physical/data link protocols specified for that device as defined earlier in this section
- C. The Contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the inter-network.
- D. All Building Controllers shall have a communications port for connections with the operator interfaces. This may be either an RS-232 port for Point to Point connection or a network interface node for connection to the Ethernet or ARCNET network.
- E. Remote operator interface via a 9600 or faster baud modem shall allow for communication with any and all controllers on this network as described in the following section.
- F. Communications services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:
1. Connection of an operator interface device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.
 2. All database values (i.e., points, software variable, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to a point name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communications services to perform internetwork value passing.

- G. The time clocks in all controllers shall be automatically synchronized daily.

2.09 INPUT/OUTPUT INTERFACE

- A. Hard-wired inputs and outputs may tie into the system through Building, Custom, or Application Specific Controllers.
- B. All input points and output points shall be protected such that shorting of the point to itself, another point, or 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.
- C. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 ma to be compatible with commonly available control devices.
- D. Pulse accumulation input points. This type of point shall conform to all the requirements of Binary Input points, and also accept up to 2 pulses per second for pulse accumulation, and shall be protected against effects of contact bounce and noise.
- E. Analog inputs shall allow the monitoring of low voltage (0-10 Vdc), current (4-20 ma), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with, and field configurable to commonly available sensing devices.
- F. Binary outputs shall provide for on/off operation, or a pulsed low voltage signal for pulse width modulation control.
 - 1. Binary outputs shall be selectable for either normally open or normally closed operation.
 - 2. Binary outputs on custom and building controllers shall have 3-position (on/off/auto) override switches and status lights.
- G. Analog outputs shall provide a modulating signal for the control of end devices.
 - 1. Outputs shall provide either a 0-10 Vdc or a 4-20 ma signal as required to provide proper control of the output device.
 - 2. Analog outputs on building or custom programmable controllers shall have status lights and a 2-position (auto/manual) switch and manually adjustable potentiometer for manual override.

2.10 VARIABLE FREQUENCY FAN DRIVES (VFD)

- A. Variable Frequency Drives: VFD shall be furnished for each variable air volume air handling unit supply fan and elsewhere where indicated. Each VFD shall have an automatic and a manual bypass switch where indicated on VFD schedule. All VFD's shall have integral disconnect and contactor mounted within a common, NEMA 1

enclosure for indoor applications and NEMA 3R for outdoor applications. The CONTRACTOR shall install the VFD's and provide power wiring to line and load sides. The FMC shall furnish and install all other wiring and instrumentation required to vary the speed of the pump and fan motors to control the water and air volume as specified.

1. VFD Input Power: Shall be 208/3/60 or 480/3/60 as noted and verified. The VFD shall tolerate plus or minus 10% voltage and plus or minus 5 percent Hz.
2. VFD Output Power: Shall vary frequency to the motor from 0 to 400 Hz to vary the motor speed in proportion to the motor nameplate rated speed, with output voltage variation from zero to motor rated voltage for optimum voltage per hertz ratio for air handling unit motors loads. Output current shall be rated at 150 percent of the VFD'S constant torque rating. The output must be voltage source type generating a sine coded pulse width modulated waveform utilizing an asynchronous carrier frequency. The carrier frequency shall be adjustable to minimize harmonically induced noise or vibration. These criteria shall be accomplished by using microprocessor-based techniques.
3. VFD Power Structure: The power structure which converts AC power to variable frequency output power shall consist of three functional stages:
 - a. Input Stage: Shall convert three phase AC line power to a fixed DC bus voltage with a solid state, three phase full wave diode rectifier with metal oxide varistor three phase protection. Displacement power factor shall be .98 throughout the speed range (if the supplied VFD can not provide .98 power factor, the FMC must furnish and install power factor correcting capacitors as required). The VFD shall prevent voltage line notching (or the FMC shall furnish and install isolation transformers).
 - b. Intermediate Stage: Shall be interfaced with the VFD diagnostics to provide continuous monitoring for power component protection. The DC bus shall be fused for short circuit protection and shall have capacitive filtering to provide smooth DC power to the output stage.
 - c. Output Stage: shall utilize switching transistors to convert DC bus power to sine coded pulse width modulated output current of all three phases to the motor. Current transformers shall be provided to detect current for utilization by the microprocessor to provide information generation for:
 - 1) Electronic thermal overload protection
 - 2) Three phase current limit
 - 3) Ground fault and short circuit protection
 - 4) Speed search, which shall allow starting the motor into a rotating load.
 - d. Insulated Gate Bipolar Transistors used in the inverter output section to enable a fixed 15 KHz carrier frequency to provide for:
 - 1) Limit increase in audible magnetic noise to 2dB above across the line power.
 - 2) Provide for 100% full load motor torque for starting the motor at minimum output frequency of 1.5Hz.

B. Operation and Protective Functions

1. Provide adjustable DC injection braking, selectable for deceleration braking or braking before start (anti-windmill).
2. Provide with three (3) adjustable prohibited frequency ranges to avoid mechanical resonant vibration.
3. Provide with auto speed reference loss detection, which shall automatically drop the VFD to a preset speed until auto speed command is restored.
4. Provide with programmable automatic restart for up to ten attempts of automatic restart.
5. The VFD shall "ride through" a power loss of up to two (2) seconds.

6. Provide with reverse run inhibit which shall prevent reverse rotation even if started into a reverse wind milling fan.
7. Provide with input electrical power protection, including phase reversal, phase loss, under and over voltage protection, etc.
8. Input line reactors.
9. Provide load reactors if motor leads exceed 100 ft.
10. Provide with fuse integral disconnect switch with lockout provisions.

C. Control Terminal Functions

1. Provide terminal strip to accept the following external commands:
 - a. Forward Run/Stop to enable the VFD from any normally open contact.
 - b. Speed reference input which shall accept a manual speed potentiometer signal or an instrument follower signal of:
 - 1) 0 to 10 VDC
 - 2) 4 to 20 mA
 - 3) 1 to 5 VDC
2. Provide terminal strip and output generators as follows:
 - a. One relay contact rated at 1 A. at 230 VAC
 - b. Two collector outputs.
 - c. These may be individually programmed for any of the following indications:
 - 1) Run Mode
 - 2) Zero Speed Detect
 - 3) Over torque Detect
 - 4) Coast to Stop Detect
 - 5) Run Reference Mode
 - 6) Speed reference Mode
 - 7) Speed Synchronization
 - 8) Output Frequency
 - 9) Low Voltage Detect
 - 10) Operation Ready
 - 11) Speed Reference Missing
 - 12) Braking Resistor Fault
 - 13) Drive Fault
 - 14) External Fault (safety, such as smoke detector).
3. Provide terminal strip and a form C fault relay contact for remote indication that the VFD diagnostics has detected a fault condition. The indication may be selected for immediate indication or for indication after the final attempt for automatic restart.
4. Provide input terminals for external fault signal, which shall cause the VFD to shut down and shall provide a digital readout.
5. Provide output terminals for 0 to 10 VDC selectable for proportional output frequency or current.

D. Local Operator Controller

1. Provide, mounted upon the face of the common enclosure, a sealed, touch pad local control which shall include:
 - a. Local run/stop keys
 - b. Local speed command
 - c. Reset key
 - d. Digital output frequency meter and speed reference meter that may be programmed for speed related indications such as RPM, CFM, FPM, etc.
 - e. Digital voltmeter
 - f. Digital Kilowatt meter
 - g. Digital Ammeter

- h. Input and output terminal status indication
 - i. Control function programming (without requiring stopping the VFD) for at least the following:
 - 1) Acceleration and deceleration
 - 2) Frequency command bias and gain
 - 3) Torque compensation
 - 4) Slip compensation
 - 5) Energy savings gain
 - 6) Multi-step speed references
 - j. Digital indication and protection for:
 - 1) DC bus under voltage
 - 2) DC bus over voltage
 - 3) Load over torque
 - 4) Fuse blown
 - 5) Motor overload
 - 6) VFD overload
 - 7) Heat sink over temperature
 - 8) Instantaneous over current
 - 9) Operator error
 - 10) CPU fault
 - 11) External fault
 - 12) Dynamic braking fault
- E. VFD Bypass Control: Shall be provided within a common enclosure (see schedule on Drawings for enclosure type) that shall allow the motor to run at full speed with line power while the VFD is being serviced or is out of service. The bypass and the VFD shall be electrically interlocked to prevent line power and VFD output being connected to the motor at the same time. The unit shall be so constructed that the VFD can be removed and the bypass remain in service. The bypass control shall include:
- 1. Door interlocked disconnect
 - 2. Bypass contactor
 - 3. VFD input contactor
 - 4. VFD output contactor
 - 5. Overload relay
 - 6. Control transformer
 - 7. Safety circuit terminal strip
 - 8. Drive-Off-Line selector switch
 - 9. Normal-Test selector
 - 10. VFD select light
 - 11. Line select light
 - 12. NOTE: VFD shall fault in the full run capacity mode (motor fully powered). Air terminal unit air valves shall correspondingly be driven to full open (maximum scheduled cfm capacity).
- F. Quality Assurance:
- 1. All printed circuit boards shall utilize surface mounted devices to provide high reliability and strengthened printed circuit assembly. Printed circuit boards shall be "burned in" for at least 96 hours. Circuit boards shall be tested to accepted quality level (AQL) of .5%.
 - 2. The fully assembled VFD shall be factory tested with fully loaded induction motor.
 - 3. Provide test data (if requested) to show mean time between failure value of 100,000 hours.
 - 4. The VFD shall be UL listed, and constructed per NEMA and IEEE standards.
 - 5. The VFD shall be fully operable in the following environmental conditions:

- a. Ambient temperature from -10 to +60° C.
- b. Humidity to 90% RH, non-condensing
- c. Service factor: 1.15.

2.11 FINAL CONTROL ELEMENTS AND OPERATORS

- A. Fail Safe Operation: Design and install control valves and dampers to "fail safe" in either the normally open or normally closed position as required for freeze, moisture, smoke or fire protection.
- B. Spring Ranges: As required for system sequencing and to provide tight close-off.

2.12 OPTIONAL WIRELESS CONTROLS

A. Architecture/Communication:

- 1. Wireless equipment controllers and auxiliary control devices shall conform to:
 - a. IEEE 802.15.4 radios to minimize risk of interference and maximize battery life, reliability, and range.
 - b. Communication between equipment controllers shall conform to ZigBee Building Automation (ZBA) standard as BACnet tunneling devices to ensure future integration of other ZBA certified devices.
 - c. Operating range shall be a minimum of 200 feet; open range shall be 2,500 ft. with less than 2 percent packet error rate to ensure reliable operation.
 - d. To maintain robust communication, mesh networking and two-way communications shall be used to optimize the wireless network health.
 - e. Wireless communication shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.
 - f. Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES.

B. Operator Interface:

- 1. Wireless Space Sensors:
 - a. Battery life shall be 15 years or greater to minimize the need for battery replacement in typical operating conditions.
 - b. To check for proper operation, wireless space temperature sensors shall include a signal strength on the space sensor display. The battery indication lights shall flash periodically for a minimum of 5 days to indicate the need for battery replacement prior to failure.
 - c. To allow local troubleshooting without specialized tools, error codes shall be displayed on the digital display. Error codes shall include: not associated, address to 000, improper software configuration, input voltage too high, or general sensor failure. Codes shall be indicated on inside of sensor back cover.
 - d. An optional 2% relative humidity sensors module shall be available for humidity control applications and shall not shorten typical battery life to less than 15 years.
- 2. Service Tools:
 - a. To support network setup and troubleshooting, service tools shall display link quality and hop quantities for each wireless device.
 - b. Wireless service tool access to communications link shall be provided to minimize installation and troubleshooting labor.
- 3. Auxiliary Control Devices:
 - a. Space Sensors:
 - 1) Temperature and Humidity Range
 - (a) The ambient operating temperature range for the wireless space sensor shall be 32 to 122 Deg F.

- (b) The ambient storage temperature range for the wireless space sensor shall be minus 40 Deg F to 185 Deg F.
 - (c) The ambient operating and storage humidity range for the wireless space sensor shall be 5 percent to 95 percent, non-condensing.
- 2) Components:
 - (a) Wireless space sensors shall be available as: temperature only, field configurable model with digital display, and optional 2 percent humidity module for use in either model above. The field configurable model shall all allow field configuration without a field service tool. Configuration options include: setpoint, override pushbuttons, fan speed, and system mode switches. System mode, fan speed and setpoint shall include a lock option. The digital display shall also be field configurable to display in Fahrenheit or Celsius units of measure, and can also be configured to display setpoint only.
 - (b) The wireless space sensor addresses shall be held in non-volatile memory to ensure operation through system voltage disturbances and to minimize the risk of incorrect association.
 - (c) The wireless space sensor shall be addressed using pushbuttons and display with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing. Two position DIP switches are not acceptable.
 - (d) Installation and replacement of failed sensors shall be accomplished automatically after power up.
 - (e) The wireless space sensor shall include security screws to protect against theft.
 - (f) Wireless space sensor component certifications shall include:
 - (1) TFP-13651127 - Canada Compliance
 - (2) UL 916 - Energy Management Equipment
 - (3) UL 94 - The Standard for Flammability of Plastic Materials for Parts in Devices and Appliances: 5 VA flammability rating
 - (4) UL 873 - Temperature regulating and indicating equipment
- 3) Accuracy:
 - (a) To ensure proper system performance, the wireless space sensors shall automatically determine when the space temperature is rapidly changing. When the space temperature is readily changing, the space temperature shall be transmitted at least once each 30 seconds. The maximum time between transmissions shall be 15 minutes. Space temperature sensing accuracy shall be plus or minus 0.5 Deg F.
- 4) Power Requirements:
 - (a) The wireless space sensor battery life shall provide at least 15 years life under normal operating conditions and must be readily available size AA, 1.5V.
- b. Wireless Communications Interface:
 - 1) Temperature and Humidity Range:
 - (a) The ambient storage temperature range for the wireless communications interface shall be minus 40 Deg F to 185 Deg F.
 - (b) The ambient operating and storage humidity range for the wireless communications interface shall be 5 percent to 95 percent, non-condensing.
 - 2) Components:
 - (a) The wireless communications interface shall be addressed using rotary switches with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing. Two position DIP switches are not acceptable.

- (b) Wireless Comm Interface certifications shall include:
 - (1) TFP-13651127 - Canada Compliance
 - (2) UL 916 - Energy Management Equipment
 - (3) UL 94 - The Standard for Flammability of Plastic Materials for Parts in Devices and Appliances: 5 VA flammability rating
 - (4) UL 873 - Temperature regulating and indicating equipment
 - (5) ZigBee Building Automation, BACnet Tunneling Device

PART 3 - EXECUTION

3.01 INSTALLATION AND ADJUSTMENT

- A. Install and adjust required control components and systems in accordance with instructions of the manufacturer. Work shall be performed by employees of the manufacturer or an authorized representative.
- B. All control wiring exposed to view shall be routed in conduit - Install electrical control connections in accordance with applicable Sections of Division 26.
- C. Except for short apparatus connections run conduit parallel to or at right angles to the building structure. Conceal conduit in finished and equipment room spaces.
- D. Do not run conduit concealed under insulation or inside ducts. Mount control devices, tubing and conduit located on ducts or apparatus with external insulation or stand-off support to avoid interference with insulation.
- E. Run wire connecting devices on or in control cabinets parallel with the sides of the cabinet neatly racked to permit tracing. Rack connections bridging a cabinet door along the hinge side and protect from damage. Provide grommets, sleeves or vinyl tape to protect wires from sharp edges of panels, conduit, and other items.
- F. Mount room thermostatic sensors 48 inches above the floor. Securely mount sensors and capillaries and position to measure correct average temperature/humidity. Thermally isolate elements from brackets and supports so that response is to air temperature only.
- G. Provide all necessary factory and/or field labor for complete calibration and adjustment of the air flow control components, and be responsible for setting all control set-points, operating sequences, and alarm systems contained within the air flow control center to produce the system performance specified.

3.02 FIELD QUALITY CONTROL

- A. All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this Section.
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.
- C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

3.03 PROGRAMMING

- A. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25 percent of available memory free for future use.
- B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.
- C. Software Programming:
 - 1. Provide programming for the system as per specifications and adhere to the strategy algorithms provided.
 - 2. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the Contractor.
 - 3. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.

3.04 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 mechanical systems:
 - 1. Schematics shall be 2-D or 3-D and shall be based substantially on the schematics provided on Drawings.
 - 2. Each unit shall be identified in the graphic screen by the unit tag name as scheduled on the drawings. The unit's control address is not sufficient identification.
 - 3. All relevant I/O points and setpoints being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. 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.
 - 4. Animation or equipment graphic color changes shall be used to indicate on/off status of mechanical components.
 - 5. 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 and humidity) 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 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. Building homepage: Background shall be a building footprint, approximately to scale, oriented as shown on the architectural Drawings. Include links to floorplan, roof and each mechanical room/area, and to summary graphics described below.
2. 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. The colors shall be updated dynamically as a zone's actual comfort condition changes. In each zone, provide links to associated terminal equipment.
 - b. If multiple floor plans are necessary to show all areas, provide a graphic building key plan. Use elevation views 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.
3. Each equipment floor/roof/area plan: To scale, with links to graphics of all EMCS controlled/monitored equipment.
4. Each boiler and air conditioning unit.
5. Each zone terminal: Provide link to associated air handling unit where applicable and to floor plan where terminal is located.
6. 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. Air conditioning 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, etc. (all key operating variables)
 - b. VAV Zone terminal units: operating mode, airflow rate, airflow rate setpoint, zone temperature, zone temperature setpoint, damper position, HW valve position (reheat boxes), supply air temperature (reheat boxes), supply air temperature setpoint (reheat boxes), CO2 concentration and CO2 loop output (where applicable), Static Pressure request enable switch, current Static Pressure requests, Cooling request enable switch, current Cooling requests, Heating request enable switch, current Heating requests.
7. All other EMCS 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 values that are in a Level 1 or 2 condition in a red color, Level 3 and higher alarm condition in a blue color, and normal (no alarm) condition in a neutral color (black or white).

3.05 EARLY COMPLETION REQUIREMENTS

- A. In conjunction with the requirements of Divisions 22 and 23, the FMS shall be complete and operational. During this pre-substantial completion date, this shall include

completion of all specified programming, installation of workstation, remote connection and operation and input of all OWNER'S zone temperature and occupancy schedules for ATU's, AHU's, zones, etc. During the pre-substantial completion period, trend logs, as defined hereafter, shall be setup, maintained, monitored by FMC daily. Copies of these trend logs shall be shared weekly with the ENGINEER for verification purposes.

3.06 OPERATOR INSTRUCTION

- A. After acceptable software, operation, and TAB has been completed, the FMC shall provide instruction to the operating personnel during normal working hours.
- B. Before turning the project over to the OWNER, the FMC shall provide two (2) working days of formal instruction to the operating personnel. Instruction shall include overall operation, equipment functions, commands, advisories, trends, appropriate operator intervention, etc.
- C. Up to four (4) additional training sessions of up to four (4) hours each shall be provided annually during the warranty period as requested and coordinated with OWNER for training replacement personnel or for refresher.

3.07 GUARANTEE

- A. The entire installation shall be guaranteed free from defects in materials and workmanship for one (1) years from date of full OWNERS' acceptance. See Part 1 for more information.
- B. The CONTRACTOR shall monitor the system on a daily basis for a minimum of sixty (60) days after project acceptance. If monitoring is done via remote site login, the CONTRACTOR shall promptly go to the project to make any required adjustments or repairs required. The CONTRACTOR shall be equipped to respond to requests from the OWNER for remote assistance throughout the guarantee period.
- C. See Part 1 - General for additional requirements.

3.08 TREND LOGS

- A. The following trend log/histories shall be setup by custom programming. This is not a comprehensive list. Note that other trends may be required and shall be included during the project completion and warranty period to help monitor and solve comfort control and sequence issues, and shall be done at no additional cost to this OWNER and done as a part of this project. Logs shall be maintained beginning fourteen (14) days prior to the initially scheduled contract substantial completion date of any phase of the contract. The CONTRACTOR shall provide three ring "D" style binders with divider tabs for each log group designated below. Provide neat identification/labeling for each binder.
- B. Submit copies of these trend logs weekly (minimum) or as requested by ENGINEER, beginning at onset of trend logging for any phase of the project, and extending until eight (8) weeks after OWNER'S acceptance of the total project. The trend data shall

be programmed to be automatically printed (output) at the beginning of each day, with information compiled from the previous day. This trend data shall be also automatically stored in preset and preprogrammed space at the workstation. This information shall be readily and easily downloaded and accessible at the workstation or from a remote site.

- C. It is preferred that trends are presented in graph format with time along the bottom axis and the value of the point/variable on the vertical axis.
- D. The following trend logs shall be setup and data maintained:
 - 1. Log each point at a maximum 10 minute intervals.
 - 2. Rooftop Units:
 - a. Date/Time
 - b. RTU #
 - c. Outside Air Temp (db/wb)
 - d. Chilled E.W.T./L.W.T.
 - e. Heating E.W.T./L.W.T.
 - f. Air Flow (S/A & O/A)
 - g. Heating & Cooling Coils (E.A.T./L.A.T.)
 - h. S/A & E/A VFD Speed (hz)
 - i. Zone RH
 - j. Supply Duct Static Pressure
 - k. VAV Critical Zone
 - 3. VAV Boxes:
 - a. Date/Time
 - b. VAV #
 - c. CFM
 - d. S/A Temperature, degrees F
 - e. Damper % Open
 - f. Zone Temperature Setpoint, degree F
 - g. Actual Zone Temperature, degree F
 - 4. Boilers:
 - a. Date/Time
 - b. Boiler #
 - c. Outside Air Temperature (db/wb)
 - d. E.W.T.
 - e. L.W.T.
 - f. Percent Input
 - 5. Chillers
 - a. Date/Time
 - b. Chiller #
 - c. Outside Air Temperature (db/wb)
 - d. Evaporator (E.W.T./L.W.T.)
 - e. Condenser (E.W.T./L.W.T.)
 - f. VFD percent
 - 6. Cooling Towers:
 - a. Date/Time
 - b. Cooling Tower #
 - c. Outside Air Temperature (db/wb)
 - d. E.W.T.
 - e. L.W.T.
 - f. VFD Speed (hz)

3.09 SEQUENCES OF OPERATION AND POINTS LISTS

- A. Refer to Drawings for Sequences of Operation and Points lists.

END OF SECTION

SECTION 23 09 90

TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.01 SCOPE

- A. The process of Testing, Adjusting and Balancing (TAB) for mechanical HVAC and Plumbing systems is a requirement for this project.
- B. Definitions and Abbreviations:
 - 1. TAB: Testing, Adjusting and Balancing. The process of checking and adjusting HVAC and plumbing systems to meet design objectives and performance intent.
 - 2. AABC: Associated Air Balance Council.
 - 3. NEBB: National Environmental Balancing Bureau.
 - 4. Plumbing Systems: Domestic hot water and re-circulating systems.
 - 5. Air Systems: Included all supply air, return air, exhaust air, transfer air and outside air systems.
- C. The CONTRACTOR shall provide the services of a qualified independent TAB Agency for testing, adjusting, and balancing as described herein and include same in his bid. CONTRACTOR shall submit TAB AGENCY experience, agenda and associated credentials to PROFESSIONAL for TAB AGENCY and agenda approval.

1.02 APPLICABLE STANDARDS

- A. TAB Agency Qualifications: Current membership in AABC or NEBB.
- B. Performance Criteria: Work shall be performed in accordance with the approved TAB agenda requirements.
- C. Test Equipment Criteria: The basic instrumentation requirements and accuracy/calibration required by AABC (Section Two) or Section II of the NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
- D. A factory air test hood, recently calibrated, shall be utilized for ceiling air device CFM measurement.

1.03 APPLICABLE PUBLICATIONS

- A. The following publications form a part of this Specification to the extent indicated by the reference thereto. In text the publications are referred to by the initials of the organization.
- B. Associated Air Balance Council (AABC): National Standards for Total System Balance, 2002 Edition
- C. National Environmental Balancing Bureau (NEBB):
 - 1. Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems, 8th Edition, 2015
 - 2. Procedural Standards for Measuring Sound and Vibration, 2nd Edition, September 2006

1.04 CORRESPONDENCE

- A. Representative of TESTING, ADJUSTING and BALANCING Agency shall report to the CONTRACTOR, during all phases of the test and balance process, any deficiencies that will impair the proper balance and operation of the systems involved. This shall include, but not limited to, reporting balancing valves/dampers, controls, and safety sensors, etc. not installed as called for on the Plans or in the Specifications.
- B. The TAB Agency shall submit preliminary reports a minimum seven (7) days prior to scheduled Date of Completion for this project or any phase thereof, and including a comprehensive narrative of problems, obstacles, recommendations, and remedial actions for PROFESSIONAL'S review and approval.
- C. TAB Agency shall not release any reports to other parties until such has been approved by the PROFESSIONAL.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 GENERAL

- A. Coordinate TAB procedures with any phased construction requirements for the project so that usable increments of finished work may be accepted for beneficial occupancy. Systems serving partially occupied phases of the project may require balancing for each phase prior to final balancing and shall required separate TAB effort and reports for each phase and submittal prior to advancing to next phase of project.
- B. Allow sufficient time in construction schedule for TAB prior to substantial completion inspection for the project.
- C. Conduct final TAB after system has been completed and is in full working order. Put all HVAC systems into full operation and continue operation of the systems during each working day of TAB. Accomplish TAB in accordance with the CONTRACTOR provided Agenda approved by PROFESSIONAL.
- D. Date of Completion: Date of Completion of mechanical systems shall not be given without TAB Agency's written certification that the mechanical systems and controls have been thoroughly tested and are safely performing as intended. See certification required herein. No other certification will be acceptable.
- E. Preparation of Equipment and Systems for Testing and Balancing:
 - 1. The CONTRACTOR shall, upon completion of items or work required by this contract, thoroughly clean all dirt and debris from equipment, ducts, piping systems, strainers, accessories, etc.
 - 2. All bearings, gear boxes, wearing surfaces, or other equipment components requiring lubrication shall be properly serviced as recommended by the equipment manufacturer and shall be tagged with the date of service and type of lubricant used.

3. All specified cleaning and protective devices shall then be installed in equipment, piping, plenums, ductwork, etc., and systems shall be placed in continuous operation.
4. All fans shall have been in operation for at least twenty-four (24) hours prior to the start of testing and balancing so that initial stretch of drive belts will have taken place, and all other mechanical equipment including all temperature and operating control devices will have been adjusted and calibrated for complete and functional operating service.

F. System balancing and performance testing:

1. The CONTRACTOR shall secure copies of all report forms, data sheets, and instrumentation to be used by the agency in the performance of their services and submit the same for approval.
2. This submittal data shall include a tabulation of instruments and devices to be utilized in the performance of testing and balancing operations and shall include the name of the manufacturer of the instrument of devices, model number, range, degree of accuracy, date of last calibration, or the other pertinent information that may be required to determine the utility of the instrument of device.
3. As a minimum requirement, the following instrumentation shall be employed in the performance of balancing and testing of mechanical system: swinging vane or hot wire type anemometer, low ran (0-0.25 in. water column) inclined tube manometer, high range (0-20 in. water column) U-tube manometer, pilot tube, ammeter, volt-meter, self-timing tachometer (maximum scale Division 2 rpm) pyrometer, powered psychrometer, vibration meter, other instruments, tools, and devices as required to accurately balance and test mechanical systems and components.

G. The testing and balancing agency shall review all approved equipment, controls, specialties, and accessories, together with the design Drawings of duct systems, air distribution devices, piping systems, control diagrams, wiring diagrams, equipment schedules, specified sequences of operation, etc., for the purpose of verifying the compatibility between system design requirements and approved equipment selections. This review shall be made in sufficient time to permit revisions of equipment or components at the minimum possible expense in the event that discrepancies may be discovered.

H. It is the responsibility of this Section to make certain that all the submitted and/or existing equipment has proper motor size, sheave size, belt size, etc.

3.02 AIR BALANCE

- A. Place all interactive systems in operation with all filters installed and automatic control systems completed and operating. Artificially load air filters by partial blanking or other means to provide air pressure drop midway between the clean and dirty condition. Set/reset room thermostats and humidistat, and/or equipment controls as necessary to check heating and cooling functions, and air flow rates for air distribution devices and adjust units if not within specified tolerances.
- B. Balance systems to design ratings. Adjust fan speeds to provide design flows, including system diversities, at actual system pressures. Belt drives, including sheaves, belts, etc. shall be adjusted and/or replaced as required to safely obtain specified performance.
- C. Make pitot tube traverses of all trunk lines and major branches when required to determine proper proportioning of air flows. Airflow measuring devices, where installed, may be utilized for this purpose. Seal duct access holes with snap-in plugs.

- D. Record pressure drop readings across all major system components and significant drops within duct systems such as air filters, coils, heaters, etc.
- E. Make flow and pressure measurements at each terminal device, and each supply, return, or exhaust diffuser. Adjust each air outlet unit within plus or minus 10 percent of design requirements, but total air for each system shall be not less than shown unless otherwise approved by PROFESSIONAL. Adjust grilles and diffusers to minimize drafts in all areas. Mark permanently all damper quadrants at final set points. Total differentials between ventilation and exhaust for the purpose of proper pressurization, shall be maintained.
- F. Adjust exhaust systems to indicated CFM requirements (plus or minus 10 percent). The overall zone/building pressure shall be tested and after consultation with PROFESSIONAL, exhaust and/or ventilation capacities shall be adjusted to provide minimum 0.01" wg. and maximum 0.15" wg.
- G. Test and balance supply and exhaust to Kitchen Hood Systems, maintaining the net differential between them as required by the hood manufacturer. Balance and set dampers to equally distribute exhaust and supply along the hood length, per manufacturer's recommendations.

3.03 VIBRATION TESTING

- A. Check for excessive vibration of rotating equipment.

3.04 SOUND TESTING

- A. Check for excessive noise from equipment, air distribution devices, etc. and notify PROFESSIONAL of any objectionable noise levels. Perform noise/sound measurement and provide noise level calculations/results in rooms and areas requested by PROFESSIONAL.

3.05 DUCT LEAKAGE TESTS

- A. See Section 23 38 90 - Ductwork for duct testing requirements.

3.06 BUILDING/ZONE PRESSURIZATION

- A. The Tab Agency shall test the building pressurization and report same to PROFESSIONAL. These tests shall include various simulations between maximum and minimum ventilation capacities, to assure proper relief capability and pressurization per current ASHRAE recommendations

3.07 MINIMUM TAB DATA REQUIRED

- A. Approved TAB Agency shall furnish all labor and materials to balance the following new and/or modified equipment and systems: The following minimum information shall be provided:
- B. Fans (Exhaust and Supply):
 - 1. CFM -
 - 2. Voltage -
 - 3. F.L.A. -
 - 4. External Static Pressure -
 - 5. Size, Type, Efficiency and Relative Condition of all Air Filters -

- C. Air Handling Units: on systems scheduled to have multiple stages of heating and/or cooling capacity, or CFM requirements, provide the information for temperatures and/or airflow to indicate same for each operating condition. All information/data shall be gathered within a 90 minute period.
1. Total S/A CFM -
 2. R/A CFM -
 3. O/A CFM (Min/Max) -
 4. R/A E.A.T. - Db/Wb (Cooling) -
 5. O/A E.A.T. - Db/Wb (Cooling) -
 6. S/A L.A.T. - Db/Wb - (first stage cooling only)
 7. S/A L.A.T. - Db/Wb - (first & second stages cooling together)
 8. R/A E.A.T. - (Heating) -
 9. O/A E.A.T. (Heating) -
 10. S/A L.A.T. - (first stage heating only) -
 11. S/A L.A.T. - (first and second stages heating together) -
 12. External Static Pressure
 13. Fan RPM
 14. Fan Motor F.L.A. rated vs. actual
 15. Fan Motor Horsepower and Service Factor (belt drive units)
 16. Size, Type, Efficiency and Relative Condition of all Air Filters
 17. UVC emitter installation, caution labels, etc. -
- D. Air Terminal Units:
1. Total CFM with Air Control Valve Full Open -
 2. Minimum CFM with Air Control Valve closed to minimum position (occupied periods)
 3. Minimum CFM with Air Control Valve closed to minimum position (unoccupied periods)
 4. E.A.T. -
 5. L.A.T. (at minimum kW) -
 6. L.A.T. (at maximum kW) -
 7. GPM -
 8. Sound levels in space at maximum CFM -
- E. TAB Agency shall test and report the domestic hot water temperature at all Kitchen Area equipment and fixtures, which have hot water or "tepid" capability. Test all re-circulating potable hot water systems near the end of pump runs to ensure proper temperature. CONTRACTOR shall make any adjustments required of domestic water heaters, mixing valves, etc., in order to achieve scheduled domestic hot water temperature shown on Kitchen and Plumbing Fixture Rough-in Schedule on Contract Drawings (plus or minus 5 Deg F). The flow from re-circulating pumps through mixing/tempering valves shall be balanced to provide the minimum flow as specified by the mixing valve manufacturer for safe operation in all load conditions.
- F. Balance all S.A., E.A. and O.A. air distribution devices to within 10 percent of specified C.F.M., yet main area pressurization and differentials.
- G. Mark all flow C.F.M., balance valve set points, etc. on an 11 inches by 17 inches reduced scale set of working drawings and submit to PROFESSIONAL with TAB report prior to completion of work.
- H. Submit list of equipment with excessive vibration.

- I. Submit the Test and Balance report as indicated above, along with the working drawing to PROFESSIONAL for approval prior to completion and substantial completion inspection to job.
- J. Balance air distribution around perimeter of kitchen hood to avoid drafts. Balance fans to within plus or minus 10 percent of specified CFM and within 5 percent of differential between specified exhaust and supply make-up. Balance air to bypass (inside of hood) or vertical discharge to be plus or minus 40 percent of total, with remainder directed to hood front discharge. Provide a narrative substantiating same with TAB report. Equalize supply and exhaust along length of hood(s).
- K. Verify that all mechanical system controls, safety and shutdown interlock and sequence of operation is as specified. TAB Agency shall provide written certification that he has verified same and/or note any and all discrepancies. See paragraph 3.10 for specific certification. This shall include "Points-to-Point Check" as defined in AABC Commissioning Guideline-2005.
- L. Verify that all UVC emitters are installed in all units indicated and are operating as specified. Also verify that all caution labels are installed. Verify that all interlock switch(es) on all the access door(s) or panel(s) to the UVC Emitters are installed and turn the lights off when any of the access(es) are opened.

3.08 TAB SITE VISIT COORDINATION

- A. The TAB Agency shall inform the PROFESSIONAL, in writing seven (7) calendar days prior to his site visit for final TAB of systems such that PROFESSIONAL may be present to witness same, at PROFESSIONAL'S sole discretion. Changes to schedule shall be coordinated with and approved by PROFESSIONAL, with sufficient advance notice. TAB Agency shall be required to coordinate with PROFESSIONAL'S office representative, date of final inspection, and provide random tests and verification of TAB report information, at PROFESSIONAL'S selection.
- B. It shall also be the responsibility of the TAB agency to include the cost of any opposite season check-out of all system components which might be required and modify air distribution delivery and/or temperature to any room, area, or zone which may require adjustment during the first year of system operation.

3.09 SYSTEM CHANGES

- A. Final balancing changes shall be approved by the CONTRACTOR'S who installed the equipment. Changes may encompass, but not be restricted to, changing the pulleys, belts, dampers or adding dampers, balancing valves, etc.
- B. The TAB Agency shall coordinate with the CONTRACTOR any changes required including belts, sheaves, etc. to balance systems within specified tolerances. All cost of any modifications are the responsibility of the CONTRACTOR.

3.10 VERIFICATION / INSPECTION

- A. After the final TAB report is submitted and reviewed by the PROFESSIONAL, he will soon afterward schedule a verification inspection with the TAB Agency. At this inspection, the TAB Agency will test airflow flows, water flows, sound levels, control operation and sequence, for random air distribution grilles, fans, AHU's, equipment, piping, etc., as selected by PROFESSIONAL.

- B. This inspection will last no longer than four (4) hours for each completed phase of the project. Should this verification information exceed the specified tolerance, the TAB Agency may be required to retest and balance the entire system(s) to these tolerances, solely at the PROFESSIONAL's discretion. A follow-up verification inspection shall then be required, and the procedure will begin again. The cost of these inspections, re-inspections, TAB and reports shall be borne by the CONTRACTOR.

3.11 CERTIFICATION

- A. The TAB Agency shall provide the following written TAB certification within the final TAB report (see also Section Mechanical Submittals and Shop Drawings):
 - 1. "The Testing, Adjusting and Balancing (TAB) Agency certifies that the HVAC air and plumbing water systems and controls have had a full range of tests and checks carried out by the TAB Agency, to determine if all components, sub-systems, systems and interfaces between systems operate in accordance with the Contract Documents. This includes all modes and sequences of control operation, interlocks and conditional and specified control responses to abnormal, safety and emergency conditions. The (TAB) Agency had provided to the OWNER the specified training and documentation on the operation of these systems such that these systems can be safely and efficiently operated in line with design requirements."

3.12 SYSTEM DATA TRENDING

- A. The TAB Agency shall coordinate with the CONTRACTOR to provide trend log data required by Section Packaged Ventilation Equipment.
- B. The TAB Agency shall provide at each site, a miniature, battery powered, stand-alone humidity and temperature data recorder equal to Dickson Temperature & Humidity Data Logger TP120, which shall capable of recording trending data for a minimum period of 14 days. Data shall be downloaded to a personal computer and output in a transmittable form.
 - 1. Trend logs of pertinent on-going unit and zone hourly temperature and humidity history shall be transmitted to PROFESSIONAL beginning two (2) weeks prior to scheduled substantial completion for any phase, and initially continuing until thirty (30) days after OWNER'S final acceptance of project. The CONTRACTOR shall continue to provide trend log data to PROFESSIONAL, beyond this period, as requested, when system(s) fails to perform consistently and satisfactorily as indicated. The following minimal information shall be included on these trend logs and recorded once every hour:
 - a. Time/Date.
 - b. Indoor space temperature (Deg F).
 - c. Indoor relative humidity level (percent RH).
 - d. Outdoor space temperature (Deg F).
 - e. Outdoor relative humidity level (percent RH).
 - 2. The above referenced data shall be submitted to PROFESSIONAL in hardcopy form and including system number and site name with information as a line item recorded hourly.
 - 3. The cost and coordination of this requirement is be solely borne by the CONTRACTOR. The location of sensor(s) are to be coordinated with the PROFESSIONAL.

3.13 OWNER TRAINING REQUIREMENTS AND INVOLVEMENT

- A. See Section 23 00 40 - Mechanical Close-out Requirements for Owner Training requirements.

END OF SECTION

SECTION 23 20 60

MECHANICAL PIPES AND PIPE FITTINGS

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material, equipment and labor, etc., required to complete installation specified and/or shown or scheduled on Contract Drawings.
- B. Work included: Pipes, fittings, unions, couplings, flanges, gaskets, and other materials and instructions.

1.02 PIPING SCHEDULE

- A. Piping systems for this project shall include the following:
 - 1. Condensate Drain Piping.
 - 2. HVAC Piping

1.03 MANUFACTURER'S ASSISTANCE

- A. Manufacturer shall provide, if required, to the CONTRACTOR a factory trained service man to properly train CONTRACTOR'S personnel in all phases of installation.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. All piping installed on this project shall be new and of full weight and size indicated and of proper specification for service intended. Only domestic pipe may be used. Pipe and pipe fittings for the various systems shall be as follows:
- B. Condensate Drain Piping:
 - 1. Condensate drain piping routed indoors shall be type "L" hard drawn copper.
 - 2. Piping in R/A plenum space shall be galvanized steel, type "L" hard drawn copper, cast iron, or flame retardant polypropylene.
 - 3. Piping exposed outside of building shall be Schedule 40 galvanized steel with threaded joints and fittings, or Schedule 40 PVC with solvent weld joints and fittings, paying close attention to spacing of piping supports in Section Supports and Anchors.

C. HVAC and Service Piping:

1. 2 inches and smaller HVAC piping inside building shall be type "L" hard copper with 95/5 soldered joints/fittings.
2. 2-1/2 inches and larger HVAC piping inside building shall be Schedule 40 ASTM A53 steel pipe with welded joints and flanges at all valves, specialties, etc. or mechanical roll grooved joints and fittings as Victaulic.
3. "T-drill", "pulled" taps/outlets or weld-o-let/saddle taps shall NOT be utilized, only full body fittings will be allowed.
4. At CONTRACTOR's option, 4 inches and smaller HVAC piping may be Type "L" hard copper with specialty piping system connections such as "ProPress" by Viega or approved equal.
5. At building entrance, from outside building to above finished floor piping shall be stainless steel without joints. Riser shall be equal to Ames IBR.

2.02 PIPE FITTINGS, UNIONS, FLANGES, AND GASKETS

- A. All fittings shall conform to pipe as to black steel, galvanized steel, copper, PVC or cast iron, etc. or as indicated. Fittings and accessories shall have equal or greater pressure rating than piping specified for particular application.
- B. Malleable steel fittings shall be minimum 150 psi class.
- C. Steel pipe unions shall be malleable iron having bronze-to-iron ground joints.
- D. Steel nipples shall be extra heavy type. All thread nipples prohibited. Provide a minimum of 1 inch of bare pipe between threaded ends of nipples.
- E. Flange bolts: Galvanized Alloy steel, ASTM #A-196, Galvanized GR. B-7; nuts' ASTM-#s-194, GR. 2-H; both hex head style.
- F. Flange gaskets serving piping below 250 degrees F shall be synthetic composition type; serving above 250 degrees F gaskets shall be corrugated metallic type. Utilize gasket suitable for service intended.
- G. Couplings, steel pipe malleable iron, Grade II.
- H. Provide factory made reducers and increasers, and nipples of comparable materials as the piping. The use of bushings is not acceptable to obtain reduction or increase in sizes.
- I. Galvanized steel pipe shall be assembled with galvanized screw fittings unless specifically indicated otherwise.

2.03 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, degree F: 210 for water systems.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

A. General:

1. Arrange and install piping approximately as indicated, straight, plumb and as direct as possible; form right angles or parallel lines with building walls. Keep pipes close to walls, partitions, ceilings, offset only where necessary to follow walls as directed. Locate groups of pipes parallel to each other; space them at distance to permit applying full insulation and to permit access for servicing valves. The PROFESSIONAL reserves the right to require this CONTRACTOR to make minor changes in pipe locations where conflicts occur with other trades or equipment. Such changes shall be made without extra cost to OWNER.
2. Install horizontal piping as high as possible without sags or humps. Grade drainage piping at uniform slope of 1/8" per foot minimum and maximum 1/4" per foot, or as noted. Where this is impossible, maintain slope as directed, but in no case less than 1/16 inch per foot. Pitch piping in direction of flow.
3. When piping is cut, it shall be reamed with pipe reamer and all burrs, scale, trash and foreign matter removed. If any piping is found installed without being reamed, cleaned, deburred, etc., or in any way contrary to above, it shall be sufficient reason for related erected piping to be removed, inspected by the PROFESSIONAL, corrected and reinstalled, all at CONTRACTOR'S expense.
4. Where size changes on horizontal lines, use reducing fittings; bushings are prohibited. On liquid lines have eccentricity down, hold the top level. On gas or vapor lines have eccentricity up, hold the bottom level.
5. Sufficient space shall be allowed in erecting piping for proper application of thermal installations including fittings. In no case shall any insulation be cut or reduced thickness because of inadequate space.
6. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping.
7. Locate valves for easy access and operation. Concealed valves shall be provided access doors. Do not locate any valves with stems below horizontal.
8. Install gauges, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gauges to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
9. Furnish and install unions or mating flanges at all connections to each piece of equipment conveniently located to facilitate quick and easy disconnecting of equipment. Flanges or union connections shall be used on both sides of traps, control valves, pressure reducing valves and meters and the like.
10. Steam piping shall be run utilizing eccentric reducers with the bottom installed flat.

B. Steel Piping:

1. Where piping is threaded, dies shall be clean and sharp. Threads shall conform to ANSI B2.1; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads or steel pipe with joint compound and red lead paint for corrosion protection. The caulking of these joints will not be tolerated. Pipe joint compound must be approved by the PROFESSIONAL.
2. Where welding is specified or done, it shall be by electric arc by mechanics skilled in operation and holding a test certificate acceptable to the ENGINEER. All scale and flux shall be removed from piping after welding. Welding, beveling, spacing and other details shall conform to ANSI B31.1.

C. Copper Piping:

1. Copper tubing shall be thoroughly reamed, cleaned with steel wool or emery cloth and a non-corrosive flux used before soldering or brazing.
2. Copper tubing shall be thoroughly reamed and deburred before joining with specialty piping systems such as Viega "Pro-Press" or approved equal.
3. Where solder joints are specified, use solder having 95 percent tin and 5 percent antimony. Each roll of solder shall be clearly stamped as to grade and content.
4. Where brazing joints are specified, use a brazing filler metals having a melting point above 1100 degrees F and containing at least 5% silver.
5. Where copper tubing extends through concrete slab on grade, tubing shall have an "Armaflex" or "Rubatex" type.
6. Provide PVC isolation wrap where copper pipe extends through masonry walls to connect plumbing fixtures or valves, etc.

3.02 PIPE EXPANSION

- A. In the installation of all pipe runs where shown or where necessary, install swing joints, flexible couplings, turns, expansion loop or long offsets to allow for expansion. Broken pipe or fittings due to rigid connections must be removed and replaced at no additional cost to the OWNER.
- B. All lines shall be securely anchored where required. Where such anchors occur, they shall be securely fastened to the steel or concrete structure of the building in a manner approved by the PROFESSIONAL. Drawings shall be submitted before installation.

3.03 TESTS

A. Cooperation/Scheduling:

1. The ARCHITECT shall be notified no less than ninety-six (96) hours prior to any pipe test. The ARCHITECT shall also be notified in adequate time for an inspection of the test before the test is completed. The PRIME CONTRACTOR'S Superintendent shall be responsible for administering and witnessing all tests, log it for permanent record and transmit to ARCHITECT at completion of project. The PRIME CONTRACTOR'S Superintendent shall keep this on-going log on jobsite and shall include the following:
 - a. Date of Test
 - b. Duct/Piping Description (EX: "Sanitary Sewer")
 - c. Location (EX: "Northwest Quadrant First Level")
 - d. Results (EX: "Held 10 ft. of head for eight hours without leakage", etc.)
 - e. Contractor's/Superintendent's Witness Initials

B. Tests shall be as follows: (New and Existing Modified Piping shall be tested and all leaks repaired):

1. Gravity Flow Condensate Drain piping above and below slab: Minimum 10 feet static head and as required by ASA-A40.8 or local code, for a minimum period of four (4) hours, without discernible loss. All below grade piping and joints shall be clearly visible during test.
2. Refrigerant piping: 450 psig nitrogen for 8 hour period. Test piping with all piping accessories such as charging valves and filter/driers in place, unless not recommended by equipment manufacturer's installation instructions. Refrigerant piping shall be left with minimum 60 psi pressure during all phases of construction such that leaks can be promptly identified and remedied.

3. Chilled and Heating Water piping: 1.5 times maximum operating pressure for 8 hour period. Test piping with all piping accessories such as valves and filter/driers in place, unless not recommended by equipment manufacturer's installation instructions. Refrigerant piping shall be left with minimum 60 psi pressure during all phases of construction such that leaks can be promptly identified and remedied.

3.04 SYSTEM CLEANING, TREATMENT AND PROTECTION

A. All HVAC piping systems shall be cleaned as follows:

1. All piping shall be cleaned of iron cutting and other debris as installed into the system. Piping received with heavy mill scale shall not be installed in the system. Particular attention shall be given to coils, valve seats and glands, pump mechanical seals and packing glands, strainers, etc., such that surfaces are clean and free of all foreign materials.
2. At completion of the piping hook-up, after pressure tests and prior to operation of any equipment, the CONTRACTOR shall thoroughly flush the piping system with clean water to remove any debris remaining in piping.
 - a. Initial Flushing: Remove loose dirt, and scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Bypass factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any components, which may be damaged. Open all valves, drains, vents, and strainers at all system levels.
 - b. Remove plugs, caps, spool pieces, and components to facilitate early debris carrying velocity of 6 feet per second, if possible.
 - c. Connect dead end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and CONTRACTOR'S booster pumps. Flush until clean as approved by the PROFESSIONAL.
3. After the system has been thoroughly flushed with clean water, the system shall be filled and vented with clean water and a sufficient concentration of Anderson Chemical Company's detergent type system cleanser. Circulation shall be provided by the installed circulating pumps. System shall then be circulated for not less than 24 hours. During circulation of detergent, 2-way valves, etc., shall be operated such that solution shall reach all branches, bypasses, etc. After 24 hours detergent cleaning, system shall be drained and flushed with clean water until all detergent has been removed and water runs clear. Strainers shall be checked and cleaned.
 - a. System shall then be filled with clear water, vented and pressurized such that 4 psig is obtained at the highest point of the system.
4. Cleaning: Using products specified in Section Pipe and Pipe Fittings, circulate systems as normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by initial flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead end debris accumulation cannot occur. Sectionalize system is possible, to circulate at velocities not less than 6 feet per second. Circulate each section for not less than 24 hours. Blow down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.

END OF SECTION

SECTION 23 21 00

MECHANICAL VALVES

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material, equipment and labor, etc., required to complete installation as specified herein and/or shown or scheduled on Contract Drawings.

1.02 APPLICABLE STANDARDS

- A. Insofar as possible, all valves of the same type shall be of the same manufacturer.

1.03 VALVE DESCRIPTION AND IDENTIFICATION

- A. Valves shall have name or trademark of manufacturer and working pressure cast or stamped on valve body.
- B. Valve hand wheels shall be oriented when installed to provide maximum accessibility for operation.
- C. Valve discs shall be the manufacturer's standard material for the service in which the valve is used unless otherwise indicated under the individual type valve specification.

PART 2 - PRODUCTS (OTHER VALVES FROM THOSE LISTED MAY BE SUBMITTED FOR APPROVAL)

2.01 HVAC PIPING VALVES

- A. Ball Valves: (Utilized for all shutoff and isolation valves in 2 inches and smaller applications unless otherwise indicated):
 - 1. Valves 2 inches and smaller shall be two-piece brass or stainless steel construction, 1-1/4 inch extended neck, chrome plated ball with full port, P.T.F.E. seals and seats. Heavy duty steel handle with vinyl grip, quarter turn operation. Valves shall have solder end connections. Valves shall be suitable for working pressure of 200 psig and maximum 250 Deg F.
 - 2. Provide with extended operating handle of non-thermal conductive material where installed in insulated piping. Extension shall be of sufficient length to operate valve without interfering with insulation.
- B. Butterfly Valves 2-1/2 inches to 12 inches:
 - 1. Manual Operation Type:
 - a. Lug type with cast iron body, one piece stainless steel stem, with aluminum bronze disc. Valve shall be suitable for constant 200 psi positive shut-off and 225 degrees F temperature application. The valve liner design shall be such that it shall serve as a flange seal and no separate gasket shall be required. Provide valve with replaceable EPDM seat.
 - b. Provide gear operators with hand wheel on all HVAC piping 6" and larger when located within 6 feet of standing access height.
 - c. Provide gear operators with adjustable sprocket rim and chain on all HVAC piping 6" and larger when located more than 6 feet above standing access height. Chain length shall be provided to allow operation of valve at standing access height.

2. Automated Operation Type:
 - a. Lug type with cast iron body, one piece stainless steel stem, with aluminum bronze disc. Valve shall be suitable for constant 100 psi positive shut-off and 225 degrees F temperature application. The valve liner design shall be such that it shall serve as a flange seal and no separate gasket shall be required. Provide valve with replaceable EPDM seat.
 - b. All motorized valves shall have spring return feature upon loss of power.
 - c. Provide feedback position indicator and control voltage as required for sequence of operation in Section Controls and Instrumentation.
 - d. Valves shall be of either two-way or three-way design as indicated on Drawings.
 3. Valves shall be equal to the following:
 - a. Manual Operation Type
 - 1) 4 inches and smaller – Equal to Nibco LD2000
 - 2) 6 inches and larger – Equal to Nibco LD2000-5 with memory stop and adjustable sprocket rim and chain where access is above 6 feet standing height.
 - b. Motorized butterfly – Equal to Valve Teck BF Series 42
 4. Provide with extended neck where installed in insulated piping. Extension shall be of sufficient length to operate valve without interfering with insulation.
- C. Silent Check Valves:
1. Silent check valves 2 inches and smaller shall be horizontal or vertical silent spring check type. Valves shall be rated for 200 lbs. WOG. Valves shall be NSF 61 compliant and contain less than 0.25 percent lead (Pb) by weight.
 2. Silent check valves 2-1/2 inches and larger shall be iron body, 125 lb flanged connection ends, stainless steel spring, bronze trim, 200 psig working pressure, globe style valve body. Valves shall be equal to Mueller model 105MAP.
- D. Balancing Valves:
1. Automatic Balancing Flow Restrictor Type:
 - a. Combination balancing, flow control and positive shut-off valves shall incorporate a stainless steel spring and plunger loaded flow control device to automatically provide flow setpoint within plus or minus 5 percent with a wide range of system pressure range fluctuation. Provide factory assembled packages with all devices connected to a common piping arrangement for simple two-point piping connection to each assembly. Water pressure drop through entire flow restrictor/shut-off valve assembly shall not exceed 5 feet.
 - 1) Valve shall be equal to Griswold PIC-V. Provide supply connection with full port ball valve, with 1-1/4 inch extended handle, two (2) P/T extended ports with union end connections. Provide flow restrictor cartridge and metal I.D. tag assembly.
 - b. All shut-off valves, strainers and flow control assemblies shall be pipe size (not necessarily control valve size) as indicated on Drawings to each unit. Balancing valve assemblies, with flow restrictor, shut-off valves and P/T ports, shall be factory assembled as a single unit for ease of field installation. See detail on Drawings.
 - c. Provide all supply and return connections to water source heat pump coils with 12 inches long full pipe size stainless steel flexible hose sets, rated for minimum 250 psi.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation shall be such that the valve can be fully opened and have at least 6 inches clearance beyond valve stem handle and sufficient clearance to remove stem for repair.
- B. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the Drawings. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.

3.02 DISCHARGE FROM SAFETY AND/OR RELIEF VALVES

- A. Relief valves relieving steam, gas of any type, including compressed air, or liquid above 120 degrees F., shall be piped full size to outside building or as indicated so that discharge cannot hit any person or structure.

3.03 RELIEF VALVE CAPACITY

- A. Valve relieving capacity shall meet all code requirements and also be equal to at least 1.25 of possible heat input to be relieved.

END OF SECTION

SECTION 23 21 20

MECHANICAL PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all labor, equipment, materials, etc., required to complete installation as specified herein and/or shown or scheduled on Contract Drawings.
- B. Work Included: Piping specialties to connect fire protection and plumbing equipment.

PART 2 - PRODUCTS

2.01 THERMOMETERS

- A. Light powered, liquid crystal display, °F or °C selector switch and 6-inch brass stem with adjustable angle as required to read display from eyelevel.
- B. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.
- C. Equal to Weiss Instruments, Inc "Digital Vari-angle" or Weksler "AAD" series.
- D. Provide all thermometers located outdoors with waterproof cover equal to Weiss DVC-4.

2.02 AIR VENTS

- A. Air vents shall be installed where shown on Drawings and/or on all high points of liquid piping mains to insure complete elimination of air. Air vents shall be Crane Company, Sarco, or approved equal. Air vents on top of main risers shall have the capacity to eliminate at least 12 CFM of air when operating at 20 psi. Other air vents shall have capacity to eliminate at least 3 CFM of air when operating at 20 psi.
- B. Automatic air vents shall be equal to Spirotherm model Spirotop VTP.
- C. Wherever vents are installed over finished floors or ceilings, an emergency overflow connection to outside or to nearest accessible drain shall be provided. This drain shall be type "L" copper tubing.
- D. Provide air vents on liquid lines at top connection to coils and where shown. Provide manual 1/4 inch brass cock where vent point is concealed.

2.03 STRAINERS (Y OR BASKET TYPE)

- A. Circulating Liquid Services: Rated 125 PSIG saturated steam.
 - 1. 2-1/2 inch and larger: Flanged, iron body.
 - 2. 2-inch and smaller: Cast iron or bronze.
- B. Screens: Bronze, metal mesh or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows:
 - 1. Liquid service: 0.045 inch diameter perforations.
 - 2. On unit 4 inches and larger provide manufacturers standard Gusset plate and control rod, retaining ring and mating flange.

- C. Suction Diffusers: Specified in Section HVAC Pumps.
 - 1. 2-inch and smaller: Iron, ASTM A116 Grade B, or bronze, ASTM B-62 body with screwed connections.
- D. Provide valved blow down on all strainers, minimum 3/4 inch size, with capped hose thread end connection unless otherwise noted.

2.04 EXPANSION LOOPS

- A. See Drawings for models and sizes required.

2.05 WATER FLOW MEASURING DEVICES (REQUIRED AT ALL FLOOR MOUNTED HVAC PUMPS, BOILER AND WHERE SHOWN ON BRANCH CONDENSER WATER MAINS ON DRAWINGS)

- A. Minimum overall accuracy plus or minus two percent over a range of 70 to 110 percent of design flow. Select devices for not less than 110 percent of design flow rate. Maximum pressure drop of water flow measuring device shall be four (4) feet head at design flow thru pipe size indicated.
- B. Venturi Type: Bronze, cast steel, or cast iron with bronze throat, with valved pressure sensing taps upstream and at the throat. Gerand style VW-For as approved.
- C. Flow Measuring Device Identification:
 - 1. Metal tag attached by chain to the device.
 - 2. Include meter or equipment number, manufacturer's name, meter model, flow rate factor and design flow rate in gpm.

2.06 PRESSURE GAUGE

- A. 4-1/2" Dial Size, aluminum casing, 316 stainless steel bourdon tube and socket, 0-100 psi range.
- B. Extension neck to clear pipe insulation.
- C. Equal to Weksler AY24

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All equipment shall be installed as per manufacturer's recommendation and applicable codes and standards. Provide appurtenances as required for a complete system. Provide all appurtenances as indicated on Contract Drawings, where specified or not.

END OF SECTION

SECTION 23 38 90

DUCTWORK

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material, equipment and labor, etc., required including all supply, return, outside air, exhaust, and other ductwork and as required for the A/C system, including mains, branches, plenums, mixing boxes, fittings, accessories, and other related sheet metal work for a complete installation as specified herein and/or shown on Drawings.
- B. Work under this Section includes but is not necessarily limited to the following items: Ductwork for heating, ventilating and air conditioning systems.
- C. Construct ductwork to meet all functional criteria defined in the SMACNA "HVAC Duct construction Standards - Metal and Flexible" Latest Edition. This shall be subsequently referred to as the SMACNA Manual.

1.02 APPLICABLE STANDARDS

- A. APPLICABLE PUBLICATIONS: The publications listed below form a part of this Specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. National Fire Protection Association (NFPA):
 - 1. 90A.....Air Conditioning and Ventilating Systems - Latest Edition
 - 2. 90B..... Warm Air Heating and Air-Conditioning Systems - Latest Edition
 - 3. 96.....Vapor Removal From Cooking Equipment - Latest Edition
- C. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
 - 1. Low Pressure Duct Construction Standards - Latest Edition
 - 2. Guidelines for Welding Sheet Metal - Latest Edition
 - 3. Duct Liner Application Standard - Latest Edition

1.03 DEFINITIONS

- A. Seal or Sealing: Use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.
- B. Exposed Duct: Exposed to view in a finished room or outdoors.

1.04 QUALITY ASSURANCE

- A. The CONTRACTOR must comply with the enclosed specification in its entirety.
- B. At the discretion of the PROFESSIONAL, sheet metal gauges, reinforcing and sealant may be checked at various times during the construction period to verify all duct construction is in compliance.
- C. If during site observations the PROFESSIONAL finds changes have been made without prior approval, the CONTRACTOR will correct deficiencies identified to comply with this specification solely at the CONTRACTOR's expense.

- D. Duct penetrations and/or doors, etc., necessary for the PROFESSIONAL to observe the duct installations, shall be made/installed and repaired, etc. by this CONTRACTOR, in ductwork as selected by PROFESSIONAL, at no additional cost to the OWNER or PROFESSIONAL.
- E. All ductwork shall be installed un-insulated (except duct liner), subsequently sealed and observed/approved by PROFESSIONAL prior to insulating.

PART 2 - PRODUCTS

2.01 DUCTWORK PRESSURE CLASS CONSTRUCTION REQUIREMENTS

- A. Ductwork shall be constructed to meet or exceed the SMACNA Standards based upon the following table of ductwork type and function.

<u>DUCTWORK FUNCTION</u>	<u>DUCTWORK TYPE</u>	<u>DUCTWORK PRESSURE CLASS (IN. W.G.)</u>
Low Pressure Supply Air	Rectangular	2 (pos.)
Low Pressure Supply Air	Round or Oval	1 (pos.)
Low Pressure Return Air	Rectangular	2 (neg.)
Low Pressure Return Air	Round or Oval	1 (neg.)
Low Pressure Exhaust Air	Rectangular	2 (neg.)
Low Pressure Exhaust Air	Round or Oval	1 (neg.)
Low Pressure Outside Air	Rectangular	2 (pos. or neg.)
Low Pressure Outside Air	Round or Oval	1 (pos. or neg.)
Low Pressure Transfer Air	Rectangular	2 (pos. or neg.)
Low Pressure Transfer Air	Round or Oval	1 (pos. or neg.)
Kitchen Hood and Dishwasher Exhaust	Rectangular	2 (neg.)
Kitchen Hood and Dishwasher Exhaust	Round or Oval	2 (neg.)
Medium Pressure Supply Air	Rectangular	4 (pos.)
Medium Pressure Supply Air	Round or Oval	4 (pos.)
Medium Pressure Outside Air	Rectangular	4 (pos.)
Medium Pressure Outside Air	Round or Oval	4 (pos.)

- B. Ductwork with the type not specifically indicated on Drawings shall be constructed to 2 inch w.g. unless upstream of terminal units (variable air volume boxes) which shall be constructed to 4 inch w.g.

2.02 RECTANGULAR DUCTWORK

A. General Requirements

1. Construct all rectangular ductwork with approved new prime G-90 or better galvanized steel sheet ASTM S27 (LFQ) with chemical treatment or as specified, with careful, neat, and accurate workmanship and with all joints and seams air tight. Longitudinal seams, transverse joints and bracing, sheet metal gauges and other construction details shall be as recommended in the latest edition of the ASHRAE Guide and SMACNA "HVAC Duct Construction Standards - Metal and Flexible", and as specified below.
2. **The rectangular duct sizes as indicated on the Drawings are inside dimensions, or net free area.** All necessary allowances should be made in the sizes shown on the Drawings to accommodate internal insulation or acoustic lining.

3. All ductwork shall be provided with any re-enforcements factory installed to meet the SMACNA pressure classifications listed in paragraph 2.01.
4. Transitions shall have a ratio of at least 4 to 1 except where prevented by job conditions. In such case the transition shall be made as gradual as possible.
5. All duct transitions from square to round shall be smooth square-to-round transitions. Spin-in fittings at the end of capped ducts are not acceptable.
6. Flanged (TDC or TDF) ductwork with reinforced gasketed joints shall be installed in the following applications:
 - a. Indoor ductwork with any dimension greater than 30 inches.
 - b. All indoor ductwork exposed to view regardless of size.
 - c. All outdoor ductwork regardless of size.
 - d. All indoor medium pressure ductwork regardless of size.
7. Rectangular ductwork exposed to weather shall be crowned to shed water.

B. Low Pressure Ductwork:

1. Elbows shall be either mitered or radius type for 90 degree turns and radius only for all turns less than 90 degrees as indicated on the Drawings.
2. Mitered elbows shall be constructed using turning vanes in each mitered 90 degree turn. Turning vanes shall be galvanized steel of double-wall air foil design. Where ductwork is greater than or equal to 12" in the plane of the turn, install turning vanes with 4" minimum radius of curvature on a maximum of 4" centers. Where ductwork less than 12" in the plane of the turn, install turning vanes with 2" minimum radius of curvature on a maximum of 2" centers.
3. Curved elbows shall have a centerline radius of 1-1/2 times the cross sectional dimension of the duct in the plane of the turn.
4. All rectangular branch connections to rectangular ducts shall be a lateral or radius type and include an externally adjustable factory fabricated air turning vane assembly. Where lateral types are installed, the length of the lateral shall be equal to one quarter of the duct width but in no case less than 4". Where radius types are installed, the centerline radius shall be 1-1/2 times the branch duct dimension in the plane of the turn.

C. Medium Pressure Ductwork:

1. Elbows shall be radius type only. Mitered elbows are strictly prohibited.
2. Each curved elbow in rectangular ductwork shall have a centerline radius of 1-1/2 times the cross sectional dimension of the duct in the plane of the turn.
3. All rectangular branch connections to rectangular ducts shall be a rectangular radius type with a centerline radius of 1-1/2 times the branch duct dimension in the plane of the turn.

2.03 SPIRAL DUCTWORK

A. General Requirements:

1. Provide all ductwork as indicated Drawings.
2. All ductwork shall be provided with any re-enforcements factory installed to meet the SMACNA pressure classifications listed in paragraph 2.01.
3. All exposed to view ductwork indicated to be painted shall include a factory paint grip finish.
4. Galvanized areas that have been damaged by welding shall be coated with corrosion resistant paint.

5. All duct and fittings shall be manufactured by the same company. Said company shall have been in the business of manufacturing spiral ductwork for at least ten years.
6. Manufacturer shall furnish ENGINEER certified copies of test data made by an independent laboratory covering all pipe and fittings.

B. Single Wall Circular and/or Flat Oval Type:

1. Spiral pipe shall have locked seams so made as to eliminate any leakage under the pressures for which the system shall be subjected.
2. Longitudinal seam duct shall have a fusion welded butt seam.
3. All fittings shall have continuous welds along all seams. All divided flow fittings shall be manufactured as separate fittings, not as tap collars welded into spiral duct sections.
4. Transitions shall have a ratio of at least 4 to 1 except where prevented by job conditions. In such case the transition shall be made as gradual as possible.
5. Elbows shall be fabricated to a center-line radius of 1.5 times the cross-section diameter. Elbows in diameters 3 inches through 12 inches shall be die stamped true radius type. All other elbows shall be gored construction with all seams continuously welded.
6. All 90 degree tees and 45 degree laterals shall have a radius entrance into the tap, produced by machine or press forming. The entrance shall be free of weld build-up, burrs or irregularities.
7. Pipe to pipe and pipe to fitting joints shall be by the use of fully welded angle/flanged connections. Bolt hole spacing for angle rings shall not exceed 6-inches. Neoprene gaskets or other suitable sealant shall be employed in the joining method.

C. Insulated Double Wall Circular and/or Flat Oval type:

1. The outer pressure sheet and the inner liner shall be manufactured from galvanized steel meeting ASTM A-527-67, separated by spaces.
2. The inner liner of all ductwork and fittings shall be perforated.
3. The construction is to include minimum insulation sandwiched between outer shell and inner liner to provide a thermal conductivity "K" factor of 0.27B/HR/sq.ft./in./degrees F. at 75 degrees mean temperature.
4. The construction shall have means to maintain positive concentricity of liner with shell and mechanical means to retain insulation against dislocation by assembly process. Adhesives of any type are prohibited unless the flame spread, smoke developed and sound attenuation tests were performed with the adhesives as used.
5. The insulation shall include a matte face to provide positive protection against the possibility of fiber entrainment and microorganism growth with independent test lab certification of compliance with ASTM G21 and G22.
6. Spacers shall be included between inner and outer sheetmetal members to prevent liner insulation compression.
7. Outer wall construction shall meet or exceed all of the requirements listed herein for single wall round oval ductwork.

2.04 FLEXIBLE AIR DUCTWORK

- A. Insulated Flexible Air Duct: Factory made including mineral fiber insulation with maximum C factor of 0.16 (R=6) at 75 degrees F. mean temperature, encased with a low permeability moisture barrier metalized outer jacket, having a puncture resistance of not less than 50 Beach Units,. Acoustic insertion loss shall be not less than 3db per foot of straight duct, at 500 Hz, based on 6-inch duct, air velocity at 2500 fpm.

- B. Flexible ducts shall be listed by Underwriters Laboratories, Inc., complying with UL 181. Ducts larger than 8-inches diameter shall be Class 1. Ducts 8-inches in diameter and smaller may be Class 1 or Class 2.
- C. Minimum working pressure for low and medium pressure systems: 6-inches w.g. positive, 2-inches w.g. negative.
- D. Duct Clamps:
 - 1. Stainless steel strap with cadmium plated worm gear tightening device.
 - 2. Nylon tie wrap minimum 1/4 inch wide.

2.05 FLEXIBLE DUCTWORK ELBOW SUPPORTS

- A. Elbow supports shall be constructed of durable composite material and be fully adjustable to support flexible duct diameters 6 inches through 16 inches. Elbow supports shall be UL listed for use in return air plenum spaces. Flexible ductwork elbow supports equal to Thermaflex FlexFlow Elbow.

2.06 JOINT SEALING

- A. Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread and 50 smoke developed (dry state) compounded specifically for sealing ductwork. Use products as recommended by the manufacturer for low, medium or high-pressure metal duct systems.
- B. Tape/Gaskets in flanged joints such as TDC or TDF: Soft butyl rubber/elastomeric composition equal to Sticky Tape manufactured by Ductmate.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with provisions of Section, BASIC MECHANICAL MATERIALS AND METHODS, particularly regarding coordination with other trades.
- B. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards and manufacturer's printed instructions.
- C. Fabricate ductwork based on field measurements of space available. Sizes on plans may be altered by the CONTRACTOR, when approved by the ENGINEER, to other dimensions without increasing air pressure friction losses where necessary to avoid interferences and clearance difficulties.
- D. All ductwork located outdoors shall be sealed water tight on all seams and connections.
- E. Provide duct transitions, offsets and connections to dampers, coils, and other equipment.
- F. Weld sheet metal in accordance with SMACNA, Guidelines for Welding Sheet Metal. Repair damaged galvanized areas with galvanizing repair compound.
- G. Each collar for outlet and intake devices on exposed ducts shall be flanged inward at the device mounting end, and the outside dimensions of the collar shall not be less than the overall flange dimensions of the devices attached thereto.

- H. At each location where exposed ductwork passes through finished walls, floors, or ceiling, install a neat sheet metal collar completely covering the rough opening in the building construction secured to ductwork with sheet metal screws.
- I. Provide UL approved flexible connectors per Section Mechanical Sound and Vibration Control.
- J. Construct casings, eliminators, and pipe penetrations in accordance with applicable SMACNA Standards. Design casing access doors to swing against air pressure so the pressure helps to maintain a tight seal.
- K. Install fire, smoke and combination fire/smoke dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test.
- L. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, or items and other installations above the ceiling through plenum grilles, paint the inside of the duct or above ceiling installations, with flat black paint to reduce visibility.
- M. Protection and Cleaning:
 - 1. Adequately protect ductwork and equipment against physical damage and entry of foreign matter to the inside at all times both prior to and after installation into project.
 - 2. Cap open ends of ducts and equipment when not in operation.
 - 3. Clean ductwork and equipment prior to painting. See PAINTING section for specific requirements pertaining to surface preparation.
 - 4. Both the inside and outside of all ductwork and equipment shall be clean and free of dust, debris, foreign material, etc. prior to final acceptance of the project.
 - 5. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.
 - 6. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by PROFESSIONAL.
- N. Control Damper Installation:
 - 1. Provide necessary transitions required to install dampers which do not match the duct size indicated.
 - 2. Assemble multiple section dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
 - 3. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.

3.02 SPIRAL DUCTWORK

- A. Spun bell mouth connections shall be installed at each round take-off from rectangular ductwork and/or plenums.
- B. Duct sealer shall be applied to the male end of the couplings and fittings. After the joint is slipped together, sheet metal screws shall be placed 1/2-inch from the joint head for mechanical strength. Sealer shall be applied to the outside of joint extending 3" on each side of the joint head and covering the screw heads.

3.03 FLEXIBLE AIR DUCTWORK

- A. Flexible ducts shall be installed with stainless steel strap or nylon tie wraps with sealant and as approved for UL 181, Class 1 installation. A "tightening gun" shall be utilized when installing nylon tie wraps.
- B. Flexible ducts shall not penetrate any wall, floor, partition or ceiling.
- C. Flexible duct shall be installed in continuous single pieces not over five (5') feet long, as straight and short as feasible, adequately supported.
- D. Centerline radius of bends shall be not less than two duct diameters.
- E. Flexible ductwork shall be suspended on 36" centers with a minimum 1-1/4-inch wide flat banding material.

3.04 NON-FIBROUS, CLOSED CELL, OUTDOOR DUCTWORK

- A. Ducts shall be detailed and fully factory manufactured.
- B. Fabricated joints, seams, transitions, reinforcement, elbows, branch connections, access doors and panels, and damage repairs shall be according to manufacturer's written and detailed instructions.
- C. Fabricated 90-degree mitered elbows shall include turning vanes.
- D. Fabricated duct segments shall be in accordance with manufacturer's written details.
- E. Duct Fittings shall include 6 inches of connecting material, as measured, from last bend line to the end of the duct. Connections on machine manufactured duct may be 4 inches.
- F. Install ducts and fittings to comply with manufacturer's installation instructions as follows:
 - 1. Install ducts with fewest possible joints.
 - 2. Use prescribed duct support spacing as described in this specification and manufacturer's recommendations.

3.05 JOINT SEALING

- A. All ductwork joints and longitudinal seams shall be sealed airtight. Sealant shall be visibly sealed on the exterior of duct, including all factory fittings, all connections, both longitudinal and circumferential.
- B. Duct tape (gray or foil type) shall NOT be utilized as a ductwork sealer.
- C. Elastomeric or hard cast duct sealer shall NOT be utilized on fire damper sleeve to duct connections.
- D. Utilize flanged style ductwork joining system in conjunction with tape/gasket for sealing breakaway joints and connections to fire, smoke and/or combination fire/smoke dampers.

3.06 DUCT LEAKAGE TESTS AND REPAIR

A. Sealing and testing requirements:

1. ALL ductwork shall be sealed airtight per SMACNA duct seal class standards, as indicated on drawings.
2. Designated ductwork, as indicated on drawings, shall be field pressure tested and proven tight.
3. If ductwork or system is not indicated on drawings, testing shall be performed at the following criteria.
 - a. Test pressure: 1.0 in-wg higher than system design pressure - see schedules
 - b. Duct seal class: Class A
 - c. Percent of duct tested: 100%
4. Any or all ductwork may be randomly inspected by PROFESSIONAL.
5. Any or all ductwork not found to be comprehensively sealed (by visual inspection) may be thereafter required to be field pressure tested, solely at PROFESSIONAL'S discretion, to prove air tightness to specified tolerances.

B. Measured air quantity leakage test:

1. The CONTRACTOR shall use recently calibrated orifice run, manometers and portable blower as recommended by AABC.
2. Instruments used for testing and balancing of system shall have been calibrated within six months preceding tests and checked for accuracy prior to start of work.
3. The CONTRACTOR shall provide the test witness with a copy of the test apparatus's certified calibration chart. The tube number listed on the calibration chart should match the tube number on the testing apparatus.
4. Instruments shall be of a type normally recognized as adequate and accurate for the test contemplated. List type of instrument, manufacturer, serial number and latest calibration date as a part of the submitted test data.
5. Allowable Leakage:
 - a. As indicated on drawings.
 - b. If not indicated on drawings, allowable leakage shall be 1.0% of system airflow.

SECTION 23 39 10

DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

- A. Ductwork accessories for HVAC including supply air, return air, outside air, transfer air and general exhaust systems.

1.2 APPLICABLE STANDARDS

- A. Refer to Paragraph, QUALITY ASSURANCE, in Section, BASIC METHODS AND REQUIREMENTS (MECHANICAL).
- B. Fire Safety Code: Comply with NFPA 90A
- C. Duct System Construction: Referenced SMACNA Standards are the minimum acceptable quality.
- D. Duct accessories exposed to the air stream, such as dampers turning vanes, extractors, etc. and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.

1.3 DEFINITIONS

- A. Seal or Sealing: Use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.
- B. SMACNA duct pressure classification for Low Pressure: Static pressure rating up to 2 inches wg (water gauge), positive or negative, for rectangular ducts, and 1 inch wg for round ductwork.

PART 2 - PRODUCTS

2.1 TAKE-OFF FITTINGS

- A. Round ductwork take-offs shall be conical/bellmouth type or 45 deg lateral (shoe-tap) type. Provide take-offs with volume damper including continuous shaft, locking quadrant handle, nylon bushings and stand-off bracket. Located where indicated and accessible.
- B. Conical take-off fittings shall be equal to Flexmaster model CBD SOG with B03 option.
- C. 45 deg lateral (shoe-tap) take-off fittings shall be equal to Flexmaster model STOD with B03 option.

2.2 DAMPERS

- A. Rectangular Volume Dampers: Opposed blade, multi-louver type. Provide end bearing for all dampers. Quadrant or other operator for externally insulated duct shall have stand-off mount so operation is clear of the insulation.

- B. Backdraft Dampers: Self-operating, multi-blade damper to open fully on 0.06 inch wg pressure difference and close by gravity. Aluminum, 16 gauge frame, 0.023 inch blades of airfoil or elliptical shape, with tie-bar to connect blades for parallel operation. Provide resilient gasket for air seal and quiet operation. Blade pivots shall be in nylon bushings. Provide adjustable counter-balance weight(s) where indicated or required to achieve specified performance.
- C. Control/Motorized Dampers: See Section Controls and Instrumentation.
- D. Variable Volume Dampers: Opposed type multi-blade rectangular damper. Provide end bearing for all dampers. Provide rectangular concealed or round exposed electronic modulating type. Provide with duct mounted comparative temperature sensor and matching wall mounted automatic changeover thermostat similar to Trane Vari-Trac system or Young Regulator system.

2.3 DUCT ACCESS DOORS, PANELS AND SECTIONS

- A. Provide access doors, sized and located for maintenance work, upstream where possible, in the following locations:
 - 1. Each fire damper (for link service), fire/smoke damper, smoke damper and automatic control damper.
 - 2. Each duct mounted smoke detector.
 - 3. Each duct mounted coil.
 - 4. Each turn in grease ducts.
- B. Openings shall be as large as feasible in small ducts, 8 inches diameter minimum, with round spin-in access door and sash lock(s). Access sections in insulated ducts shall be double-wall, insulated.
 - 1. Provide low and medium pressure rectangular ducts equal to Flexmaster Model SDSM with R6 insulation option, flange with stick on gasket and cable door retention accessories.
 - 2. Provide round and flat oval ducts equal to Ruskin Model ADR.

2.4 LIFE SAFETY DAMPERS (FIRE, SMOKE AND COMBINATION FIRE/SMOKE)

- A. Dampers shall meet the requirements of NFPA 80, 90A, 92A, 92B, 101, & 105 and further shall be tested, rated, and labeled in accordance with the latest edition of UL Standards 555 and/or 555S.
- B. Dampers shall be of leakage Class I design per the applicable standards referenced herein.
- C. Dampers shall be constructed for the following velocities based upon application:
 - 1. Low pressure (velocity) ductwork installations shall have dampers rated up to 2000 fpm unless noted specifically otherwise on Drawings.
 - 2. Medium pressure (velocity) ductwork installations shall have dampers rated as follows unless noted specifically otherwise on Drawings:
 - a. For ductwork sizes up to 18 inches inside diameter (or equivalent oval/rectangular) dampers shall be rated 2000 fpm.
 - b. For ductwork sizes greater than 18 inches inside diameter (or equivalent oval/rectangular) dampers shall be rated 3000 fpm.

- D. Dampers shall be provided with factory fully welded wall sleeve of adequate length matched for each location and retaining angles for both sides of wall, except in shaft wall applications where dampers shall be rated for single angle installation.
- E. Dampers shall be provided with flanged break-away connections on each side for connection to ductwork.
- F. Dampers shall be constructed of materials to match the associated ductwork distribution system (stainless steel construction dampers where ductwork is required to be stainless steel).
- G. Multi-blade dampers (fire, smoke or combination fire/smoke) shall be of the airfoil blade design and be of a single piece design.
- H. Multi-blade dampers must be rated for mounting vertically (with blades running horizontal) or horizontally and be rated for airflow in either direction through the damper.
- I. Dampers shall have a fire rating of 1-1/2 hours for fire rated installations up to 2 hours. Fire rated installations requiring protection for 3 or more hours shall be rated for 3 hours. See wall type legend on Drawings for more information.
- J. Fire dampers shall be of the dynamic type and include a 160 degree F fusible link.
- K. All fire dampers of the curtain type shall be constructed with no part of the blade stack in the air stream except where installed directly behind sidewall grilles.
- L. Combination fire/smoke and/or smoke damper/actuator combinations shall have an elevated temperature rating of 250 F minimum and be dynamic rated.
- M. Combination fire/smoke and/or smoke dampers shall be supplied with an appropriate actuator installed by the damper manufacturer at the time of damper fabrication. Damper actuator shall be electric type for 120 volt operation.
- N. Each combination fire/smoke damper shall be supplied with a 165 F reusable resettable link (RRL) to facilitate testing of damper operation without replacement of damper components.
- O. Damper actuators shall be externally mounted to the damper sleeve.

2.5 AIR DISTRIBUTION DEVICES

- A. Including supply, return, transfer and exhaust ceiling, floor and sidewall installation, aluminum gasketed construction as indicated. Provide steel construction and matching UL Listed ceiling radiation damper on applications in fire rated ceiling assemblies.
- B. All inside ceiling units shall have factory finish, off-white color unless otherwise noted.
- C. All soffit outdoor units shall have factory finish, color to match soffit. Submit color chart to ARCHITECT for custom color selection.
- D. See Schedule on Drawings for more information.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with provisions of Section, BASIC MECHANICAL MATERIALS AND METHODS, particularly regarding coordination with other trades.
- B. Construct casings, eliminators, and pipe penetrations in accordance with LPDS, Chapter 3. Design casing access doors to swing against air pressure so the pressure helps to maintain a tight seal.
- C. Install duct hangers and supports in accordance with SMACNA, LPDS, Chapter 5, and HPDS, Chapter 6, in concealed applications.
- D. Install life safety dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test. Install multiple access doors to provide access to all damper linkages/fusible links of multiple section life safety dampers.
- E. Seal openings around duct penetrations of fire rated ceilings and partitions with fire stop material as required by NFPA 90A. See Section Basic Mechanical Materials and Methods. Provide sound sealant around duct penetrations in wall indicated as sound and/or full height walls.
- F. Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by ENGINEER. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.
- G. Provide primary and secondary balance dampers on all supply distribution devices. Provide a supply air duct damper and air extractor off main ductwork to branch ductwork of the types as listed below:
 - 1. Round Ductwork: Provide conical or lateral type taps with integral butterfly damper. Submit information for approval.
 - 2. Rectangular Ductwork: Provide radius or lateral elbow tap, as indicated with air extractor assembly and opposed blade multi-blade damper.
 - 3. Provide exterior duct damper and extractor controller arm assemblies that extend past proposed ductwork installation for accessible operation.
- H. When splitter dampers occur above other than lay-in ceiling, provide damper assembly complete with supports, bearings, chromium plated ceiling escutcheons and adjustable regulator, as Young models No. 1 and No. 890-A.

END OF SECTION

SECTION 23 48 85

AIR CLEANING/TREATMENT

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material, equipment and labor, etc., required to complete installation specified herein and/or shown or scheduled on Contract Drawings.
- B. Descriptions:
 - 1. Air filters for Heating, Ventilating and Air Conditioning.
 - 2. Definitions: Refer to newest edition of ASHRAE 52.2 for definitions of face velocity, net effective filtering area, media velocity, resistance (pressure drop), minimum efficiency reporting value (MERV), etc.

1.02 APPLICABLE STANDARDS

- A. Air Filter Performance Report For Extended Surface Filters:
- B. Submit a test report for each type of filter being offered. The report shall be less than two years old and have been prepared by an independent testing laboratory using test equipment, method and duct section as specified by the latest version of ASHRAE Standard 52.2 for type filter under test and acceptable to ENGINEER, indicating that filters comply with the requirements of this specification. Test for 500 fpm will be accepted for lower velocity filters provided the test report of an independent testing laboratory complies with all the requirements of this specification.
 - 1. Selection procedures for manufacturer's standard products: All filters tested shall have been procured by the independent testing laboratory from the open market independent of manufacturer of these filters and a statement to this effect must accompany test report.
 - 2. Selection procedures for new products not available on open market: Testing laboratory will certify that filters are not available in areas remote from manufacturer's facilities. For each required test the independent Testing Laboratory shall select from the manufacturer's stock or production the number of samples required. The samples selected shall be representative of standard production considering media utilized and manufacturing locations. These test reports shall be less than six months old.
- C. Filter Supplier Warranty for Extended Surface Filters: Guarantee the filters against leaks, blow-outs, and other deficiencies during their normal useful life. Defective filters shall be replaced at no cost to the Owner.
- D. Identification: Each filter shall bear markings indicating manufacturer's name, filter size, and MERV rating per ASHRAE Standard 52.2.

E. Definitions and Abbreviations

1. Spares: Filter(s) in sets to be turned over to the OWNER at the end of the project for the OWNER'S use after the project or any portion thereof, is complete.
2. Construction Period: This term generally includes the time period beginning with the OWNER'S notice-to-proceed and ending with the OWNER'S final acceptance of a project, or any phase of a project.
3. Temporary: A term generally depicting the use of air filters for use during the construction period.
4. Filter Grille: An inlet device connected to an HVAC system where an air filter is to be installed and maintained during construction and permanently after project is completed.
5. Pleated Filters: An extended surface filter with folds of air filtration media.
6. Filter or Filter Set: Air filter(s) in sizes as recommended by equipment or supplier manufacturer to prevent air bypass and to provide the maximum face size and minimum velocity to promote longer filter life expectancy.
7. F/G: fiberglass

1.03 RESPONSIBILITY

- A. The CONTRACTOR is responsible for providing, monitoring and maintaining all air filtration specified provisions during the construction period.
- B. The CONTRACTOR is also responsible for providing spare sets of air filter(s) to the OWNER, labeled and in boxes for storage, for the OWNER'S use after the project is complete and at which time the OWNER assumes control of operation and maintenance functions for the systems. One of the filter spare sets shall be installed on the day of the final inspection by the PROFESSIONAL.

1.04 AIR FILTRATION PROTECTION REQUIRED

- A. The following systems and installations shall be provided with proper air filtration prior to startup or use of the facilities new HVAC systems and existing or renovated HVAC systems in the area(s) affected by this project.
 1. All new air handling systems, including up-flow/horizontal furnaces, roof top packaged systems, outdoor air and heat recovery systems, blower coil, central station and built-up air handling system with water, or refrigerant coils.
 2. Filter grilles or registers.
 3. Filters in fan systems serving kitchen hoods and other makeup air arrangements.
 4. Ducted return air systems: Provide temporary air filtration over all return air grilles, registers and filter grilles (in addition to filters in frame of filter grille).

1.05 TYPE OF AIR FILTRATION REQUIRED

- A. The following is a listing of generic equipment and installation air filtration requirements. The CONTRACTOR may submit alternate filter thickness(es) to match specific applications but shall not be less than that listed, for PROFESSIONAL'S approval. The CONTRACTOR shall verify size, including thickness matched to CONTRACTOR supplied equipment and air distribution device accessory.

AIR FILTRATION REQUIREMENTS					
GENERAL INFORMATION			CONSTRUCTION PERIOD FILTRATION	PROJECT COMPLETION FILTRATION & SPARES	
FILTER FUNCTION	FILTER TYPE	NOMINAL FILTER THICKNESS	MINIMUM MERV RATING	MINIMUM MERV RATING	NUMBER OF SPARE SETS
RETURN AIR GRILLES/REGISTERS	PLEATED	1 inch	11	N/A	N/A
RETURN AIR FILTER GRILLES/REGISTERS	PLEATED	1 inch	11	8	3
FURNACE EVAPOR.	PLEATED	1 inch	8	8	3
BLOWER COIL UNITS	PLEATED	2 inches	8	8	3
AIR HANDLING UNITS	PLEATED	2 inches	8	8	3
KITCHEN FAN	WASHABLE ALUMINUM	1 inch	N/A	N/A	3
PACKAGE INLINE KITCHEN HOOD SUPPLY	PLEATED	1 inch	8	8	3
OUTSIDE AIR UNITS	PLEATED	2 inches	8	8	3
HEAT RECOVERY UNITS	PLEATED	2 inches	8	8	3
ENERGY RECOVERY UNITS	PLEATED	2 inches	8	8	3
ROOFTOP UNITS 5-TONS & SMALLER	PLEATED	1 inch	8	8	3
DEHUMID. PTAC'S	PLEATED	2 inches	11	11	3
ROOFTOP UNITS OVER 5-TONS	WASHABLE	1 inch	4	4	1
	PLEATED	2 inches	8	8	3

PART 2 - PRODUCTS

2.01 EXTENDED SURFACE AIR FILTERS

- A. Filter shall be pleated, disposable type. Filter shall consist of non-woven cotton and synthetic fabric media, media support grid and enclosing frame.
- B. The filter shall be listed by Underwriters Laboratories as Class 2.
- C. The media support shall be a welded wire grid with an effective open area of not less than 96 percent. The welded wire grid shall be bonded to the filter media to eliminate the possibility of media oscillation and media pull away.
- D. The enclosing frame shall be constructed of a rigid, heavy-duty beverage board with diagonal support members bonded to each side of the filter to insure pleat stability. The inside periphery of the enclosing frame shall be bonded to the filter pack to eliminate possibility of air bypass.
- E. Filter Characteristics

MINIMUM EFFICIENCY REPORTING VALUE (MERV)	FILTER THICKNESS	PRESSURE DROP (IN. W.G. @ 350 F.P.M.)		PRESSURE DROP (IN. W.G. @ 500 F.P.M.)	
		INITIAL	FINAL	INITIAL	FINAL
8	1 inch	0.23	0.50	-	-
8	2 inches	-	-	0.29	0.75
11	1 inch	0.30	0.50	-	-
11	2 inches	-	-	0.35	0.75

2.02 FIBERGLASS BULK MEDIA

- A. 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.
- B. The filter shall be listed by Underwriters Laboratories as Class 2.
- C. The filter media shall be 1" thick.
- D. This filter media is intended to be utilized over return 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.

2.03 WASHABLE AIR FILTERS (TWU'S) - SEE SECTION PACKAGED AIR CONDITIONERS

PART 3 - EXECUTION

3.01 INSTALLATION AND COORDINATION

- A. Install supports, filters and gages in accordance with manufacturer's instructions.

- B. At end of project, provide list of all HVAC air handling equipment and filter grilles, with size and quantity of air filters and MERV rating for each, and submit for Owner's future use and maintenance record. Furthermore, submit a letter signed by the OWNER acknowledging receipt of all spare sets of air filters outlined above. All boxes of air filters shall be labeled to match the individual HVAC system or return air filter grille location for which the filters are to be utilized.

3.02 START-UP AND TEMPORARY USE

- A. Clean and vacuum air handling units and plenums to the satisfaction of the ENGINEER prior to starting air-handling systems.
- B. Change out replaceable air filters, as filters are 60% loaded during construction use period and just prior to OWNER'S acceptance of project. Filters for use during construction period are in addition to OWNER'S spare sets, as specified herein.
- C. Thoroughly wash wall unit filters as filters are 40% loaded during construction period, and just prior to OWNER'S acceptance of project.

END OF SECTION

SECTION 23 48 89

BI-POLAR IONIZATION AIR PURIFICATION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. This section describes the design, performance and installation of an air purification system intended for use as part of another manufacturer's air handling unit or mounted on the duct as shown on the plans, details and equipment schedules.

1.02 REFERENCED CODES & STANDARDS

- A. The following codes and standards are referenced throughout. The edition to be used is that currently enforced by the authority having jurisdiction (AHJ) or in absence of such direction that referenced by the current enforceable IBC code or as indicated by the contract documents, except where specifically referenced by this section of the specifications.
 - 1. ASHRAE Standards 62 & 52
 - 2. National Electric Code NFPA 70
 - 3. UL 867 including ozone chamber test

1.03 RELATED WORK

- A. Testing, Adjusting and Balancing
- B. Facility Access and Protection
- C. Ductwork
- D. Filters
- E. Electrical Wiring
- F. Control Wiring

1.04 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. Technologies that do not address gas disassociation such as UV lights, powered particulate filters and/or polarized media filters shall not be considered. Uni-polar ion generators shall not be acceptable. "Plasma" particulate filters shall not be acceptable.

- D. 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.
- E. 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.

1.05 INTELLECTUAL PROPERTY RIGHTS

- A. The basis of design manufacturer has related patented products and patents pending on future products. The owner or owner's representative has been made aware of this. Any alternate vendors must prove that they are not infringing the patents of Plasma Air or that they have a license to use said technology.

1.06 SUBMITTALS

- A. Submit manufacturer's technical product data for ion generators including:
 - 1. Schedule of plasma generators indicating model number and quantity of each type required for each unit/application.
 - 2. Submittal sheet for each type of plasma generator and accessories furnished; indicating construction, dimensions, electrical data, and mounting details.
 - 3. Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1-2007 to validate acceptable indoor air quality at the quantity of outside air scheduled (when projects are designed with reduced outside air).
 - 4. Product drawings detailing all physical, electrical and control requirements.
 - 5. Copy of UL 867 independent ozone test.
- B. Operating & Maintenance Data: Submit O&M data and recommended spare parts list.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery of products shall be in factory fabricated shipping cartons. Identify on outside of carton the type of product contained within. Avoid crushing or bending.
- B. Store in original cartons and protect from weather and construction work traffic.
- C. Store indoors and in accordance with the manufacturers' recommendation for storage.

1.08 WARRANTY

- A. Equipment shall be warranted by the manufacturer against defects in material and workmanship for a period of twelve months after shipment or eighteen months from owner acceptance, whichever occurs first. Labor to replace equipment under warranty shall be provided by the owner or installing contractor.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The air purification system(s) shall be of the size, type, arrangement and capacity indicated and required by the unit furnished and shall be manufactured by Plasma Air International. Equals by GPS, Aerisa or Bio-Oxygen shall also be acceptable.

2.02 BI-POLAR IONIZATION DESIGN & 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 percent in 60 minutes or less
b. E. Coli:	93.5 percent in 30 minutes or less
c. H1N1:	86.6 percent in 60 minutes or less
d. Aspergillus:	74.8 percent in 60 minutes or less
 7. Manufacturers not providing the equivalent space kill rates shall not be acceptable. All manufacturers 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 stream will not be accepted.
2. Air Handler and Rooftop units
 - a. Ion generators for air handling units 10 tons and larger shall be furnished in a linear or bar mounted configuration to minimize the space required for installation. Ionization unit shall be no more than 3 inches deep in the direction of airflow.
 - b. The mechanical contractor shall mount the plasma ionization unit and connect it to the remote mount control panel using only low voltage wiring. Low voltage wiring shall be defined as 12V DC or 24V AC. The use of high voltage cabling shall not be acceptable due to safety concerns.
 - c. The remote mount control 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 only indicate power available 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.
3. Certifications
 - a. Bipolar ionization units shall be tested and listed by either UL or ETL according to UL Standard 867 - Electrostatic Air Cleaners. UL listings for standards other than 867 will not be acceptable.
 - b. The operation of the electrodes or bipolar ionization units shall conform to UL 867 with respect to ozone generation.
4. Electrical Requirements:
 - a. 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.
 - b. 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.
5. Control Requirements:
 - a. All plasma ion generators shall include internal short circuit protection, overload protection, and automatic fault reset. Manual fuse replacement shall not be accepted.
 - b. All BAR and 7000 series plasma ion generators shall include an external BMS interface to indicate ion generator status and alarm.

PART 3 - EXECUTION

3.01 GENERAL

- A. The Contractor shall be responsible for maintaining all air systems until the owner accepts the building (Owner Acceptance).

3.02 ASSEMBLY & INSTALLATION: PLASMA GENERATOR WITH BI-POLAR IONIZATION

- 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.

3.03 COMMISSIONING & 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.

END OF SECTION

SECTION 23 78 55

AIR HANDLING UNITS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Air Handling Units.

1.02 REFERENCES

- A. AMCA Publication 99 - Standards Handbook.
- B. AMCA Publication 611 - Certified Ratings Program - Airflow Measurement Performance
- C. AMCA Standard 500-D - Laboratory Methods of Testing Dampers for Rating.
- D. ANSI/ABMA Standard 9 - Load Ratings and Fatigue Life for Ball Bearings.
- E. ANSI/AMCA Standard 204 - Balance Quality and Vibration Levels for Fans.
- F. ANSI/AMCA Standard 610 - Laboratory Methods of Testing Airflow Measuring Stations for Rating.
- G. ANSI/AHRI Standard 410 - Forced Circulation Air-Cooling and Air-Heating Coils.
- H. ANSI/AHRI Standard 430 - Central Station Air Handling Units.
- I. ANSI/AHRI Standard 1060 - Rating Air-To-Air Energy Recovery Ventilation Equipment
- J. ANSI/ASHRAE Standard 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- K. ANSI/ASHRAE Standard 62.1 - Ventilation for Acceptable Indoor Air Quality.
- L. ANSI/ASHRAE Standard 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- M. ANSI/NEMA MG 1 - Motors and Generators.
- N. ANSI/UL 900 - Standard for Safety Air Filter Units.
- O. AHRI Standard 260 - Sound rating of Ducted Air Moving and Conditioning Equipment.
- P. ASHRAE Standard 84 - Method of Testing Air-to-Air Heat Exchangers.
- Q. ASHRAE Standard 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.
- R. ASTM B117 - Standard Practice for Operation Salt Spray Apparatus.
- S. ASTM E477 - Standard Test Method for Measure Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
- T. NFPA 70 - National Electrical Code®.
- U. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilation Systems.

V. UL 1995 - Standard for Safety Heating and Cooling Equipment

1.03 QUALITY ASSURANCE

- A. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with current AHRI Standard 410.
- B. Air handling units with fan sections utilizing single fans shall be rated and certified in accordance with AHRI Standard 430.
- C. Airflow monitoring station: Certify airflow measurement station performance in accordance with AMCA 611.
- D. ISO 9001 Certification.

1.04 SUBMITTALS

- A. No equipment shall be fabricated or delivered until the receipt of approved shop drawings from the Owner or Owner's approved representative.
- B. AHU manufacturer shall provide the following information with each shop drawing/product data submission:
 - 1. Dimensioned arrangement drawings for each AHU including a plan and elevation view of the assembled unit with overall dimensions, lift points, unit shipping split locations and dimensions, installation and operating weights, and installation, operation and service clearances.
 - 2. All electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations.
 - 3. Each component of the unit shall be identified and mechanical specifications shall be provided for unit and accessories describing construction, components, and options.
 - 4. All performance data, including capacities and airside and waterside pressure drops, for components.
 - 5. Fan curves shall be provided for fans with the design operating points indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes.
 - 6. A filter schedule must be provided for each air handling unit supplied by the air handling unit manufacturer. Schedule shall detail unit tag, unit size, corresponding filter section location within the AHU, filter arrangement (e.g. angled/flat), filter depth, filter type (e.g. pleated media), MERV rating, and filter quantity and size.
 - 7. A schedule detailing necessary trap height shall be provided for each air handling unit. Schedule shall detail unit tag, unit size, appropriate trap schematic with recommended trap dimensions, and unit supplied base rail height. CONTRACTOR shall be responsible for additional trap height required for trapping and insulation beyond the unit supplied base rail height by adequate housekeeping pad.
 - 8. A coil valve coordination schedule shall be provided for each air handling unit supplied by the air handling unit manufacturer. Schedule shall detail unit tag, coil type and corresponding section location within the AHU, valve style (e.g. global, ball), valve type (e.g. electronic 2-way/3-way), valve position (e.g. normally open/closed), size, flow coefficient (CV), and close-off pressure.

9. An electrical MCA - MOP schedule shall be provided for each electrical circuit to which field-power must be supplied. Schedule to detail unit tag, circuit description, voltage/phase/hertz, Minimum Circuit Ampacity (MCA), and calculated Maximum Overcurrent Protection (MOP).
10. Sound data shall be provided using AHRI 260 test methods. Unit discharge, inlet, and radiated sound power levels in dB shall be provided for 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz.

1.05 REGULATORY REQUIREMENTS

A. Agency Listings/Certifications:

1. Unit shall be manufactured to conform to UL 1995 and shall be listed by either UL/CUL or ETL. Units shall be provided with listing agency label affixed to the unit. In the event the unit is not UL/CUL or ETL approved, the CONTRACTOR shall, at his/her expense, provide for a field inspection by a UL/CUL or ETL representative to verify conformance. If necessary, CONTRACTOR shall perform modifications to the unit to comply with UL/CUL or ETL as directed by the representative, at no additional expense to the owner.
2. Certify air handling units in accordance with AHRI Standard 430. Units shall be provided with certification label affixed to the unit. If air handling units are not certified in accordance with AHRI Standard 430, CONTRACTOR shall be responsible for expenses associated with testing of units after installation to verify performance of fan(s). Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the CONTRACTOR.
3. Certify air handling coils in accordance with AHRI Standard 410. Units shall be provided with certification label affixed to the unit. If air handling coils are not certified in accordance with AHRI Standard 410, CONTRACTOR shall be responsible for expenses associated with testing of coils after installation to verify performance of coil(s). Any costs incurred to adjust coils to meet scheduled capacities shall be the sole responsibility of the CONTRACTOR.
4. Certify airflow monitoring stations are tested for differential pressure in accordance with AMCA 611 in an AMCA registered laboratory and comply with the requirements of the AMCA Certified Ratings Program. Airflow monitoring station shall be licensed to bear the AMCA Seal.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Shipping splits shall be clearly defined on submittal drawings. Cost associated with non-conformance to shop drawings shall be the responsibility of the manufacturer. Each section shall have lifting lugs for field rigging and final placement of AHU sections. Indoor AHUs less than 100 inches wide shall allow for forklift transport for maneuverability on jobsite.
- C. Deliver units to jobsite with fan motor(s), sheave(s), and belt(s) completely assembled and mounted in units.
- D. Indoor air handling units shall be shipped in a clear shrink-wrap or stretch-wrap to protect unit from in-transit rain and debris per ASHRAE 62.1 recommendations.

- E. The CONTRACTOR shall be responsible for storing AHU in a clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.7 START-UP AND OPERATING REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated (if applicable), condensate properly trapped, piping connections verified and leak-tested, belts aligned and tensioned, all shipping braces removed, bearing set screws torqued, and fan has been test run under observation.

1.8 WARRANTY

- A. AHU manufacturer shall provide, at no additional cost, a standard parts warranty that covers a period of one year from unit start-up or 18 months from shipment, whichever occurs first. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Unit layout and configuration shall be as defined in project plans and schedule.
- B. Unit manufacturer to provide an integral base frame to support all sections of unit and raise unit for proper trapping. CONTRACTOR will be responsible for providing a housekeeping pad when indoor air handling unit base frame is not of sufficient height to properly trap unit. Unit base frames not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel.
- C. Entire indoor air handling unit shall have a 8-inch full perimeter base rail for structural rigidity and condensate trapping.

2.02 UNIT CASING

- A. Unit manufacturer shall ship separate segments so unit can be broken down for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Indoor air handling unit casing finish to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.
- B. Casing performance - Casing air leakage shall not exceed leak class 9 (CL = 9) per ASHRAE 111 at specified casing pressure, where maximum casing leakage (cfm/100 ft² of casing surface area) = CL X P^{0.65}.
- C. Air leakage shall be determined at 1.00 times maximum casing static pressure up to 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.

- D. Unit casing (wall/floor/pressure bulkhead roof panels and doors) shall be able to withstand up to 1.5 times design static pressure up to plus 8 inches w.g. in all positive pressure sections and minus 8 inches w.g. in all negative pressure sections, whichever is less, and shall not exceed 0.0042 inch per inch of panel span (L/240).
- E. Floor panels shall be double-wall construction and designed to support a 300-lb load during maintenance activities and shall deflect no more than 0.0042 inch per inch of panel span.
- F. Unit casing panels shall be 2 inches double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior.
- G. Unit casing panels (pressure bulkhead roof panels, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 Hr*Ft²*°F/BTU.
- H. Unit casing panels (pressure bulkhead roof panels, 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.
- I. Structural frame must not extend from air-handling unit interior to exterior. All component and panel support structure must be internal to AHU. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.
- J. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.
- K. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.

2.03 ACCESS DOORS

- A. Access doors shall be 2-inch double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.
- B. All doors downstream of cooling coils shall be provided with a thermal break construction of door panel and door frame.
- C. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.
- D. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.
- E. Handle hardware shall be designed to prevent unintended closure.
- F. Access doors shall be hinged and removable without the use of specialized tools to allow.
- G. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions.
- H. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.

- I. All doors shall be a minimum 60 inches high when sufficient height is available, or the maximum height allowed by the unit height.
- J. A single door handle shall be provided for each door linking multiple latching points necessary to maintain the specified air leakage integrity of the unit.

2.04 PRIMARY DRAIN PANS

- A. All cooling coil sections shall be provided with an insulated, double-wall, stainless steel drain pan.
- B. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements.
- C. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
- D. All drain pan threaded connections shall be visible external to the unit. Threaded connections under the unit floor shall not be accepted.
- E. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2 inches beyond the base to ensure adequate room for field piping of condensate traps.
- F. The installing contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate.
- G. Coil support members inside the drain pan shall be of the same material as the drain pan and coil casing.
- H. Drain pans shall be provided for heating coils, access sections, and mixing sections as indicated in the plans.

2.05 FANS

- A. Fan sections shall have a minimum of one access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components.
- B. Provide fans of type and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans controlled by variable frequency drives shall be statically and dynamically tested for vibration and alignment at speeds between 25 percent and 100 percent of design RPM. If fans are not factory-tested for vibration and alignment, the CONTRACTOR shall be responsible for cost and labor associated with field balancing and certified vibration performance. Fan wheels shall be keyed to fan shafts to prevent slipping.

- C. All fans shall be mounted on spring isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with spring isolators. Unit sizes up to nominal 4,000 cfm shall have 1-inch springs. Unit sizes larger than nominal 4,000 cfm shall have 2-inch spring isolators. A flexible connection (e.g. canvas duct) shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.
- D. Fan airflow measurement systems shall be provided as indicated on the schedule and drawings to measure fan airflow directly or to measure differential pressure that can be used to calculate airflow. The accuracy of the devices shall be no worse than plus or minus 5 percent when operating within stable fan operating conditions. Devices shall not affect the submitted fan performance and acoustical levels. Devices that obstruct the fan inlet or outlet shall not be acceptable. Devices shall be connected to transducers with a 2-10 VDC output. Signal shall be proportional to air velocity.

2.06 MOTORS AND DRIVES

- A. All motors and drives shall be factory-installed and run tested. All motors shall be installed on a slide base to permit adjustment of belt tension. Slide base shall be designed to accept all motor sizes offered by the air-handler manufacturer for that fan size to allow a motor change in the future, should airflow requirements change. Fan sections without factory-installed motors shall have motors field installed by the CONTRACTOR. The CONTRACTOR shall be responsible for all costs associated with installation of motor and drive, alignment of sheaves and belts, run testing of the motor, and balancing of the assembly.
- B. Motors shall meet or exceed all NEMA Standards Publication MG 1 - 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.
- C. Fan Motors shall be heavy duty, NEMA Premium efficient, exceeding the EPA efficiency requirements.
- D. Belt-driven fan sections with single fans shall use 4-pole (1800 rpm) motors, NEMA Design B, with Class B insulation to operate continuously at 104 Deg F (40 Deg C) ambient without tripping of overloads.
- E. Motors shall have a plus or minus 10 percent voltage utilization range to protect against voltage variation.
- F. V-Belt Drive shall be variable pitch rated at 1.5 times the motor nameplate. Drives 20 hp and larger or any drives on units equipped with VFDs shall be fixed pitch.
- G. All fans with fixed-pitch drives and motors 15 hp and larger shall be equipped with multiple belt drives.
- H. Manufacturer shall provide for each fan a nameplate with the following information to assist air balance CONTRACTOR in startup and service personnel in maintenance:
 - 1. Fan and motor sheave part number
 - 2. Fan and motor bushing part number
 - 3. Number of belts and belt part numbers
 - 4. Fan design RPM and motor HP

5. Belt tension and deflection
6. Center distance between shafts

2.07 COILS

- A. Coils section side panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.
- B. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.
- C. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.
- D. Construct coil casings of stainless steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.
- E. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle shall be degreased and cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.
- F. When two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. The intermediate drain pan shall be designed being of sufficient size to collect all condensation produced from the coil and sloped to promote positive drainage to eliminate stagnant water conditions. The intermediate drain pan shall be constructed of the same material as the primary drain pan.
- G. The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil.
- H. Intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The intermediate drain pan outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
- I. Hydronic Coils
 1. Supply and return header connections shall be clearly labeled on unit exterior such that direction of coil water-flow is counter to direction of unit air-flow.
 2. Coils shall be proof-tested to 300 psig and leak-tested to 200 psig air pressure under water.
 3. Headers shall be constructed of round copper pipe or cast iron.
 4. Tubes shall be 1/2 inch O.D., minimum 0.016 inch thick copper or 5/8 inch O.D., minimum 0.020 inch thick copper. Fins shall be aluminum.

2.08 FILTERS

- A. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall have side access filter guides and access door(s) extending the full height of the casing to facilitate filter removal. Provide fixed filter blockoffs as required to prevent air bypass around filters. Blockoffs shall not need to be removed during filter replacement. Filters to be of size and quantity required to maximize filter face area for each air handling unit.
- B. Filter type, MERV rating, and arrangement shall be provided as defined in project plans and schedule.
- C. Manufacturer shall provide one set of startup filters.
- D. Each filter section shall be provided with a factory-installed, flush-mounted Dwyer dial-type differential pressure gauge piped to both sides of the filter to indicate status. Gauge shall maintain a plus or minus 5 percent accuracy within operating temperature limits of minus 20 Deg F to 120 Deg F. Filter sections consisting of pre- and post-filters shall have a gauge for each.

2.09 DAMPERS

- A. All dampers shall be internally mounted. Dampers shall be premium ultra-low leak and located as indicated on the schedule and plans. Blade arrangement (parallel or opposed) shall be provided as indicated on the schedule and drawings. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 3 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Manufacturer shall submit brand and model of damper(s) being furnished, if not Ruskin CD60.
- B. Airflow measuring stations shall be provided and located in the outside air intake hood(s). See Drawings and Section Controls and Instrumentation for more information.

2.10 ACCESS SECTIONS

- A. Access sections shall be provided where indicated in the schedule and plans to allow additional access for inspection, cleaning, and maintenance of unit components. The unit shall be installed for proper access. Procedure for proper access, inspection and cleaning of the unit shall be provided in the AHU manufacturer's maintenance manual.

2.11 DISCHARGE PLENUM SECTIONS

- A. Plenums shall be provided as indicated in the schedule and plans to efficiently turn air and provide acoustical attenuation. Discharge plenum opening types and sizes shall be scaled to meet pressure drop requirements scheduled and align with duct takeoffs.

2.12 MARINE LIGHTS

- A. Marine lights shall be provided throughout AHUs as indicated on the schedule and plans.
- B. Light fixture shall be weather-resistant, enclosed and gasketed to prevent water and dust intrusion.
- C. All lights on a unit shall be wired in the factory to a single on-off switch.

- D. CONTRACTOR shall be responsible for providing 115V supply to the factory-mounted marine light circuit.

PART 3 - EXECUTION

3.01 SHIPPING

- A. Paper copies of the IOM shall also be shipped with each AHU.
- B. The AHU manufacturer shall identify all shipments with the order number. Enough information shall be provided with each shipment to enable the CONTRACTOR to confirm the receipt of units when they are received. For parts too small to mark individually, the AHU manufacturer shall place them in containers.
- C. To protect equipment during shipment and delivery, all indoor units shall be completely stretch or shrink wrapped. Wrap shall be a minimum of 7 mil plastic. Pipe ends and pipe connection holes in the casing shall be capped or plugged prior to shipment.
- D. After loading the equipment for shipment, the AHU manufacturer shall contact the shipping contact on the order and provide the name of the carrier, description of equipment, order number, shipping point, and date of shipment.

3.02 ON-SITE STORAGE

- A. If equipment is to be stored for a period of time prior to installation, the CONTRACTOR shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in a well-drained area. Covering units with plastic tarps shall not be acceptable.

3.03 FIELD EXAMINATION

- A. The CONTRACTOR shall verify that the mechanical room and/or roof are ready to receive work and the opening dimensions are as indicated on the shop drawings and contract documents.
- B. The CONTRACTOR shall verify that the proper power supply is available prior to starting of the fans.

3.04 INSTALLATION

- A. The CONTRACTOR shall be responsible to coordinate ALL installation requirements with the Owner and the Owner's selected CONTRACTOR 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.
- B. The AHU manufacturer shall provide all screws and gaskets for joining of sections in the field.
- C. 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 and steam 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.

3.05 LEVELING

- A. The CONTRACTOR shall level all unit sections in accordance with the unit manufacturer's instructions. The CONTRACTOR shall provide and install all necessary permanent shim material to ensure individual sections and entire assembled units are level.

3.06 FINAL INSPECTION AND START UP SERVICE

- A. The CONTRACTOR, shall perform the following tests and services and submit a report outlining the results:
 1. Record date, time, and person(s) performing service.
 2. Lubricate all moving parts.
 3. Check all motor and starter power lugs and tighten as required.
 4. Verify all electrical power connections.
 5. Conduct a startup inspection per the AHU manufacturer's recommendations.
 6. Record fan motor voltage and amperage readings.
 7. Check fan rotation and spin wheel to verify that rotation is free and does not rub or bind.
 8. Check fan for excessive vibration.
 9. Check V belt drive or coupling for proper alignment.
 10. Check V belt drive for proper tension. Tighten the belts in accordance with the AHU manufacturer's directions. Check belt tension during the second and seventh day's operation and re-adjust belts, as may be required, to maintain proper tension as directed by the AHU manufacturer.
 11. Remove all foreign loose material in ductwork leading to and from the fan and in the fan itself.
 12. Disengage all shipping fasteners on vibration isolation equipment.
 13. Check safety guards to insure they are properly secured.
 14. Secure all access doors to the fan, the unit and the ductwork.
 15. Switch electrical supply "on" and allow fan to reach full speed.
 16. Physically check each fan at start up and shut down to insure no abnormal or problem conditions exist.
 17. Check entering and leaving air temperatures (dry bulb and wet bulb) and simultaneously record entering and leaving chilled water temperatures and flow, steam pressures and flow, and outside air temperature.
 18. Check all control sequences.

END OF SECTION

SECTION 23 89 30

VARIABLE AIR VOLUME BOXES

PART 1 - GENERAL

1.01 SCOPE

- A. Variable air volume boxes (VAV's), including induction units, and constant and variable volume units, with or without heating coils, and fan-powered reheat VAV's.

1.02 APPLICABLE STANDARDS

- A. Air Diffusion Council Test Code: 1062R4.....Certification, Rating, and Test Manual (1977)
- B. Air Conditioning and Refrigeration Institute (ARI): 445-75.....Standard for Room Air Induction Units
- C. U. S. Department of Commerce, National Bureau of Standards (NBS), Commercial Standard.
- D. Underwriters Laboratories, Inc. (UL): 181-74.....Factory Made Air Duct Materials

PART 2 - PRODUCTS

2.01 VARIABLE AIR VOLUME BOXES (VAV'S)

- A. General: Factory built, pressure independent units, factory set volume, suitable for single or dual duct applications, as indicated. Clearly show on each unit the unit number and factory set air volume corresponding to the contract drawings. Coordinate flow controller sequence and damper operation details with the drawings and Section Controls and Instrumentation.
- B. Test and Rating Standard: ADC Test Code 1062R4, tested in an ADC certified laboratory and ASHRAE Standard 36B.
 - 1. Maximum pressure drop: As shown on the drawings.
 - 2. Maximum room sound levels: Not to exceed criteria as scheduled for the inlet pressure shown on drawings or not less than 1-1/2 inches wg, if not shown. Provide VAV sound attenuators where necessary to comply with the noise criteria. Sound tests and correction of deficiencies are specified in Section Testing, Adjusting and Balancing.
- C. Casing: Construction shall be single wall construction casing. Construct portions of casing exposed to high upstream static pressures of die cast aluminum, 22 gage galvanized sheet metal, or equivalent strength aluminum sheet. Downstream portions of casing maybe constructed of not lighter than 26 gage galvanized steel sheet or equivalent strength aluminum sheet. All joints and seams shall be either welded or sealed. Provide hanger brackets for attachment of supports.
 - 1. Insulation material: Suitable to provide required acoustic performance, thermal insulation and prevent sweating. Meet the requirements of NFPA 90A, one inch minimum thickness, secured to supporting surfaces in such a manner that it will not sag, delaminate or settle. Comply with UL Standard 181 for erosion. Surfaces, including edges, shall be faced with perforated metal or coated so that material will not be detached by the air stream.

2. Removable Panels: Provide panels large enough for access to all moving parts (except neoprene bellows when bellows are the only moving part) for inspection, adjustment and maintenance without disconnecting ducts. Panels shall be flush, gasketed airtight and shall require no tool other than a screwdriver to remove.
 3. Total Leakage from Casing: Not to exceed 1 percent of the nominal capacity of the unit when subjected to a static pressure of 1/2-inch water gage, with all outlets sealed shut and inlets fully opened.
- D. Construct dampers and other internal devices of corrosion resisting materials, which do not require lubrication or other periodic maintenance.
1. Air volume damper shall be rigid butterfly type with neoprene gasket sealer. Damper leakage rate shall not exceed 3 percent of total specified CFM at 3.0 inches w.g.
- E. Single Duct VAV's: Provide manufacturer's standard cataloged and factory mounted heating coil where indicated on the drawings.
1. Variable volume units (VAV): Externally powered, variable volume, with field adjustable maximum and minimum set points.
 - a. Volume damper or bellows: Provide internal or external factory mounted damper operator.
 - b. Variable constant volume controller: To provide constant output (specific percentage of maximum specified flow) called for by the room thermostat, plus or minus 5 percent regardless of variations in inlet static pressure up to 3 inches water gage. Controller set points shall be factory adjusted and field resettable through use of an integral scale. Provide flow measuring taps and unit mounted calibration chart for field calibration of the controller.
 - c. External differential pressure taps (separate from the control pressure taps) shall be provided for airflow measurement with a 0-1 inch gage. Each VAV shall have a flow chart attached.
 - d. Discharge and radiated sound levels shall not exceed values on drawings.
 - e. VAV's shall be pressure independent and capable of resetting air flow between present maximum and minimum as determined by the space thermostat regardless of changes in system air pressure. Devices using cfm limiters will not be acceptable.
 - f. Controls contractor and HVAC contractor shall coordinate to have controller and actuator factory mounted.
 - g. See control specifications for operating requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install VAV's as per detail(s) on Contract Drawings. Hang VAV's adequately from building structure.
- B. Locate VAV's to provide a straight section of inlet duct for proper functioning of volume controls per manufacturer's recommendations and detail on drawings.

3.02 COORDINATION

- A. Coordinate factory mounting of actuators and controls with EMS vendor.
- B. Coordinate location of controls and actuators with space and each unit such that controls for initial TAB and future Owner maintenance are easily accessible.

END OF SECTION

SECTION 26 05 05

SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Electrical demolition.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that abandoned wiring and equipment serve only abandoned facilities.
- B. Demolition drawings are based on casual field observation and existing record documents.
- C. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- C. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.
- D. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner before partially or completely disabling system.
 - 2. Make notifications at least 48 hours in advance.
 - 3. Make temporary connections to maintain service in areas adjacent to work area.

- E. Existing Communications (Voice/Data) System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner at least 24 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.
- F. Existing Electronic Safety and Security (ESS) System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration. ESS includes, but is not limited to Closed Caption Television (CCTV) and Automatic Access Control System (AACS).
 - 1. Obtain permission from Owner at least 48 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
 - 1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
 - 2. PCB- and DEHP-containing lighting ballasts.
 - 3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply. Existing circuits may be demolished back to the nearest junction box and reused in new construction activities provided separation of circuits as identified in Construction Documents is maintained. As-Built documents shall be updated to accurately reflect conditions.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- F. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- G. Repair adjacent construction and finishes damaged during demolition and extension work.
- H. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- I. Extend existing installations using materials and methods as specified.

3.04 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or that are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER
CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single conductor building wire.
- B. Metal-clad cable.
- C. Wiring connectors.
- D. Electrical tape.
- E. Heat shrink tubing.
- F. Wire pulling lubricant.
- G. Cable ties.
- H. Firestop sleeves.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 05 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2018).
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011 (Reapproved 2017).
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2017.
- F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.
- G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

- H. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.
- I. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2009.
- J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- L. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- M. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- N. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- O. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- P. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
- Q. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Metal-clad cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Provide new conductors and cables manufactured not more than one year prior to installation.
- D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- E. Comply with NEMA WC 70.
- F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- H. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.
- I. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.

J. Conductor Material:

1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
3. Tinned Copper Conductors: Comply with ASTM B33.

K. Minimum Conductor Size:

1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
2. Control Circuits: 14 AWG.

L. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

M. Conductor Color Coding:

1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.
 - d. Isolated Ground, All Systems: Green with yellow stripe.
 - e. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:

1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
2. Control Circuits: Stranded.

- C. Insulation Voltage Rating: 600 V.
- D. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
 - a. Size 4 AWG and Larger: Type XHHW-2.

2.04 METAL-CLAD CABLE

- A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- B. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Solid.
 - 2. Size 8 AWG and Larger: Stranded.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
- E. Provide oversized neutral conductors where indicated or required.
- F. Provide dedicated neutral conductor for each phase conductor where indicated or required.
- G. Grounding: Full-size integral equipment grounding conductor.
 - 1. Provide additional isolated/insulated grounding conductor where indicated or required.
- H. Armor: Steel, interlocked tape.

2.05 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- D. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.

3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
 5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
 6. Conductors for Control Circuits: Use crimped terminals for all connections.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
 - F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
 - G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
 - H. Mechanical Connectors: Provide bolted type or set-screw type.
 - I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
 - J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

2.06 ACCESSORIES

- A. Electrical Tape:
 1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
 2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
 3. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
 4. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
 5. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
- C. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
- D. Cable Ties: Material and tensile strength rating suitable for application.

- E. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 - 2. When circuit destination is indicated without specific routing, determine exact routing required.
 - 3. Arrange circuiting to minimize splices.
 - 4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
 - 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 - 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 - 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
 - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - b. Increase size of conductors as required to account for ampacity derating.
 - c. Size raceways, boxes, etc. to accommodate conductors.
 - 8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit. In instances where existing circuits, including homeruns, are utilized to serve new spaces/circuiting, the Electrical Contractor shall assure that the requirements identified in NEC 210.4(B) and 240.15(B) are met. This includes, but is not limited to, installation of handle ties at existing panel locations.
- B. Install products in accordance with manufacturer's instructions.

- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Install metal-clad cable (Type MC) in accordance with NECA 120.
- E. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- F. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- G. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
 - 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
- H. Terminate cables using suitable fittings.
 - 1. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- I. Install conductors with a minimum of 12 inches of slack at each outlet.
- J. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.
- K. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- L. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- M. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.

- 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- N. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
- 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
 - 3. Wet Locations: Use heat shrink tubing.
- O. Insulate ends of spare conductors using vinyl insulating electrical tape.
- P. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- Q. Identify conductors and cables in accordance with Section 26 05 53.
- R. Install firestopping to preserve fire resistance rating of partitions and other elements as directed.
- S. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 26 05 26

Grounding and Bonding for Electrical Systems

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures []for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified. Existing grounding system shall be extended to serve newly installed devices and equipment.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Bonding and Equipment Grounding:
 - 1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 - 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 - 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 - 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 - 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
 - 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
- F. Isolated Ground System:
 - 1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated/insulated equipment grounding conductors.
 - 2. Connect isolated/insulated equipment grounding conductors only to separate isolated/insulated equipment ground busses.
 - 3. Connect the isolated/insulated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 2. Provide products listed and labeled as complying with UL 467 where applicable.

- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26: Use insulated copper conductors unless otherwise indicated.
- C. Connectors for Grounding and Bonding:
 - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 - 2. Unless otherwise indicated, use mechanical connectors or compression connectors for accessible connections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 4. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- D. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- B. Section 26 05 33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
- C. Section 26 51 00 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2019.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing: Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems.

1.06 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 2. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - c. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.

- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Comply with MFMA-4.
 - 2. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - 3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
 - 4. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch diameter.
 - c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
 - e. Outlet Boxes: 1/4 inch diameter.
 - f. Luminaires: 1/4 inch diameter.
- F. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 - 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 - 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 - 4. Hollow Masonry: Use toggle bolts.
 - 5. Hollow Stud Walls: Use toggle bolts.
 - 6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 - 7. Sheet Metal: Use sheet metal screws.
 - 8. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
 - d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that mounting surfaces are ready to receive support and attachment components.
- B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).

- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Conduit Support and Attachment: Also comply with Section 26 05 33.13.
- I. Box Support and Attachment: Also comply with Section 26 05 33.16.
- J. Interior Luminaire Support and Attachment: Also comply with Section 26 51 00.
- K. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- L. Secure fasteners according to manufacturer's recommended torque settings.
- M. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 05 33.13 CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Aluminum rigid metal conduit (RMC).
- C. Intermediate metal conduit (IMC).
- D. Flexible metal conduit (FMC).
- E. Liquidtight flexible metal conduit (LFMC).
- F. Electrical metallic tubing (EMT).
- G. Conduit fittings.
- H. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Includes additional requirements for fittings for grounding and bonding.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 33.16 - Boxes for Electrical Systems.
- E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 26 27 23 - Indoor Service Poles.
- G. Section 27 10 00 - Structured Cabling: Additional requirements for communications systems conduits.

1.03 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2015.
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2015.
- C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A); 2015.
- D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.

- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.
- G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- J. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- K. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
- L. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
- M. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- N. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- O. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing: Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Project Record Documents: Record actual routing for conduits 2 inch (53 mm) trade size and larger.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- D. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- E. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- F. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- G. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
- H. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit:
 - 1. Maximum Length: 6 feet.
- I. Connections to Vibrating Equipment:
 - 1. Dry Locations: Use flexible metal conduit.
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 - 3. Maximum Length: 6 feet unless otherwise indicated.
 - 4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.

2.02 CONDUIT REQUIREMENTS

- A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.

- B. Communications Systems Conduits: Also comply with Section 27 10 00.
- C. Fittings for Grounding and Bonding: Also comply with Section 26 05 26.
- D. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- E. Provide products listed, classified, and labeled as suitable for the purpose intended.
- F. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 1/2 inch (16 mm) trade size.
 - 2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
 - 3. Control Circuits: 1/2 inch (16 mm) trade size.
 - 4. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
- G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- B. Fittings:
 - 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
 - 3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 INTERMEDIATE METAL CONDUIT (IMC)

- A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- B. Fittings:
 - 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
 - 3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.05 FLEXIBLE METAL CONDUIT (FMC)

- A. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.

2.07 ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
 - 3. Connectors and Couplings: Use compression (gland) type.
 - a. Do not use indenter type connectors and couplings.
 - b. Do not use set-screw type connectors and couplings.
 - 4. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.

2.08 ACCESSORIES

- A. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- B. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- C. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that mounting surfaces are ready to receive conduits.
- B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install intermediate metal conduit (IMC) in accordance with NECA 101.

E. Conduit Routing:

1. Unless dimensioned, conduit routing indicated is diagrammatic.
2. When conduit destination is indicated without specific routing, determine exact routing required.
3. Conceal all conduits unless specifically indicated to be exposed.
4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
5. Arrange conduit to maintain adequate headroom, clearances, and access.
6. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
7. Arrange conduit to provide no more than 150 feet between pull points.
8. Route conduits above water and drain piping where possible.
9. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
10. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
11. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.

F. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use of spring steel conduit clips for support of conduits is permitted only as follows:
 - a. Support of electrical metallic tubing (EMT) up to 1 inch (27 mm) trade size concealed above accessible ceilings and within hollow stud walls.
9. Use of wire for support of conduits is not permitted.
10. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

G. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

H. Penetrations:

1. Make penetrations perpendicular to surfaces unless otherwise indicated.
2. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
3. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
4. Provide metal escutcheon plates for conduit penetrations exposed to public view.
5. Install firestopping to preserve fire resistance rating of partitions and other elements.

I. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:

1. Where conduits cross structural joints intended for expansion, contraction, or deflection.

J. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:

1. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

K. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

L. Provide grounding and bonding in accordance with Section 26 05 26.

M. Identify conduits in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

- C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 05 33.16

BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 33.13 - Conduit for Electrical Systems:
 - 1. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 27 26 - Wiring Devices:
 - 1. Wall plates.
 - 2. Additional requirements for locating boxes for wiring devices.
- F. Section 27 10 00 - Structured Cabling: Additional requirements for communications systems outlet boxes.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2018.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 508A - UL Standard for Safety Industrial Control Panels; 2018.
- J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for outlet and device boxes and junction and pull boxes.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 BOXES

A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
4. Use cast aluminum boxes where aluminum rigid metal conduit is used.
5. Use raised covers suitable for the type of wall construction and device configuration where required.
6. Use shallow boxes where required by the type of wall construction.
7. Do not use "through-wall" boxes designed for access from both sides of wall.
8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
10. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
11. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.
 - b. Communications Systems Outlets: Comply with Section 27 10 00.
12. Wall Plates: Comply with Section 26 27 26.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:

1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
4. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.

- D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may not be used.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that mounting surfaces are ready to receive boxes.
- B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Box Locations:
 - 1. Locate boxes to be accessible. Provide access panels as required where approved by the Architect.
 - 2. Locate boxes as required for devices installed under other sections or by others.
 - a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 27 26.
 - b. Communications Systems Outlets: Comply with Section 27 10 00.
 - 3. Locate boxes so that wall plates do not span different building finishes.
 - 4. Locate boxes so that wall plates do not cross masonry joints.
 - 5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 - 6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 - 7. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
 - 8. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.

9. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.
10. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Electrical rooms.
 - c. Mechanical equipment rooms.

H. Box Supports:

1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.

I. Install boxes plumb and level.

J. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

K. Install boxes as required to preserve insulation integrity.

L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

M. Install firestopping to preserve fire resistance rating of partitions and other elements.

N. Close unused box openings.

O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

P. Provide grounding and bonding in accordance with Section 26 05 26.

Q. Identify boxes in accordance with Section 26 05 53.

3.03 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Warning signs and labels.

1.02 RELATED REQUIREMENTS

- A. Section 09 91 23 - Interior Painting.
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- C. Section 26 27 26 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.
- D. Section 27 10 00 - Structured Cabling: Identification for communications cabling and devices.

1.03 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 70E - Standard for Electrical Safety in the Workplace; 2018.
- E. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.06 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 - PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain whose designations are changed as part of the new work.
- B. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify power source and circuit number. Include location when not within sight of equipment.
 - 2) Identify load(s) served.
 - b. Transfer Switches:
 - 1) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
 - 2) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
 - 2. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
 - 3. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations indicated.
 - 4. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
 - a. Minimum Size: 3.5 inches by 5 inches.
 - b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
- C. Identification for Conductors and Cables:
 - 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 - 2. Identification for Communications Conductors and Cables: Comply with Section 27 10 00.

D. Identification for Raceways:

1. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.

E. Identification for Boxes:

1. Use color coded boxes to identify systems other than normal power system.
 - a. Color-Coded Boxes: Field-painted in accordance with Section 09 91 23 per the following color code:
 - 1) Fire Alarm System: Red.
 - b. For exposed boxes in public areas, do not color code.
2. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
 - a. For exposed boxes in public areas, use only identification labels.

F. Identification for Devices:

1. Identification for Communications Devices: Comply with Section 27 10 00.
2. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
3. Use identification label to identify fire alarm system devices.
 - a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
4. Use identification label to identify serving branch circuit for all receptacles.
5. Use identification label to identify serving branch circuit for all light switches.
6. Use identification label to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Labels:

1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - a. Use only for indoor locations.
2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

B. Format for Equipment Identification:

1. Minimum Size: 1 inch by 2.5 inches.
2. Legend:
 - a. Equipment designation or other approved description.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
 - a. System Designation: 1 inch.
 - b. Equipment Designation: 1/2 inch.
 - c. Other Information: 1/4 inch.
 - d. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.
5. Color:
 - a. Normal Power System: White text on black background.
 - b. Emergency Power System: White text on red background.

C. Format for Receptacle Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Power source and circuit number or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

D. Format for Fire Alarm Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on white background.

2.03 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:

1. Materials:
2. Minimum Size: 7 by 10 inches unless otherwise indicated.

C. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - a. Do not use labels designed to be completed using handwritten text.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:

1. Surface-Mounted Equipment: Enclosure front.
2. Flush-Mounted Equipment: Inside of equipment door.
3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
4. Elevated Equipment: Legible from the floor or working platform.
5. Interior Components: Legible from the point of access.
6. Conduits: Legible from the floor.
7. Boxes: Outside face of cover.

- 8. Conductors and Cables: Legible from the point of access.
- 9. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

- A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 26 08 00

ELECTRICAL SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Systems and equipment Start-Up and Functional Performance Testing.
- B. Validation of proper and thorough installation of Division 26 systems and equipment.
- C. Generic Startup Documentation for mechanical systems and equipment.
- D. Development of final Startup Documentation for mechanical systems and equipment.
- E. System Startup and Turn-Over procedures.
- F. Coordination and execution of Training Events.

1.2 GENERAL DESCRIPTION

- A. Commissioning (Cx) is the process of ensuring that (i) all building systems are installed and perform interactively according to the design intent; (ii) that systems are efficient and cost effective and meet the Owner's operational needs; (iii) that the installation is accurately documented; and (iv) that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.
- B. Commissioning Authority (CA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.
- C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.
- D. This Section outlines the Cx procedures specific to the Division 23 Contractors. Requirements common to all Sections are specified in Section 019100 and Section 019113.13 This Section and other sections of the specification details the Contractor's responsibilities relative to the Cx process.

1.3 SCOPE

- A. Electrical Systems: All Division 26 equipment and systems are subject to commissioning, including but not limited to the systems listed below. All components and devices that make up these systems are included.

1. Medium Voltage Feeders and Primary Service Feeders.
2. Medium Voltage Disconnect & Grounding Switches.
3. Medium Voltage Interior Transformers.
4. Grounding Equipment and Building Grounding System.
5. Network Protectors.
6. Switchgear/Switchboards.
7. Disconnect Switches.
8. Circuit Breakers.
9. Motor Controllers.
10. Distribution Dry-Type Transformers.
11. Distribution and Branch Circuit Panelboards.
12. Feeders and Large Branch Circuits.
13. Branch Circuits and Receptacles.
14. Lighting and Lighting Controls.
15. Motors.
16. Commissioning coordination with Division 23 Requirements for BAS Integration.

1.4 RELATED WORK AND DOCUMENTS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents. See Division 01 for details.
- B. The Cx process references many related Sections, particularly Section 019100 - General Commissioning Requirements. It is important for all Contractors subject to the Cx process to be familiar with Section 019100.
- C. Section 019113.13 – General Commissioning Requirements for Functional Performance Testing.
- D. Section 220800 – Plumbing System Commissioning.
- E. Section 230800 – HVAC System Commissioning.
- F. Section 230810 – BAS Commissioning.

1.5 DEFINITIONS AND ABBREVIATIONS

- A. Refer to Section 019100 for a complete list of Definitions and Abbreviations.

1.6 REFERENCE STANDARDS

- A. Refer to Section 019100 for a complete list of Definitions and Abbreviations.
- B. ASHRAE Standard 202 – Commissioning Process for Buildings and Systems.
- C. ASHRAE Guideline 0 – The Commissioning Process.
- D. ASHRAE Guideline 1.1 – HVAC&R Technical Requirements for the Commissioning Process.
- E. ASHRAE Guideline 1.3 – Building Operations and Maintenance Training for the HVAC&R Commissioning Process.

- F. ASHRAE Guideline 1.4 – Procedures for Preparing Facility Systems Manual.
- G. National Electric Code (NEC).
- H. American Society for Testing and Materials (ASTM).
- I. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA).
- J. Illuminating Engineering Society (IES).
- K. Institute of Electrical and Electronics Engineers (IEEE).
- L. International Electrical Testing Association (NETA).
- M. National Electrical Manufacturers Associates (NEMA).
- N. National Fire Protection Association (NFPA).
- O. Underwriters Laboratory, Inc. (UL).
- P. Refer to Section 019100 for additional Reference Standards.

1.7 DOCUMENTATION

- A. Documentation shall be as required in Section 019100. In addition, Contractor shall also provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:
 - 1. Short Circuit and Coordination Study: CA shall review and recommend approval.
 - 2. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase. Factory Test Reports shall be provided in PDF electronic format. These include but are not limited to:
 - a. Enter any factory tested equipment.
 - 3. Field Testing Agency Reports: Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in PDF electronic format. These may include but are not limited to:
 - a. Electrical Testing Agency Reports per Division 26.
 - b. Thermographic Survey Report.
 - c. Generator Load Testing.
 - d. Other.
 - 4. Sample of distribution panel and receptacle labeling for approval.
 - 5. Fire Alarm System Approvals and Certifications.

1.8 SEQUENCING AND SCHEDULING

- A. Refer to Section 019100.

1.9 COORDINATION MANAGEMENT PROTOCOLS

- A. Coordination responsibilities and management protocols relative to Cx are initially defined in Section 019100 and the Cx Plan, but shall be refined and documented in the Construction Phase Cx Kick-Off Meeting. Contractor shall have input into the protocols to be used and all Parties will commit to scheduling obligations. The CA will record and distribute.

1.10 CONTRACTOR RESPONSIBILITIES

- A. Refer to Section 019100: Detailed Contractor responsibilities common to all Divisions are specified in Section 019100. The following are additional responsibilities or notable responsibilities specific to Division 26.
- B. Construction Phase.
 - 1. Provide skilled technicians qualified to perform the work required.
 - 2. Provide factory-trained and authorized technicians where required by the Contract Documents.
 - 3. Prepare and submit required draft Startup Documentation and submit along with the manufacturer's application, installation and startup information.
 - 4. Provide assistance to the CA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review FPT procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.
 - 5. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere in this Section.
 - 6. Startup, test/adjust/balance, and Turn-Over systems and equipment prior to functional performance testing by the CA. Approved Startup Documentation shall be in accordance with Contract Documents, reference or industry standards, and specifically elsewhere in Part I of this Section.
 - 7. Record Startup on approved Startup Documentation forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above. Each task or item shall be indicated with the Party actually performing the task or procedure.
 - 8. Coordinate the work of the Electrical Testing Agency and the Cx requirements.
 - 9. Coordinate the checkout of the Fire Alarm System and the approval of the regulatory authorities with the Cx process.
- C. Acceptance Phase.
 - 1. Assist CA in Functional Performance Testing. Assistance will typically include the following:
 - a. Manipulate systems and equipment to facilitate Functional Performance Testing (as specified in Section 019100, Section 019113.13, and the Cx Plan; in some cases this will entail only an initial sample).
 - b. Provide any specialized instrumentation necessary for Functional Performance Testing.
- D. Warranty Phase.
 - 1. Maintain record documentation of any configurations, setpoints, parameters, etc. that change throughout the Warranty Period.

2. Provide representative for off-season testing as required by CA.
3. Respond to warranty issues as required by Division 01 and the General Conditions.

1.11 EQUIPMENT SUPPLIER RESPONSIBILITIES

- A. Refer to Section 019100.

1.12 CONTRACTOR NOTIFICATION AND SCHEDULING

- A. Refer to Section 019100.

1.13 STARTUP DOCUMENTATION

- A. Refer to Section 019100.

1.14 EQUIPMENT NAMEPLATE DATA

- A. Refer to Section 019100.

1.15 FUNCTIONAL PERFORMANCE TESTING

- A. For applicable systems and equipment, Contractor shall participate in the initial samples of Functional Performance Testing as stipulated in Section 019100 and Section 019113,13.

1.16 FPT ACCEPTANCE CRITERIA

- A. Acceptance criteria for tests are indicated in Section 01 91 10 and in the specification Sections applicable to the systems being tested. Unless indicated otherwise, the criteria for acceptance will be that specified with the individual system, equipment, component, or device, which shall typically conform to NFPA 70B and International Electrical Testing Association (NETA) testing specifications NETA ATS-1991.

1.17 TRAINING EVENTS AND TRAINING PLAN

- A. Contractors, subcontractor, vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 019100 and the individual Specifications.

1.18 SYSTEMS MANUAL AND O&M DOCUMENTATION CONTENT

- A. Refer to Section 019100.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

- A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. Unless otherwise noted, all equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.
- B. Testing Instrumentation: Contractor shall provide all instrumentation necessary for tests for which they are responsible. CA will provide standard instrumentation for measuring medium and low voltage electrical voltage, current, power factor, power, and total harmonic distortion (THD). CA will provide receptacle testers for normal and GFI receptacle tests. Contractor shall provide all other instrumentation required to accomplish the specified testing.

PART 3 - EXECUTION

3.1 GENERAL STARTUP DOCUMENTATION

- A. This Section outlines 'generic' or minimally acceptable Startup Documentation (which are defined to include both 'Startup Checks' and 'Startup Tests') and individual systems training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimally acceptable guideline for required Contractor development of Startup Documentation. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized final Startup Documentation specific to the equipment and systems installed on this project.
- B. Section 019100 defines the systems and equipment Startup process in detail and provides definitions for Startup Documentation, including the generic Startup Documentation provided below.
- C. Refer to Division 26 for additional details regarding the Electrical Testing required.

3.2 STARTUP DOCUMENTATION COMMON TO ALL SYSTEMS

- A. The following Startup Documentation (Checklists and Tests) shall be considered common to all systems:
 - 1. Checkout shall proceed from lower level devices to larger components to the entire system operation.
 - 2. Verify labeling is affixed per specification and visible.
 - 3. Verify prerequisite procedures are done.
 - 4. Inspect for damage and ensure none is present.
 - 5. Verify system is installed per the manufacturer's recommendations.
 - 6. Verify system has undergone Startup per the manufacturer's recommendations.
 - 7. Verify that access is provided for inspection, operation and repair.
 - 8. Verify that access is provided for eventual replacement of the equipment.
 - 9. Verify that record drawings, submittal data and O&M documentation accurately reflect the installed systems.

10. Verify all gauges and test ports are provided as required by contract documents and manufacturer's recommendations.
11. Verify all recorded nameplate data is accurate.
12. Verify that the installation ensures safe operation and maintenance.
13. Verify specified replacement material/attic stock has been provided as required by the Contract Documents.
14. Verify all rotating and moving parts are properly lubricated.
15. Verify all monitoring and ensure all alarms are active and set per Owner's requirements.
16. Complete all nameplate data and confirm that ratings conform to the design documents.

3.3 TESTING PROCEDURES

A. Thermographic Scanning.

1. The infrared scan shall be made when the equipment is energized and is operating at its normal capacity, unless otherwise noted. It is intended that the scan be made after the equipment has been in full operation; however, the exact time of conducting the scan will be determined by the CA near the completion of the project.
2. Test equipment, miscellaneous tools, and materials shall be transported properly, moved, and set up by trained personnel. Equipment used in testing shall be capable to perform all recommended procedures required by the apparatus and related equipment. All test equipment shall have certification of calibration and be in working order.
3. All hot spots shall be marked, identified and an infrared thermographic scanning report prepared and furnished to the Owner.
4. The report shall contain infrared photos of trouble spots with temperature readings.
5. All sources indicating heat problems shall be promptly reported to the Owner for corrective action by the Division 26 contractor.

B. Grounding Systems.

1. Perform three-point fall-of-potential test per IEEE Standard 81 on the main grounding electrode or system. Resistance shall be no greater than 5 ohms.
2. Perform the two-point method test per IEEE Standard 81 to determine the ground resistance between the main ground system and all major electrical equipment frames, system neutral, and/or derived neutral points. Resistance shall be no greater than 5 ohms.

3.4 MEDIUM VOLTAGE FEEDERS AND PRIMARY SERVICE FEEDERS

- A. Include all applicable "Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.
- B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.
- C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions:
 1. Inspect underground duct banks.
 2. Inspect cable and perform field testing on reels.
 3. Inspect splicing and terminations.
 4. Verify that all phase, neutral, and ground conductors are routed together in raceways and properly grouped within switchgear to minimize heating.

5. Visually and mechanically inspect to include the following: Exposed cable, compression type terminations, splices, and fire proofing in manholes, cable vaults, etc.
 6. Correct identification and phasing arrangements.
- D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions:
1. Inspect cable support and terminations. Inspect cables for physical damage and connections as per the single-line diagram. Ensure equipment edges are not in contact with cables or that protective padding is provided. Verify cable size, type, identification, and ratings match specifications and single-line diagram. Verify correct over-current protection.
 2. Check visible cable bends against ICEA and manufacturer's minimum allowable bending radius.
 3. Verify that neutrals and grounds are properly terminated for normal operation of protective devices.
 4. Perform insulation resistance tests on each cable with respect to ground and adjacent cables.
 5. Perform shield-continuity tests on each power cable by ohmmeter method.
 6. Perform acceptance test on cables in accordance with NETA 7.3.3.2.4.

3.5 MEDIUM VOLTAGE DISCONNECT / GROUNDING SWITCHES

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.
- B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project. For switches that contain medium voltage circuit breakers, provide the services of a factory-authorized Service Representative to supervise the installation, make adjustments, perform tests on the breakers and train Owner's maintenance personnel.
- C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions:
1. Visual and Mechanical Inspections listed in NETA 7.5.1.2.1.
 2. Visual and Mechanical Inspections listed in NETA 7.6.1.3.2 (MV circuit breakers).
 3. Inspect incoming power cable terminations.
 - a. Verify voltage source is correct for cubicle space heater.
- D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
1. Visually and mechanically inspect to include the following: anchoring, grounding, oil level, torque of bus and cable connections, and mechanical operation of switch and operating mechanisms.
 2. Electrical Tests listed in NETA 7.5.1.2.2.
 3. Electrical tests listed in NETA 7.6.1.3.2 (MV circuit breakers). Optional tests are not required.
- E. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.6 MEDIUM VOLTAGE LIQUID-FILLED INTERIOR TRANSFORMERS

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.
- B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.
- C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.
 - 1. Visual and Mechanical Inspections listed in NETA 7.2.2.1.
- D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
 - 1. Visually and mechanically inspect to include the following: anchoring, grounding, liquid levels, installation verification using manufacturer's checklist, torque of bus and cable connections, and tap changer operation.
 - 2. Electrical tests listed in NETA 7.2.2.2. Optional tests are not required.
 - 3. Check and confirm percent of impedance is identical for all paralleled transformers comparing nameplates.
 - 4. Verify oil level based on current temperature.
 - 5. Measure the pressure of the transformer. Recheck 1 week, 1 month, and 6 months after initial measurement and verify the pressure remained constant.
- E. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.7 MEDIUM VOLTAGE DRY-TYPE INTERIOR TRANSFORMERS

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.
- B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.
- C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.
 - 1. Visual and Mechanical Inspections listed in NETA 7.2.1.2.1.
- D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
 - 1. Visually and mechanically inspect to include the following: anchoring, grounding, liquid levels, installation verification using manufacturer's checklist, torque of bus and cable connections, and tap changer operation.
 - 2. Electrical tests listed in NETA 7.2.1.2.2. Optional tests are not required except for winding resistance test.
 - 3. Check and confirm percent of impedance is identical for all paralleled transformers comparing nameplates.

- E. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.8 GROUNDING/BUILDING GROUNDING SYSTEM

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.
- B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.
- C. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
 1. Conduct fall of potential ground resistance tests per IEEE Standard 81 at each test well and at service equipment.
 2. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

3.9 SWITCHGEAR AND SWITCHBOARDS

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.
- B. General: Provide the services of a Factory-Trained Manufacturer's Representative to assist the Contractor in the installation and start-up service of the equipment for a period of 3 working days in 3 visits and train Owner's maintenance personnel as specified below. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.
- C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.
 1. Visual and Mechanical Inspections listed in NETA 7.1.1.
 2. Check calibration/setting of trip devices using system coordination study.
 3. Verify calibration/setting of digital metering.
- D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
 1. Visually and mechanically inspect to include the following: anchoring; grounding; torque of feeder and incoming bus duct connections; feeder cable and integral main bus connections; switchgear section alignments; electrical clearances; mechanical operation of breaker/fuse drawout elements and operating mechanisms, manual trip function; main bus safety shutters; and installation verification using manufacturer's checklist.
 2. Electrical tests listed in NETA 7.1.2. Optional tests are not required.
 3. Test each breaker in accordance with the Circuit Breaker tests listed in this Section.
 4. Conduct operational/functional tests of protective relaying. Time-current tests shall be conducted and trip points shall be set per the Short Circuit and Coordination Study.
- E. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.10 DISCONNECT SWITCHES

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.
- B. General: Refer to the quality control requirements listed in applicable Sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.
- C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.
 - 1. Visual and Mechanical Inspections listed in NETA 7.5.1.1.1.
 - 2. Check installation of warning nameplates and equipment nametags.
- D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
 - 1. Electrical tests listed in NETA 7.5.1.1.2.
- E. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.11 CIRCUIT BREAKERS

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.
- B. General: Provide the services of a manufacturer-certified specialist to supervise the installation, make adjustments, and perform tests on the insulated case breakers, power breakers and medium- voltage breakers and train Owner's maintenance personnel. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.
- C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.
 - 1. Visual and Mechanical Inspections listed in NETA 7.6.1.1.1 insulated case and molded case breakers, NETA 7.6.1.2.1 for low-voltage power breakers, and NETA 7.6.1.3.1 for medium- voltage air breakers.
- D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
 - 1. Electrical tests listed in NETA 7.6.1.1.2 insulated case and molded case breakers, NETA 7.6.1.2.2 for low-voltage power breakers, and NETA 7.6.1.3.2 for medium-voltage air breakers. Optional tests are not required.
- E. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.12 MOTORS

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.
- B. General: Electrical contractor shall check for adequate electrical connection for each motor. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.
- C. Start-Up Checks and Tests: Follow the manufacturer's written procedures and the following as a minimum:
 - 1. Inspect terminations and grounding.
 - 2. Ensure proper access to all electrical equipment.
 - 3. Ensure proper labeling of all electrical equipment.
 - 4. Compare wiring of poles to manufacturer's instructions.
 - 5. Check voltage-to-disconnects with disconnect open and compare to rating data.
 - 6. In collaboration with the Contractor who supplied the motor, bump it and ensure proper rotation.
 - 7. Test each motor with megger and record readings. Megger test shall be performed at the final disconnect switch/breaker for the motor.
 - 8. Check the overloads in comparison to FLA noted on the motor nameplate and ensure adequacy of protection and reliability.
 - 9. Observe several starts to ensure the start is reliable.

3.13 DISTRIBUTION DRY-TYPE TRANSFORMERS

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.
- B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.
- C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.
 - 1. Inspect wiring connections.
 - 2. Insure taps are adjusted.
 - 3. Inspect grounding.
- D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
 - 1. Visually and mechanically inspect to include the following: mounting, grounding, electrical clearances, and K-factor and/or isolating transformers are installed where required.
 - 2. Perform insulation resistance, turns ratios, and polarity tests on each type /size of transformer.
- E. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.14 DISTRIBUTION AND BRANCH CIRCUIT PANELBOARDS

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.
- B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.
- C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.
 - 1. Visually and mechanically inspect to include the following: mounting, separate ground and neutral connections per circuit, completed circuit directories, electrical clearances, KAIC ratings of panelboard and breakers.
 - 2. Inspect wiring connections.
- D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
 - 1. Correct surge suppression devices installed.
 - 2. Conduct insulation resistance tests.
 - 3. Correct identification and phasing arrangements.
 - 4. Verify that branch circuit labeling on a minimum of 10% of the panelboard branch circuits matches the printed panelboard directory. If 25% or more of the tested branch circuits do not match the printed directory, verify another 10% of the panelboard branch circuits. If 25%, or more, of these branch circuits do not match the printed directory, verify 100% of the panelboard branch circuits.
- E. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.15 FEEDERS AND LARGE BRANCH CIRCUITS

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.
- B. General: This paragraph and subparagraphs apply to all feeders serving panelboards, and motor control centers, all conductors connected to switchgear and switchboards, and all circuits that are rated for 100 amps, or larger. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.
- C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.
 - 1. Inspect cable support and terminations.
 - 2. Verify equipment edges are not in contact with cables or that protective padding is provided.
 - 3. Visually and mechanically inspect to include the following: large junction and pull boxes, supports of raceways and cable bus, and compression type terminations.
 - 4. Torque test terminations and verify they are in accordance with manufacturers recommendations.
 - 5. Correct identification and phasing arrangements.

- D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
 - 1. Verify cable size and ratings match single-line diagram. Verify correct overcurrent protection.
 - 2. Torque test terminations and verify they are in accordance with manufacturers recommendations.
 - 3. Correct identification and phasing arrangements.
 - 4. Conduct continuity test of each feeder.
 - 5. Conduct insulation resistance test on each cable with respect to ground and adjacent cables.

3.16 LIGHTING CONTROLS

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.
- B. General: Refer to the quality control requirements listed in applicable sections of Division 23 and 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.
- C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.
 - 1. Ensure all labeling for all relays/contactors is affixed and accurate.
 - 2. Ensure all terminations are tight.
 - 3. Check sensor placement is adequate for required duty.
 - 4. Ensure adequate access is provided to all relays/contactors, timeclocks, etc.
 - 5. Ensure all circuits for the loads are energized and ready for testing.
 - 6. Obtain all time schedules and individual device time-delay settings for all spaces from the Owner.
- D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
 - 1. Test, calibrate, and set all sensing (photocells, motion sensors, etc.) devices.
 - 2. Verify the correct operation of all control devices (contactors, relays, timeclocks, BAS interface relays, etc.).
 - 3. Check full load current on all breakers serving controlled lighting to ensure that the breaker is properly sized.
 - 4. Check full load current on all control device contacts serving controlled lighting to ensure that the contact rating is properly sized.
 - 5. Enter all time schedules per Owner's direction. Individual device time-delay settings are handled as part of the Room/Zone Checkout described in this Section.
 - 6. Validate all interfaces with other systems on a point-by-point basis.
- E. Training: Train Owner's maintenance personnel on the operation, programming and maintenance of the lighting controls.

3.17 INTEGRATED LIGHTING CONTROL SYSTEMS

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.

- B. General: Provide the services of a factory-trained manufacturer's representative to assist the Contractor in the installation and start-up service of the lighting control system and train Owner's maintenance personnel as specified below. Representative will confirm the proper installation and operation of all system components. Refer to the quality control requirements listed in applicable sections of Division 23 and 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.
- C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.
 - 1. Ensure all labeling is affixed and accurate.
 - 2. Ensure all terminations are tight.
 - 3. Check sensor placement is adequate for required duty.
 - 4. Ensure adequate access is provided to all panels and that documentation of that panel is provided in it.
 - 5. Ensure all circuits for the loads are energized and ready for testing.
 - 6. Obtain all time schedules, individual device time-delay settings for all spaces, and on/off fade- rate settings from the Owner.
- D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
 - 1. Test, calibrate, and set all digital and analog sensing, and actuating devices. Calibrate each instrumentation device by making a comparison between the graphic display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the Start-Up Report.
 - 2. Check each digital control point by making a comparison between the control command at the control panel and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the OI display. Record the results for each device in the BAS Start-Up Report.
 - 3. Check full load current on all breakers serving controlled lighting to ensure that the breaker is properly sized.
 - 4. Check full load current on all control device contacts serving controlled lighting to ensure that the contact rating is properly sized.
 - 5. Enter all time schedules, override time-delays and on/off fade rates per Owner's direction.
 - 6. For Operator Interfaces:
 - a. Verify all elements on the graphics are functional and properly bound to physical devices and/or virtual points and that hot links or page jumps are functional and logical.
 - b. Output all specified reports for review and approval.
 - c. Verify the alarm printing and logging is functional and per requirements.
 - 7. Validate all interfaces with other systems on a point-by-point basis.
- E. Training: Train Owner's maintenance personnel on the operation and programming of the lighting control system. Two days of training will be provided.

3.18 ROOM AND ZONE CHECKOUT

- A. Include all applicable 'Start-Up Checks Common to All Systems'. Additional Start-Up Checks and Tests are as follows.

B. Contractor shall complete a checklist acknowledging completion of Div. 26 responsibilities for all rooms. Checklist shall include items such as the following as applicable:

C. Typical Room:

1. Receptacle covers on, clean and labeled.
2. Test every receptacle installed or reconnected under this contract with a receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open. Rewire receptacles with faults and retest.
3. Test each receptacle or branch circuit breaker having ground-fault circuit protection to assure that the ground-fault circuit interrupter will operate when subjected to a ground-fault current exceeding 5 mA within 1/40th of a second. Perform testing using an instrument specifically designed and manufactured for testing ground-fault circuit interrupters. "TEST" button operation shall not be acceptable as a substitute for this test. Replace receptacles that do not shut off power within the specified time limit and retest.
4. Visually and mechanically inspect raceways to include the following: large junction and pull boxes, supports of raceways, & compression type terminations.
5. Visually inspect the wiring connections and splices in surface wireways. Confirm that splices are adequately insulated and performed using components approved for the quantity of conductors included in the splice.
6. Light fixture in place and clean with lamps installed.
7. All lighting control devices checked for operation and labeling.
8. Verify that all occupancy sensors are installed according to manufacturer's recommendations to avoid incorrect cycling of light fixtures (motion outside of space causes lights to turn on, air discharging from ceiling registers causes lights to turn on, etc.)
9. Adjust occupancy sensor time delay according to Owner's instructions. Record the adjustment.

D. Rooms with Fire Alarm Devices:

1. Fire alarm sensors and enunciators in place and validated.

3.19 WORK SEQUENCE ILLUSTRATION

A. Reference Section 019100.

3.20 TRAINING

A. System training requirements are detailed in 019100.

END OF SECTION

SECTION 26 27 23 INDOOR SERVICE POLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Utility columns.

1.02 REFERENCE STANDARDS

- A. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS

- A. See Section 01 33 00 - "Submittal Procedures" for administrative requirements for submittal procedures.
- B. Product Data: Provide data on materials, finishes, receptacle and connector configuration, and attachment details.

1.04 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 UTILITY COLUMN COMPONENTS

- A. Main Body: Steel.
- B. Cover Plates: Steel.
- C. Convenience Receptacle Configuration: NEMA WD 6; Type 5-20. Furnish as specified in the design documents.
- D. Communications receptacles, if required to be mounted in the utility column, will be identified in the plans. Otherwise, the utility column will be used as a pathway between accessible locations and systems furniture connections.
- E. Foot: Suitable for floor finish as indicated.
- F. Provide concealed top clamp to fasten pole to inverted "T" grid ceiling suspension member.

2.02 ACCESSORIES

- A. Trim plates for closing ceiling opening.
- B. Flexible cable assembly with connector for branch circuit connections.

2.03 FABRICATION

- A. Wire utility column with 12 AWG copper conductor to outlet box attached to top of pole. Allow 6 inch leads for connection to branch circuit.
- B. Provide full-sized opening at top of pole.
- C. Finish: Coordinate with Interior Designer and the Owner.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that installation of ceiling suspension system is complete.
- B. Verify that floor covering installation is complete.
- C. Verify branch circuit wiring installation is completed, tested, in proper location, and ready for connection to indoor utility columns.
- D. Verify telephone raceway installation is completed, in proper location, and ready for connection to indoor utility columns.
- E. Verify data communication raceway installation is completed, in proper location, and ready for connection to indoor utility columns.

3.02 INSTALLATION

- A. Install utility columns plumb and fasten supports to structure.
- B. Make wiring connections to branch circuit outlets using flexible conduit under provisions of Section 26 05 33.13 – Conduit for Electrical Systems
- C. Bond equipment grounding conductor and body of pole to branch circuit equipment grounding conductor.
- D. Neatly cut openings in ceiling panels. Install trim plate.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Wall switches.
- B. Wall dimmers.
- C. Fan speed controllers.
- D. Receptacles.
- E. Wall plates.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 27 23 - Indoor Service Poles.
- F. Section 27 10 00 - Structured Cabling: Voice and data jacks.

1.03 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; 2017h.
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); 2017g.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2015).
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- I. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

- J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- L. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.
- M. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
5. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 - PRODUCTS

2.01 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D. Provide GFCI protection for receptacles installed within 6 feet of sinks or water sources.
- E. Provide GFCI protection for receptacles serving electric drinking fountains.
- F. Unless noted otherwise, do not use combination switch/receptacle devices.

2.02 WIRING DEVICE FINISHES

- A. Provide wiring device finishes as described below unless otherwise indicated.
- B. Wiring Devices, Unless Otherwise Indicated: White with white nylon wall plate.
- C. Wiring Devices Installed in Finished Spaces: White with white nylon wall plate.
- D. Wiring Devices Installed in Unfinished Spaces: Black with galvanized steel wall plate.
- E. Wiring Devices Installed in Wet or Damp Locations: Black with specified weatherproof cover.
- F. Isolated Ground Convenience Receptacles: Orange.
- G. Wiring Devices Connected to Emergency Power: Red with red nylon wall plate.

2.03 WALL SWITCHES

- A. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- B. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.04 WALL DIMMERS

- A. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
- B. Control: Slide control type with separate on/off switch.

2.05 RECEPTACLES

- A. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 - 2. NEMA configurations specified are according to NEMA WD 6.
- B. Convenience Receptacles:
 - 1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 - 2. Automatically Controlled Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; controlled receptacle marking on device face per NFPA 70; single or duplex as indicated on the drawings.
 - 3. Isolated Ground Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, with ground contacts isolated from mounting strap; isolated ground triangle mark on device face; single or duplex as indicated on the drawings.
- C. GFCI Receptacles:
 - 1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 - a. Provide test and reset buttons of same color as device.
 - 2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.

2.06 WALL PLATES

- A. Wall Plates: Comply with UL 514D.
 - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 - 2. Screws: Metal with slotted heads finished to match wall plate finish.
- B. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.
- C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- D. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.
- E. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- B. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- C. Verify that final surface finishes are complete, including painting.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switches: 48 inches above finished floor.
 - b. Wall Dimmers: 48 inches above finished floor.
 - c. Receptacles: 18 inches above finished floor or 6 inches above counter.
 - 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - 3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
 - 4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
 - 5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.
- I. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- J. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- K. Install wall switches with OFF position down.
- L. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- M. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- N. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- O. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- P. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- Q. Identify wiring devices in accordance with Section 26 05 53.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch and wall dimmer with circuit energized to verify proper operation.
- D. Test each receptacle to verify operation and proper polarity.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Architect.

3.06 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 51 00

INTERIOR LIGHTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Interior luminaires.
- B. Exit signs.
- C. Ballasts and drivers.
- D. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 26 05 33.16 - Boxes for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 27 26 - Wiring Devices: Manual wall switches and wall dimmers.

1.03 REFERENCE STANDARDS

- A. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Corrigendum 2012).
- B. IES LM-63 - IESNA Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).
- C. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.
- D. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015, with Errata (2017).
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- F. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2006.
- G. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2016.
- H. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012.
- I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

- L. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- M. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures for submittal procedures.

B. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
2. Provide photometric calculations where luminaires are proposed for substitution upon request.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires:

- a. Include estimated useful life, calculated based on IES LM-80 test data.
- b. Include IES LM-79 test report upon request.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting) and manufacturer's written instructions.

- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 77 00 - Closeout Procedures, for additional warranty requirements.
- B. Provide five year manufacturer warranty for LED luminaires, including drivers.
- C. Provide ten year pro-rata warranty for batteries for exit signs.

PART 2 - PRODUCTS

2.01 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.
- B. Substitutions: See Section 01 25 00 - Substitution Procedures, for substitutions.

2.02 LUMINAIRES

- A. Manufacturers:
 - 1. H. E. Williams Lighting: www.hew.com.
 - 2. Lithonia Lighting: www.lithonia.acuitybrands.com
 - 3. Columbia Lighting: www.hubbell.com/columbialighting/en
- B. Provide products that comply with requirements of NFPA 70.
- C. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- D. Provide products listed, classified, and labeled as suitable for the purpose intended.
- E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- H. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.

I. LED Luminaires:

1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.03 EXIT SIGNS

A. Manufacturers - Powered and Self-Luminous Signs:

1. Acuity Brands, Inc: www.acuitybrands.com/#sle.
2. Hubbell Lighting, Inc: www.hubbelllighting.com/#sle.
3. www.hew.com/products/indoor/Emergency.

B. Description: Internally illuminated exit signs with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

1. Number of Faces: Single or double as indicated or as required for the installed location.
2. Directional Arrows: As indicated or as required for the installed location.

2.04 BALLASTS AND DRIVERS

A. Ballasts/Drivers - General Requirements:

1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
3. Electronic Ballasts/Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.

B. Dimmable LED Drivers:

1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
2. Control Compatibility: Fully compatible with the dimming controls to be installed.
 - a. Wall Dimmers: See Section 26 27 26.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- B. Verify that suitable support frames are installed where required.
- C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install products in accordance with manufacturer's instructions.
- D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting).
- E. Provide required support and attachment in accordance with Section 26 05 29.
- F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- G. Suspended Ceiling Mounted Luminaires:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 - 3. Secure recessed luminaires to ceiling support channels or framing members or to building structure.
 - 4. Secure pendant-mounted luminaires to building structure.
 - 5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 - 6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gage, connected from opposing corners of each recessed luminaire to building structure.
 - 7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- H. Recessed Luminaires: Install trims tight to mounting surface with no visible light leakage.
- I. Suspended Luminaires:
 - 1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
 - 2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 - 3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
 - 4. Install canopies tight to mounting surface.
 - 5. Unless otherwise indicated, support pendants from swivel hangers.
- J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- K. Install accessories furnished with each luminaire.
- L. Bond products and metal accessories to branch circuit equipment grounding conductor.

M. Exit Signs:

1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

N. Install light source in each luminaire.

- O. Fixture Burn-In: Operate fixtures at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.04 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
- B. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

3.05 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting) and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

- A. Just prior to Substantial Completion, replace any fixtures that have failed or are not performing to their published specifications.

3.07 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 27 10 00 STRUCTURED CABLING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Communications pathways.
- B. Communications grounding and bonding.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 33.13 - Conduit for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products.

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2019d.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Owner will procure service related to providing and installing of communications receptacles, faceplates, horizontal cabling, patch panels, etc.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.

- B. Keep stored products clean and dry.

PART 2 - PRODUCTS

2.01 SYSTEM DESIGN

- A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
 - 1. Provide pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.

2.02 PATHWAYS

- A. Conduit: As specified in Section 26 05 33.13; provide pull cords in all conduit.
- B. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

2.03 GROUNDING AND BONDING COMPONENTS

- A. Comply with TIA-607.
- B. Comply with Section 26 05 26.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

- A. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.
- B. Install firestopping to preserve fire resistance rating of partitions and other elements.

3.02 INSTALLATION OF PATHWAYS

- A. Install pathways with the following minimum clearances:
 - 1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
 - 2. 12 inches from power conduits and cables and panelboards.
 - 3. 5 inches from fluorescent and high frequency lighting fixtures.
 - 4. 6 inches from flues, hot water pipes, and steam pipes.
- B. Conduit, in Addition to Requirements of Section 26 05 33.13:
 - 1. Arrange conduit to provide no more than the equivalent of 3 90 degree bend(s) between pull points.
 - 2. Conduit Bends: Inside radius not less than 10 times conduit internal diameter.
 - 3. Arrange conduit to provide no more than 100 feet between pull points.
 - 4. Do not use conduit bodies.

C. Outlet Boxes:

1. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of telecommunications outlets provided under this section.
 - a. Mounting Heights: Unless otherwise indicated, as follows:
 - 1) Telephone and Data Outlets: 18 inches above finished floor.
 - 2) Telephone Outlets for Side-Reach Wall-Mounted Telephones: 54 inches above finished floor to top of telephone.
 - 3) Telephone Outlets for Forward-Reach Wall-Mounted Telephones: 48 inches above finished floor to top of telephone.
 - b. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - c. Provide minimum of 24 inches horizontal separation between flush mounted outlet boxes installed on opposite sides of fire rated walls.
 - d. Unless otherwise indicated, provide separate outlet boxes for line voltage and low voltage devices.
 - e. Locate outlet boxes so that wall plate does not span different building finishes.
 - f. Locate outlet boxes so that wall plate does not cross masonry joints.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.

END OF SECTION



COMMISSIONING PLAN

FOR

**MDOT Administration Building
HVAC Control System Upgrade and
3rd Floor Space Reallocation**

**401 North West Street
Jackson, MS 39201**

Construction Documents

Version: January 19, 2021

Prepared By:

Chad E. Moore, Principal

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I. INTRODUCTION

A. Commissioning (Cx) Plan

This Commissioning (Cx) Plan shall outline the commissioning process for Administration Building HVAC Control System Upgrade and 3rd Floor Space Reallocation. Herein described are the responsibilities of the various Parties involved in the design, construction, and commissioning process and the procedures by which all Parties will endeavor to ensure the facility is designed, installed, started, tested, and documented to meet the Owner's needs and to ensure that the Operator's personnel are fully trained.

This plan focuses on the overview of the entire process and on the details of the non-construction contract Cx processes. The construction contract requirements are detailed in the project specifications.

B. Project Description

Renovation of the MDOT Administration Building 3rd Floor. Installation of new Building Automation System (BAS) to control the new 3rd Floor HVAC systems. The new BAS will be expanded in the future as additional floors are renovated.

C. Cx Plan Progression

Engineering Resource Group, Inc. (ERG) has been selected as the Commissioning Authority (CA) for the project. The CA has issued this Cx Plan at the stage of the design/construction process indicated on the title page. This Cx Plan will evolve throughout the process and be expanded with more detail as the design/construction of the facility evolves. Subsequent issues of this Cx Plan will be released at the appropriate stages of the process.

D. Role of the Cx Plan versus Cx Specifications

Although the Cx Plan is designed to cover the rules and responsibilities for the commissioning process, it is intended to primarily govern activities in the Programming and Design Phases of the project. The specific requirements of the Contractors are to be delineated within the various Cx related specifications, so as to minimize the need for the Contractor to consult the Cx Plan.

E. Cx Plan Scope Limits

The Commissioning Plan is a narrative that is intended to be instructional as opposed to directive in nature. The Cx Plan provides an extensive set of deliverables and milestones relating to commissioning that may or may not be within the scope of services contracted. Suggested deliverables may be presented within the Cx Plan that are unfunded, but these are kept within the Cx Plan in the event that the Owner may choose to fund these as the process progresses and/or the need arises.

F. Commissioning Overview

Commissioning is the systematic process of ensuring that all building systems perform interactively according to the *Owner's Project Requirements*. The commissioning process involves all the Parties involved in the design and construction process as well as the Owner and the Commissioning Authority (CA). It ideally begins early in the design process when the facility is being programmed and when the initial concepts and requirements for the building are being formulated. Commissioning then continues through the design and construction phases, through

the acceptance phase of the building and systems, and into the early occupancy of the building. Primary elements of commissioning include:

- Identifying and documenting the Owner's needs and the requirements of the facility;
- Ensuring that the designed systems are commensurate with and meet the Owner's needs;
- Ensuring that the systems installed are operable and maintainable;
- Testing of the systems to ensure that they are interacting and performing optimally;
- Ensuring that the *Owner's Project Requirements*, the installation, and the O&M requirements are clearly and thoroughly documented;
- Training for the operators and the facility staff to ensure they can operate and maintain the facility per the *Owner's Project Requirements*.

The CA oversees and coordinates the Cx efforts, although all Parties play a vital role in commissioning process.

II. GENERAL

A. Definitions and Abbreviations

1. **Acceptance Phase:** This is the phase of the project when the facility and its systems and equipment are inspected, tested, verified, and documented; and when most of the Functional Performance Testing and final training occurs. This will generally occur after the Construction Phase is complete. The Acceptance Phase begins upon System 'Turn-Over' with certification by the Contractor that the systems have been placed into service in accordance with the approved protocols and after the submission of the approved Start-Up Documentation. The Acceptance Phase ends with the successful completion of all Functional Performance Testing and sign-off by the CA.
2. **Action Item (AI):** Any issue that requires a response, completion, corrective or additional work, or any other action. Examples include a Request for Information (RFI), a work directive, a clarification request, a to-do item, an identified deficiency, or any other like item. Action Items must be categorized as appropriate.
3. **Action List:** This is a list that is maintained and updated by the CA that includes all Action Items that relate to Cx activities.
4. **Activation:** The process of relocating the occupants into the facility; fitting out the furniture, furnishings, and equipment (FF&E); and generally ensuring a smooth occupant transition. The Activation Manager is also known as the Move Coordinator.
5. **Architect (Architect):** General reference to the Architect/Engineer lead-design entity.
6. **ASHRAE:** American Society of Heating, Refrigerating, and Air Conditioning Engineers.
7. **Basis of Design (BOD) Document:** The Basis of Design document is developed by the design team, and shall respond to and be consistent with the performance criteria specified in the Owner's Project Requirements. The BOD illustrates the means by which the OPR criteria are to be achieved, documenting the assumptions and parameters used in the design, and documenting the primary thought processes or decisions made that resulted in the selected

alternatives. At the end of the project, the final BOD content may be incorporated into the Systems Manual if desired in part or in its entirety. The BOD is a required component for LEED-certified projects, and is recommended by ASHRAE for all projects subject to the Cx process.

8. **Building Automation Contractor (BAC):** Contractor generally responsible for the BAS installation specified in Division 23.
9. **Building Automation System (BAS):** The computer-based control or automation system. BAS is used throughout these Sections. Alternate references common in the industry include facility management system, automatic temperature control system, direct digital control system, building management system, building management and control system, digital control system, Energy Management System, Energy Management and Control System or System Control and Data Acquisition (SCADA) System.
10. **Building Automation Sub-System:** A reference to any automation system that must integrate to the BAS. This may be an individual Chiller to a complete Lighting System.
11. **Checklist Item:** An item to inspect to verify proper installation of equipment or systems by the Contractor. Checklist items simply require a 'Yes/No' or 'OK/Not' response. Start-Up Checklist items are one component of the Start-Up Documentation.
12. **Commissioning (Cx):** The process of ensuring that all building systems perform interactively in accordance with the *Owner's Project Requirements*, that the systems are efficient and cost effective, and that they meet the Owner's operational needs.
13. **Commissioning Authority (CA):** The Party retained by the Owner who will oversee and manage the Cx process, develop and stipulate many of the Cx requirements, and ensure and validate that systems and equipment are designed, installed and tested to meet the Owner's requirements.
14. **Commissioning Coordinator (CxC):** This refers to the Individual within each of the various Parties that is designated the POC for that Party relative to Cx activities. Each of the Contractors subject to the Cx process should designate a CxC and make that person available to the CA as the point-of-contact for that Contractor.
15. **Cx Record Matrix:** The Cx Record Matrix provides an ongoing and updated status of the Cx program as it is being executed. It is a table of all systems and equipment subject to the Cx process and the status and responsible party of Cx procedures relating to that equipment. Typical fields tracked include equipment tag, location, description, Start-Up Documentation status, FPT status, training status, status of submittals and record drawings, and final Cx disposition.
16. **Commissioning Specifications:** Generic reference to any of the Cx-specific specification Sections, as inferred by the usage. Divisions 01, 22, 23, 26, and others contain Sections that are specific to or reference the Cx process. All Contractor requirements relating to Cx should be conveyed within the Cx Specs. Cx Specs should be referenced but not duplicated within the Cx Plan (the Cx Plan is designed to govern non-Contractor-related Cx issues).
17. **Commissioning Team:** The group of Parties involved in the Cx process for any given system. The Cx Team will include a core group involved with all systems, consisting of the CA and CxC members representing the GC and the Owner. On any given system, the Cx Team will additionally include the Cx Coordinators for the Contractors responsible for the system or equipment.

18. **Contractor:** As used herein, 'Contractor' is a general reference to the installing Party and can therefore refer to the GC, subcontractors, or vendors as inferred by its usage.
19. **Construction Phase:** Phase of the project during which the facility is constructed and/or when systems and equipment are installed and started. Contractor and subcontractors complete the installation, complete Start-Up Documentation, submit O&M information, establish trends, and perform any other applicable requirements to make systems operational. Contractor and Vendors may also conduct '*Equipment and Systems Training*' events during this phase. The Construction Phase concludes upon completed Start-Up and TAB of systems and equipment.
20. **Contract Documents:** The documents governing the responsibilities and relationships between Parties involved in the design and construction of this project including (but not necessarily limited to):
 - a) Agreements/Contracts;
 - b) Construction Plans and Drawings;
 - c) Specifications;
 - d) BOD, OPR;
 - e) Addenda;
 - f) Change Orders;
21. **Construction Documents:** Refers generally to the Contract Documents that dictate the details of the installation (all but item a. above).
22. **Deficiency:** A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents, does not perform properly or is not complying with the *Owner's Project Requirements*.
23. **Electrical Contractor (EC):** Contractor generally responsible for Division 26 work.
24. **Factory-Authorized Representative:** An individual fully trained on the equipment and certified by the manufacturer to perform the respective task.
25. **Factory Testing:** Testing of equipment off-site at the manufacturer's facility. May be witnessed by the members of the project team.
26. **FF&E:** Furniture, Furnishing, and Equipment. This term is used to refer to the generally movable fit-out elements of a building that are not included in the construction contract but are dealt with during the Activation.
27. **Fire Alarm Contractor (FAC):** Contractor generally responsible for the fire alarm system installation specified in Division 28.
28. **Fire Suppression Contractor (FSC):** Contractor generally responsible for the installation of the fire suppression system (sprinkler, standpipe, and fire pump) as specified in Division 21.
29. **Fixed Construction:** elements of the building that are built in. This term is typically used in contrast to FF&E.
30. **Functional Performance Tests/Testing (FPT):** The detailed and thorough tests (and test procedure) developed and performed by the CA to document proper operation of building systems and the components and equipment making up those systems during the Acceptance Phase. References made to

FPT throughout the documents are inclusive of ISFPT unless specifically indicated otherwise.

31. **IAQ:** Indoor Air Quality
32. **Interactive System Functional Performance Testing (ISFPT):** The detailed and thorough testing of the interactions of various systems in the building. ISFPTs are considered a subset of the overall concept of FPT and therefore references made to FPT generally will include ISFPTs unless specifically indicated otherwise.
33. **Manufacturer's Representative:** Either an individual in direct employ of the manufacturer of the applicable system, or an individual who is certified by that manufacturer to perform the applicable work for which the reference is made. This is synonymous with Factory-Authorized Representative.
34. **Mechanical Contractor (MC):** Contractor generally responsible for Division 22 and 23 work.
35. **O&M Documentation:** Contractor-developed documentation designed to address the needs of facilities personnel and customized for the context of the specific facility and installation. The foundation of O&M Documentation is manufacturer's literature (O&M Manuals), with additional Contractor-developed step-by-step instructions for manual start/stop, emergency procedures, operating sequences, preventative maintenance, and other installation-specific information. O&M Documentation content is indexed and organized by equipment-type. When a Systems Manual is being developed by the CA, some of the Contractor developed content will need to be made available to the CA for inclusion into the Systems Manual.
36. **O&M Manuals:** Generic reference to manufacturer-published O&M materials, which have no information specific to the facility, but may be edited or marked up to indicate specific equipment or systems installed. O&M Manuals include documents covering installation, operation, maintenance, troubleshooting guides, parts numbers, engineering and design parameters, applications manuals, and any/all information available from the manufacturer pertaining to the installed equipment or systems. Specifications should strive for this information to be submitted in electronic form whenever possible. The electronic versions of these documents can also be electronically edited to indicate equipment installed and to delete or mask-over equipment and content that is not installed on the project.
37. **Observation Period (BAS):** Also known as Trend Period. The period of time either prior to or immediately following Functional Performance Testing where the BAS is shown to operate properly without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with the specifications.
38. **Opposite Season:** The season opposite that when the majority of the testing occurs.
39. **Owner:** The Owner is the Mississippi Department of Transportation (MDOT). MDOT's Architectural Services Department is the project's primary execution team. This team coordinates and implements project deliverables. This can be an individual or team directly employed by the Owner.
40. **Owner's Project Requirements (OPR):** The OPR is intended to provide the basis from which all design, construction, acceptance, and operational decisions are made. It details the functional requirements of the project, including systems subject to commissioning. The OPR defines the benchmarks

and metrics by which the success of the project is ultimately judged, and evolves through each project Phase. The OPR is typically developed early in the project cycle by the Owner and the Architect and provides the user needs, requirements, goals, and metrics that are defined by the Owner to be important. The OPR criteria are referenced by and should be the foundation of the BOD narrative. At the end of the project, content the final BOD may be incorporated into the Systems Manual. The OPR/BOD is a required component for LEED certified projects, and is recommended for all projects subject to the Cx process.

41. **Party:** Entity (company, corporation, stakeholder group, etc.) responsible for a portion of the project work or communications. Each Party will be designated by a shorthand acronym or abbreviation defined by the CA in all communications. This will facilitate grouping communications and clarifying individual responsibilities within the larger context of the construction project.
42. **Point of Contact (POC):** General reference to the key management individual within each Party. This may also be the CxC, but might be his superior or colleague.
43. **Pre-Contractual Phase:** This phase begins the inclusion of the Architect and possibly other subject matter experts into the process. During this phase the OPR will be refined and further developed to include the Architect project outputs, Commissioning Team outputs and necessary changes as required and defined within the DSM. The CA is responsible for coordinating and capturing these outputs into the OPR. The second development revision of the OPR is the primary output of this project phase.
44. **Prefunctional Checkout:** It is a modifier/property for checks, tests, and other activities that occur prior to and are prerequisites for Functional Performance Testing.
45. **Preliminary Service:** Refers to the initial operation of a system or piece of equipment to provide temporary service to the project. Initial Start-Up to determine safe operation will have been performed prior to placing any system into operation. Final adjusting, balancing, and Functional Performance Testing proceeds while the system is in Preliminary Service.
46. **Pre-Test:** Preliminary testing accomplished to verify system functionality prior to placing the system/equipment into Preliminary Service.
47. **Program Phase:** This phase marks the beginning of a new project. It is the initiating phase of all projects. The Office of Design and Construction and the Facilities Engineering and Campus Energy are responsible for initial OPR development, pre-project planning and preliminary design during this phase. The first development revision of the OPR is the primary output of this phase.
48. **Project Phases:** Phases of the project in chronological order are Program/Pre-Contractual Phase, Pre-Schematic Phase, Design Phase, Construction Phase, Acceptance Phase, Occupancy, Operations and Warranty Phase, and Occupancy.
49. **RFI:** Request for Information.
50. **Scheduled Outage:** A period of time, scheduled by the Owner, in which the system is out-of-service or not to be used by occupants.
51. **Start-Up:** Refers to the quality control procedures whereby the Contractor verifies the proper installation of a device or piece of equipment, executes the manufacturer's starting procedures, completes the 'Start-Up Checklist', energizes the device, verifies that it is in proper working order and ready for

dynamic testing, and completes the 'Start-Up Tests'. Start-Up procedures are performed by the Contractor with or without a formal Cx process, although the documentation is more formalized when the Cx process is used.

52. **Start-Up Checklist:** A list of items to inspect to verify proper installation of equipment or systems by the Contractor. Checklist items simply require a 'Yes/No' or 'OK/Not' response. These include primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension checked, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). Start-Up Checklist items are one component of the Start-Up Documentation.
53. **Start-Up Documentation:** Refers to the combination of Start-Up Checklists and Start-Up Tests. The Contractor documents the Start-Up procedure by completing and submitting the Start-Up Documentation. Start-Up Documentation may be a combination of procedures prepared by the CA, those included in the Contractors in-house quality assurance process, and those required by the manufacturer. Regardless of the context of the documentation or format of the forms used to document it, the reference to 'Start-Up Documentation' includes all of the stated procedures, checklists and tests.
54. **Start-Up Test:** This is a quality assurance test that is required to ensure the system is ready to be placed into service. It differs from a checklist item in that it requires more than a binary (yes/no, OK/Not OK) response. An observation, measurement, or sequence of events must be documented. Start-Up Tests are one component of the Start-Up Documentation.
55. **Substantial Completion:** The point in time where the Owner accepts responsibility for the following items: Maintenance & Operation of the building and its systems, cost of utilities, security for the site and building, and property insurance for the facility. Substantial completion does not relieve the contractor from completing the punchlist and incomplete items.
56. **System Turn-Over Meeting ("Turn-Over" or STOM):** Turn-Over is a quality control milestone in which all Contractors responsible for completing the installation and start-up of a system or equipment, along with the Owner's Representatives, meet to validate that the system or equipment is completed and operational per the contract documents and ready for Functional Performance Testing, and that all the Start-Up Documentation and nameplate data is complete and accurate. The CA will in many cases participate in this. GC shall organize and lead the process in all cases.
57. **Systems Manual:** The Systems Manual is the final deliverable from the Cx process, and provides the information needed to understand, operate, and maintain the facility and its systems. It is typically developed by the CA or Architect, but with content required to be provided by the design team and the Contractors. The Systems Manual expands the scope of standard O&M documentation to incorporate additional information developed through the Cx process. The Systems Manual should be the repository of all updates and corrections as they occur for the entire Life Cycle of the facility. It is narrative in nature and organized by system types and by area/usage of the facility (if applicable). Systems Manual content typically includes narrative descriptions of the facility and systems, sequences of operation, schematic diagrams, cuts from design drawings and equipment literature, photos, and manual start/stop and emergency operating procedures for important equipment. The content of the Systems Manual is dictated by budget, and usually consists of a single narrative document with references to and inclusive of the entire set of O&M and Training materials.

58. **Test:** A task, procedure or measurement that confirms a performance criteria of a system or component of a system. Tests are assigned one of 4 possible status values; "Pass", "Fail", "Couldn't Test" or "Didn't Test". The status value may apply to Start-Up or Functional Performance Tests.
59. **TAB:** Can refer to the test, adjust, and balance process or the Testing, Adjusting, and Balancing Agency as inferred by its usage.
60. **Temporary Conditioning Plan:** A plan that summarizes the logistics, procedures and protocols for taking permanent equipment and using it to maintain conditions throughout construction. The Temporary Conditioning Plan must be approved by all members of the Cx Team prior to placing equipment into temporary service.
61. **Testing Agency:** An independent agency typically retained by the Contractor to perform specialized testing of systems or equipment (most commonly electrical). The Testing Agency shall be qualified and equipped to perform the testing and shall submit appropriate qualifications.
62. **Trending:** Monitoring and recording a history of parameters typically using the building automation system.
63. **Turn-Over:** See "System Turn-Over Meeting" above.
64. **Vendor:** Refers to the organization that sold a system or equipment to the subcontractor. This may be a branch office of the manufacturer or a value-added reseller.
65. **Warranty Period:** The period defined by the construction documents where elements of the facility are under contractual warranty.
66. **Warranty Phase:** Includes the early occupancy of the building and can continue through the contractual Warranty Period and at least into the opposite season from when the facility systems were initially tested.

B. Scope of Commissioning Services

The following systems and equipment are included in the Scope of Commissioning for this project. The sampling rates are 100% of central systems and 25% of zone systems.

1. **Mechanical/HVAC Systems:** Most Division 23 equipment and systems are subject to commissioning, including the systems listed below. All components and devices (sensors, valves, etc.) that make up these systems are included.
 - a) Air Handling Units (AHU)
 - b) VAV terminal units
 - c) Hydronic Systems
 - d) Supply, Return, Relief, Exhaust Air systems
2. **Building Automation Systems (BAS)**
 - a) The entire BAS shall be subject to commissioning, including all hardware components, software, networking, programming and engineering services, and controls documentation.
3. **Electrical Systems:** All Division 26 equipment and systems may be subject to commissioning, including but not limited to the systems listed below. All components and devices that make up these systems are included.
 - a) Luminaires
 - b) Lighting Control Systems

- c) Power Distribution Systems (Feeders, Disconnects, Switches, Panelboards, transformers, Motor Control Centers)
 - d) Fire Alarm and Detection Equipment and Systems
 - e) Switchgear and Automatic Transfer Switches
 - f) Grounding Systems
 - g) Uninterruptible Power Systems (UPS)
 - h) Emergency Power Systems
4. **Plumbing Systems:** Most Division 22 equipment and systems are subject to commissioning, including the systems listed below. All components and devices (valves, pipe, components, etc.) that make up these systems are included.
- a) Plumbing, Toilet, and Lavatory Fixtures

C. Cx Process and Sequence

The following provides an overview of the Cx Process and defines the project phases in the terms used in this Plan.

1. **Programming Phase:** The Owner is responsible for initial OPR development, pre-project planning and preliminary design. At this early project stage, the Commissioning Authority (CA) rests with the Owner. The first development revision of the OPR is the primary output of this phase
 - a) The Owner, acting as the CA, creates a new OPR document from the OPR Template to begin the process of populating it with the project requirements.
 - b) The CA defines the Commissioning Team.
 - c) The CA coordinates the updates to the OPR and performs all Cx roles and responsibilities as this phase proceeds, or until a consultant CA is brought into the process.
2. **Pre-Contractual Phase:** The Owner begins the inclusion of the Architect and possibly other subject matter experts into the process. The second development revision of the OPR is the primary output of this project phase.
 - a) The OPR will be refined and further developed to include the Architect project outputs, Commissioning Team outputs and necessary changes as required and defined within the DSM. The CA is responsible for coordinating and capturing these outputs into the OPR.
 - b) Cx responsibilities are assigned based upon the Cx Process Model selected. If necessary, RFPs are developed and contracts between Owner and CA/Design team.
 - c) Commitment to and experience in supporting a formal Cx process are considered in the CA selection criteria.
 - d) Budgets developed include Cx costs.
3. **Pre-Schematic Design Phase:** Design team along with the Owner formulate the concepts upon which the design will be based. The CA working with all Owner project stakeholders and the Architect coordinates and completes the initial production version of the OPR. This production version is considered the first version that will fully conceptualize all of the functional and performance requirements of the project.
 - a) CA retained.
 - b) CA meets with Owner to establish Owner requirements and protocols.

- c) CA develops initial Cx Plan.
 - d) CA directs and assists in reviewing and advising on the content of the OPR and BOD.
 - e) Architect records primary thought processes to document the decisions made so that they may be included in the OPR and BOD.
4. **Schematic Design Phase:** Concepts of the project are developed to the point of schematic and single line drawings. Architect also documents Basis of Design.
- a) User and Operator representatives to the Cx process identified and begin participating in the Cx process.
 - b) CA conducts Design-Phase Cx Orientation Meeting.
 - c) CA reviews schematic designs and posts comments on the project Portal.
 - d) CA reviews, formats and supplements Basis of Design documentation and posts comments on the project Portal.
 - e) CA produces preliminary versions of Cx specific sections.
 - f) CA refines and updates Cx Plan as needed.
 - g) Operators provide direction on naming conventions to be used on project equipment.
5. **Construction Documents Phase:** Detailed design is accomplished and Contract Documents are prepared for bidding. This phase may consist of multiple sub-phases.
- a) Architect responds to all schematic design comments and gives due consideration to Cx suggestions.
 - b) Architect develops Systems Matrix in concert with developing the specification.
 - c) Operator reviews and comments on Systems Matrix.
 - d) Architect incorporates results of Systems Matrix review into the Contract Documents.
 - e) Architect submits draft spec in an electronically editable fashion.
 - f) CA edits both General Requirements (Div.1) and Technical specification sections to incorporate, coordinate, and reference Cx requirements.
 - g) CA expands Cx Plan and refines Cx specifications to reflect the latest design.
 - h) CA develops 'Cx Record Matrix', a summary document that will track the status of system's progress through the Cx process.
 - i) CA reviews construction documents at 35, 65, & 95%.
 - j) Architect responds to all design review commentary on comment tracking system and CA tracks closure.
 - k) CA develops Cx precedent diagrams to reflect Cx tasks and how to most effectively sequence systems turn over to minimize the Cx impact on the schedule.
 - l) CA finalizes the Cx specs and the Cx Plan with generic testing procedures.
 - m) Architect incorporates all Cx edits and specifications and generally ensures that the hand-off procedures, protocols and requirements are thoroughly and clearly specified including submittal requirements, endurance periods as applicable, temporary conditioning and associated O&M requirements, start and duration of Warranty, etc.
 - n) Architect further updates the OPR/BOD.

- o) CA develops the Design Phase version of the Systems Manual incorporating OPR/ BOD documentation and room data sheets, and authors systems overviews.
 - p) CA provides technical support to the Owner team during the bid process.
6. **Construction Installation Phase:** Phase of the project during which the facility is constructed and/or systems and equipment are installed and started. Contractor and subcontractors complete installation, Start-Up Documentation, submit O&M information, establish trends, and perform other tasks per contract. Contractor/Vendors conduct equipment-specific training. Construction Phase will generally end upon completed start-up of systems and equipment and completion of trending requirements.
- a) All Parties subject to the Cx program (MC, EC, BAC, etc.) and Owner designate a Cx Coordinator (CxC) to represent them in the Cx process.
 - b) CA conducts Construction Cx Kick-Off Meeting. At a minimum, all CxC's attend.
 - c) Contractor incorporates detailed Cx tasks in project schedule. Contractor actively maintains the schedule throughout the construction phase, presenting an updated schedule at each Cx progress meeting.
 - d) Contractor submits shop drawings and CA reviews those essential to Cx.
 - e) CA provides submittal comments on the comment tracking system for Architect consideration. Architect responds to all comments, and incorporates CA comments into the submittal review at Architect discretion.
 - f) CA conducts periodic inspections and attends periodic progress meetings. All CxC members attend.
 - g) CA produces detailed project specific Start-Up and FPT procedures.
 - h) Contractors submit Start-Up Documentation, manufacturer-specific installation and application instructions to supplement the Start-Up Documentation developed by CA. CA and Owner review Start-Up protocol and approve.
 - i) Contractors submit Training Plan.
 - j) CA and Owner review Training Plan and approve.
 - k) Contractor submits the Systems Manual.
 - l) Architect, CA, and Owner review O&M information and approve.
 - m) Contractor submits Piping Cleaning, Flush, and Fill Plan and Temporary Operating and Conditioning Plan conforming to Owner requirements as applicable and CA, Owner, and Architect review and approve.
 - n) Contractor adheres to the Temporary Operating and Conditioning Plan.
 - o) Owner witnesses close-in inspections.
 - p) Independent testing agencies conduct tests as required by the construction specifications.
 - q) Contractor provides required notification of System Turn-Over Meetings. Owner and CA witness desired Start-Ups.
 - r) Contractor records all nameplate data in an agreed upon electronic format that is conducive to importing into asset/maintenance management systems.
 - s) Contractor provides training per contract documents and Cx requirements. GC distributes, collects and organizes evaluations and training documentation.

- t) Contractor conducts specialized equipment testing as specified in the construction specifications.
 - u) Architect conducts Design Orientation Training with assistance from CA.
 - v) Contractor sets up required BAS trends to document system performance.
7. **Construction Acceptance Phase:** The facility and its systems and equipment are inspected, tested, verified, and accepted. This Phase is when most of the formal training occurs. Architect and Contractor finalize 'as built' or record documentation. 'Approved Functional Completion' marks the end of this phase.
- a) Contractors establish trending and monitoring as applicable for systems.
 - b) Owner provide representative to assist with and participate in Functional Performance Testing.
 - c) CA and Owner spot check Start-Ups and balancing.
 - d) CA directs/conducts FPTs in which most Parties are also participants to some degree, primarily for initial samples. CA and Owner continue with active Functional Performance Testing repetitive samples.
 - e) CA documents functional testing and recommends acceptance as applicable.
 - f) CA updates the Cx summary document that indicates FPT status.
 - g) Contractor and Architect finish Record Documentation and submit for approval.
 - h) Contractor remedies issues causing failed FPTs and CA retests. Contractor compensates project for failed tests that were their responsibility.
8. **Warranty Phase:** Includes the early occupancy of the building and can continue through the warranty period and at least into the opposite season from when it was initially tested. Contractor performs warranty service and corrects deficiencies. Contractor finalizes record documentation to reflect actual conditions at the end of the warranty period. Owner works with the CA and the design team to fine tune the facility to meet actual occupancy.
- a) Warranty starts on completion of Acceptance Phase.
 - b) CA provides final Cx report that documents all start up and checkout, functional testing, action items and their resolution, training agendas and evaluations. CA also adds to Systems Manual important lessons learned, changes made, etc. during the Cx process.
 - c) DM keeps log of warranty calls and tracks diagnosis and resolution. Warranty on replaced equipment restarts the specified warranty period for that equipment.
 - d) Owner calls GC or subs as directed by GC for warranty calls.
 - e) Changes made to the facility that affect Record Documentation are reflected in updated record documentation.

III. PARTIES INVOLVED IN THE CX PROCESS

A. Architect (Arch)

Architectural Consultant retained by Owner:

Cooke Douglas Farr Lemons

Newell Watkins	(601) 366-3110	nwatkins@cdfi.com
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B. BAS Contractor (BAC)

Subcontractor retained by MC to install building automation system (Division 23 Contractor):

(Name)	(Phone)	(Email)
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C. General Contractor (GC)

Contractor retained by Owner to construct the facility:

(Name)	(Phone)	(Email)
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D. Commissioning Authority (CA)

Contractor retained by Owner to oversee the Cx process: Engineering Resource
Engineering Resource Group, Inc.

Chad Moore	(601) 362-3552	cmoore@ergms.com
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E. Electrical Contractor (EC)

Contractor retained by GC to install Electrical Systems (Div. 26 Contractor):

(Name)	(Phone)	(Email)
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F. Electrical Design Engineer (EE)

Consultant retained by Architect to design electrical systems (Div. 26 Engineer):
Cooke Douglass Farr Lemons

Ron Fender	(601) 366-3110	rfender@cdfs.com
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G. Fire Alarm Contractor (FAC)

Contractor retained by GC or EC to install the fire alarm systems for the facility:

(Name)	(Phone)	(Email)
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H. Fire Suppression Contractor (FSC)

Contractor retained by GC to install fire suppression system:

(Name)	(Phone)	(Email)
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I. Mechanical Contractor (MC)

Contractor retained by GC to install Mechanical Systems:

(Name)	(Phone)	(Email)
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J. Mechanical Design Engineer (ME)

Consultant retained by Architect to design mechanical systems (Div. 23 Engineer):
Cooke Douglass Farr Lemons

David Luter	(601) 366-3119	dluter@cdfs.com
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K. Owner(Owner):

Reference to the Owner's point-of-contacts.

MDOT

Seth Winchester	(601) 359-7537	swinchester@mdot.ms.gov
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Rusty Perkins	(601) 359-7292	jrperkins@mdot.ms.gov
Aaron King	(601) 359-9680	aaking@mdot.ms.gov

L. Plumbing Systems Contractor (PSC)

Contractor retained by GC to install all plumbing systems:

(Name)	(Phone)	(Email)
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M. TAB Agency (TAB)

Contractor retained to test, adjust, and balance mechanical systems (Section 23 09 90)

(Name)	(Phone)	(Email)
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IV. RESPONSIBILITIES**A. General**

1. All Parties involved in the design and construction of the facility bear responsibility in the Cx process. The Cx process does not fundamentally change the responsibilities of the team members from conventional projects where a formal Cx process was not used. The Cx process synthesizes, coordinates, and in some cases supplements and/or formalizes the responsibilities of all Parties.
2. The role of the CA is to oversee the Cx process and to endeavor to assist all other Parties in achieving the goals of the project.
3. The Architect retains all responsibility for design. The CA reviews conducted during the design process are solely to assist the Owner and Architect and are intended to be constructive. Comments are generally to be considered as suggestions. It shall be the Architect's sole responsibility to incorporate and validate CA comments. The Architect shall respond to the comments with justification for discarding any of the CA comments.
4. Contractors retain all responsibility for the installations. CA inspections and tests will determine the adequacy and completeness of the installations thereby assisting the Contractor in providing a sound installation. CA testing does not alleviate Contractor's responsibility for ensuring the systems are complete and functional per the Contract.
5. Detailed responsibilities are indicated below. These responsibilities relate only to the Cx process and do not encompass non-commissioning aspects of the project. Furthermore, the responsibilities presented in this Plan deal primarily with the intent of the project OPR and BOD and how these documents impact the contracted parties. The details for the specific requirements of construction related parties are specified in the contract construction documents.
6. Some scopes or tasks indicated in the following list of responsibilities are further detailed in later sections of this Cx Plan.

B. Owner Responsibilities

1. **Programming Phase**
 - a) Assign CA role to Owner MEP Project Engineer.

- b) Obtain budget and commitment for commissioning of the project.
 - c) Include the requirements for Cx in the contracts with the various parties and professionals retained in the early phases of the project.
 - d) Consider the Cx processes in the initial schedules.
 - e) Identify the Cx Process Model to be implemented, In-House or Third Party.
2. **Pre-Contractual & Pre-Schematic Design Phase**
- a) Select the Third Party CA, if the project is assigned the Third Party Process Model.
 - b) Clearly communicate requirements, preferences, and budget targets to Architect in a timely manner.
 - c) Establish effective communication logistics to facilitate effective interface between, planners, designers, occupants and their representatives, etc. Establish forums for early collaboration and ensure protocols are in place to document the key metrics that will establish success of the project.
 - d) Facilitate owner review of the conceptual design. This will generally be a coordination effort to manage the review of multiple agencies/ disciplines/ organizations.
 - e) Attend *Design Phase Cx Orientation Meeting*. Provide direction on scope and logistical items discussed at meeting.
 - f) Notify operations organizations of their Cx project obligations approaching as the project progresses so that they can staff accordingly.
 - g) Review preliminary Cx Plan, Responsibility Matrix, Document Matrix.
 - h) Direct management protocols specific to this project.
 - i) Provide Direction on Cx related scope, logistics, and work products.
3. **Schematic Design Phase**
- a) Review/update OPR
 - b) Review/comment upon the BOD documentation.
 - c) Begin to establish infrastructures required to compile and maintain multidiscipline documentation required by Cx.
 - d) Review suggestions and alternatives proposed by Architect and CA and decide upon direction for design.
 - e) Attend design meetings.
 - f) Administer the Cx requirements with all design professionals.
 - g) Appropriately notify anticipated Operators of Cx activities and involve them in key decisions made during this phase.
 - h) Copy CA on all pertinent correspondence
 - i) Manage/Attend Cx meetings.
 - j) Track closure of all of conceptual review comments
 - k) Organize VE review panel and either facilitate and document the process, or retain a representative to facilitate and document the process.
 - l) Facilitate effective communications between all Parties involved in the design.
4. **Design Development/Construction Documents Phase**
- a) Schematic Design Phase responsibilities apply also to this phase
 - b) Facilitate/coordinate detailed review of all documents prepared by Architect and CA in a timely manner, and issue comments to clarify or

specify requirements and/or preferences, including specifically those of Operators.

- c) Endeavor to fully understand the *OPR/BOD* documents, and the Contract Documents and request clarifications as appropriate.
- d) Develop Preventative Maintenance and Object Naming Codes to be used. These codes should be incorporated in the CMMS (computerized maintenance management system) and Facility Maintenance Life Cycle Processes. These codes will be used to index the equipment and associated documentation.
- e) Attend Cx meetings.
- f) Maintain Cx requirements and impact on budget and schedule.
- g) Ensure the Cx requirements of the schedule are inserted into the project CPM schedule.
- h) Ensure the Cx requirements are incorporated into all construction contracts, agreements, construction costs/GMP as applicable.
- i) Provide final approval of the Construction Documents.

5. Construction Installation Phase

- a) Attend *Construction Phase Cx Kick Off Meeting* and progress meetings to observe progress and decide upon direction for open issues.
- b) Facilitate coordination of the Cx work between the CA and the Contractors.
- c) Include the cost of Cx in the project budgets.
- d) Furnish copy of all material/information required by CA including those provided by Contractors for forwarding to the CA.
- e) Furnish current project contract documents necessary to keep CA current on the project requirements. All changes and addenda, "Conformed Sets" of plans and specs, etc. shall be provided to the CA in a timely manner.
- f) Where GC is performing the contracting activity, include all requirements of the Cx process in the project requirements.
- g) Organize and compile the Systems Manual information required by the Cx requirements. Most content is provided by the Contractors to the GC for organization and compilation. Disseminate information as required for review.
- h) Facilitate Owner inspection to thoroughly inspect construction through all phases of installation. Inspectors shall identify deficiencies in a timely manner. Owner shall sign off on the closure of items and processes.
- i) Involve operators in the inspection process and communicate their observations and requirements.
- j) Assist in facilitating and coordinating training.
- k) Provide master format for Systems Manual compilation to Contractors to ensure consistency.
- l) Manage resolution of contractual issues generated as a result of Cx. Issue information requests, change orders, work directives, and other communication as required to resolve these issues. Examples of contractual issues include those to which the Contractor disputes responsibility that result in a change of contract price or schedule, or that need design modifications to accommodate. These are processed through the regular construction management protocols.

6. Construction Acceptance Phase

- a) Provide direction on issues requiring Owner judgment.

- b) Provide facilities for training sessions and personnel.
 - c) Endeavor to fully understand the *OPR/BOD*, system and equipment inspections, operation, maintenance, repair and troubleshooting of systems and equipment.
 - d) Participate in testing that requires Owner involvement.
 - e) Witness equipment and system Turn-Over's as desired.
 - f) Sign off on testing witnessed.
7. **Warranty Phase**
- a) Notify design/construct team of any significant changes required or of any unanticipated occupancy requirements that become evident.
 - b) Coordinate the dissemination of Record Documentation within Owners organization.
 - c) Inform the design/construct team of any salient alterations or changes to the systems and their setup and indicate why it was necessitated.

C. Architect Responsibilities (Architect)

1. Includes the engineering support teams of the Architect. Primarily Mechanical and Electrical Engineers.
2. **Programming Phase**
 - a) Assist the Owner in developing the OPR.
 - b) Notify Owner of codes and regulations that affect the facility.
 - c) Begin the drafting of the BOD.
3. **Pre-Conceptual Design Phase**
 - a) Endeavor to fully understand and improve the OPR and propose design alternatives to meet those requirements. Advise the Owner of advantages, disadvantages, and limitations of various alternatives.
 - b) Attend design meetings and present alternatives.
 - c) Document the primary thought processes and key design metrics that result in the concepts that will be included in the OPR and BOD.
 - d) Respond to all design/peer reviews in the established electronic forum.
 - e) Develop Room/Zone Data Sheet templates to be used and maintained throughout the project.
4. **Schematic Design Phase**
 - a) Attend design meetings and present alternatives.
 - b) Draft the BOD documents based upon the OPR to communicate expectations and limitations of facility/systems and equipment. Submit to Owner and CA for review.
 - c) Consult with CA and consider incorporating CA input.
 - d) Copy CA on all pertinent correspondence.
 - e) Consider value engineering alternatives and recommend.
5. **Design Development Phase**
 - a) All responsibilities of the Schematic Design phase apply here as well.
 - b) Collaborate with the CA and DSM on integrating the Cx requirements and protocols into the General Conditions and Division 1 specification. Provide an editable version of the specifications to CA who will suggest edits for their consideration.

- c) Prepare thorough, accurate, and clear Contract Documents.
- d) Send CA one copy of all review submissions. Documents shall be forwarded in PDF format.
- e) Specify materials and finishes that do not outgas excessive air contaminants and/or cause poor IAQ.
- f) Develop the System Matrix to reflect the construction documents specification requirements.
- g) Incorporate Cx specifications, Cx processes, Cx requirements and/or related edits in the construction specifications. Clearly specify the point at which warranty starts, when Substantial Completion will be awarded in the context of the Cx testing, and any other important milestones.
- h) Consider and respond to Owner and CA comments and questions in a timely fashion. Incorporate Owner and CA comments/suggestions in Contract Documents when they will not adversely affect the project.
- i) Update BOD documents to reflect final design. Comment upon updated OPR to ensure both document sets are fully integrated.
- j) Incorporate the Owners direction on equipment nomenclature into the design documents.

6. Construction Installation Phase

- a) Issue necessary changes in construction and copy CA.
- b) Review shop drawings and product data. Contact CA prior to approval of pertinent systems/equipment and incorporate CA comments in Architect's markup or approval.
- c) Inspect construction in accordance with Owner - Architect agreement.
- d) Issue clarifications or interpretations of OPR and BOD as required.
- e) Maintain a record set of shop drawings, product data, warranties, test reports, balance reports, start-up certifications, and other official construction documentation.
- f) Update OPR/BOD documents and room/zone data sheets to reflect any changes made throughout construction.

7. Construction Acceptance Phase

- a) Witness key tests and verifications as selected by Architect.
- b) Consult on and resolve any design related issues/problems that arise during this phase.

8. Warranty Phase

- a) Consult with Owner as necessary to convey and maintain OPR/BOD and respond to any identified deficiencies.

D. Engineer Responsibilities (ME & EE)

These roles are in addition to the Architect's roles noted above. The ME/EE must comply with all responsibilities outlined above for the Architect, in addition to those listed here.

1. Pre-Conceptual Phase

- a) Contribute to Room/Zone Data Sheet templates to be used and maintained throughout the project.

2. Schematic Design Phase

- a) Draft the appropriate portions of the BOD documents based upon the OPR to communicate expectations and limitations of facility/systems and equipment. Submit to Owner and CA for review.
 - b) Provide schematic and riser diagrams on all systems to communicate the organization of the designed systems and the ranges of operation.
3. **Design Development Phase**
- a) Collaborate with the CA on integrating the Cx requirements and protocols into the specifications covered by the scope of commissioning. Provide an editable version of the specifications to CA who will suggest edits for ME/EE consideration.
 - b) Contribute to the Systems Matrix to reflect the construction documents specification requirements.
 - c) Provide schematic and riser diagrams on every system to communicate in a clear and simplified fashion the organization of the systems and distribution of capacity.
 - d) Prepare and submit clear and orderly calculations to Owner and CA for review and comment. Respond in writing to comments.
 - e) Update and finalize the Room/Zone Data Sheets to be used and maintained throughout the project.
4. **Construction Installation Phase**
- a) Attend *Construction Phase Cx Kick Off Meeting* and progress meetings.
 - b) Issue necessary changes in construction and copy CA.
 - c) Review shop drawings and product data. Contact CA prior to approval of pertinent systems/equipment and incorporate CA comments in ME/EE's markup or approval.
 - d) Participate in the resolution of system deficiencies identified during commissioning, in accordance with the contract documents. Issue clarifications or interpretations of design intent as required.
 - e) ME shall review and approve TAB reports. EE shall review and approve Electrical Testing Agency reports and short circuit study.
5. **Construction Acceptance Phase**
- a) Witness key tests and verifications as selected by ME/EE.

E. Contractor's Responsibilities

- 1. All Phases
 - a) As outlined in Construction Specifications. Sections relating solely to Cx are Section 01 91 00 and 01 91 13.13 (General Commissioning), Section 22 08 00 (Plumbing Systems Commissioning), Section 23 08 00 (HVAC Commissioning), Section 23 08 10 (BAS Commissioning), and Section 26 08 00 (Electrical Systems Commissioning). Other Sections will reference commissioning requirements as well.

F. CA Responsibilities

- 1. **Programming Phase**
 - a) Identify the requirements, goals, preferences, Owner standards or guidelines that will impact the design of the facility. Collect these requirements into the initial OPR.
 - b) Develop the initial OPR from the template in the DSM.

- c) Initiate the creation of the Cx specification requirements beginning with the DSM guide specifications.
- d) Develop the initial Cx Plan to include the initial Cx Team members list.
- e) Develop the initial Cx Roles and Responsibility Matrix
- f) Develop the initial Cx Document Matrix.
- g) Develop the initial Cx Scope document.

2. **Pre-Schematic Phase**

- a) Assist the Architect with the format for the BOD documents and provide guidance on OPR documents.
- b) Review the Conceptual Design documents, BOD documents as applicable. Prepare collaborative forum to present and track peer review commentary throughout design.
- c) Prepare the initial Cx Plan and submit for review.
- d) Collate the initial Cx Team. Solicit from operating organizations the identification of operations personnel for the facility who will be involved in key decisions throughout the design/construct processes and eventually operate the facility.
- e) Conduct interviews and attend meetings to populate, guide and create the initial production version of the OPR.
- f) Conduct *Design Phase Cx Orientation Meeting*. Outline the scope and procedural options to the process and solicit direction from the Owner or their representatives.

3. **Schematic Design Phase**

- a) Review the schematic design documents.
- b) Conceive/propose alternatives/issues for design consideration.
- c) Review correspondence and advise on design direction.
- d) Endeavor to ensure Owner's best interests are incorporated in design.
- e) Attend design meetings selected by CA to facilitate performance of work.
- f) Review design outputs against the OPR content and intent. Comment as necessary, provide alternatives and maintain the Cx issues log.
- g) Review, edit and supplement the OPR as design progresses and project documentation is created.
- h) Prepare initial Cx specifications for Divisions 01, 21, 22, 23 and 26 for inclusion in the project manual after Architect and Owner approvals.
- i) Finalize the Cx Scope, Cx Document Matrix, Cx Precedent Schedule, Cx Roles and Responsibility Matrix and Cx Plan.

4. **Design Development Phase**

- a) Applicable Schematic Design responsibilities apply.
- b) Review design phase submissions for equipment and systems included in the Cx scope as described in this Cx Plan.
- c) Track all CA comments to closure.
- d) Prepare, edit and/or supplement specifications to identify Cx requirements. This includes suggesting electronic edits to the divisions sections to integrate the Cx requirements into the construction documents.
- e) Respond to Cx document review comments.
- f) Attend key design/review meetings as selected by CA and as required to facilitate work.

- g) Conduct Cx progress meetings to facilitate coordination of Cx activities.
- h) Provide Scheduling Precedent diagram suggesting conceptual logic and consult with the Owner, and other Parties as necessary to incorporate the Cx activities into the master construction schedule.
- i) Review design calculations selected by CA.
- j) Expand and update the Cx Plan as decisions are made and systems are finalized.
- k) Edit the Cx Record Matrix to indicate the submittals the CA is to be either included in the review, or copied on the record approved submittal.

5. **Construction Installation Phase**

- a) Coordinate and direct the commissioning activities in a logical, sequential and efficient manner using consistent protocols, centralized documentation, and clear and regular communications and consultations with all necessary Parties.
- b) Prepare and conduct *Construction-Phase Cx Kick-Off Meeting*.
- c) Revise the Cx Plan as necessary to reflect agreed upon management protocols and responsibilities.
- d) Collaborate with the contractors to refine and maintain the project schedule.
- e) Review applicable project submittals (shop drawings, product data, draft TAB reports, Training Plans, etc. according to the Cx Document Matrix and Systems Matrix) for adequacy and to ensure system functionality.
- f) Perform a detailed review of the BAS shop drawings to ensure sufficient clarity and detail is included as direction to installers and programmers; submittals adequately reflect required information for start-up and acceptance testing, Owner standards are being applied, and that the system will be functional and reliable commensurate with the Owner's needs.
- g) Generate and distribute generic Start-Up Documentation.
- h) Review and approve Start-Up Documentation forms generated by Contractors.
- i) Conduct and document Cx progress meetings to ensure the Cx process stays on track and on schedule.
- j) Inspect installation periodically to observe quality of installation and check conformance to the Cx requirements.
- k) Maintain the project Issues List (master deficiency and resolution logs and Cx request for information), nameplate data modules, and electronic project data association, testing and checkout procedures, and submittal tracking.
- l) Review TAB execution plan.
- m) Witness selected equipment and systems Turn-Over meetings.
- n) Prepare training evaluation forms.
- o) Attend selected equipment training.
- p) Review testing agency reports.
- q) Review and approve Systems Manual submittals.
- r) Facilitate compilation and organization of the Systems Manual.

6. **Construction Acceptance Phase**

- a) Review start up documentation and assess readiness for functional testing.

- b) Review trending information.
- c) Review field contractor testing reports.
- d) Ensure required documentation is submitted.
- e) Verify (spot-check) TAB reports.
- f) Verify (spot-check) control component calibration.
- g) Verify (spot-check) equipment performance certifications.
- h) Functionally test systems and equipment and recommend approval as applicable when functional requirements are met.
- i) Record Cx procedures and maintain the Issues Log and status of acceptance testing.
- j) Optimize system settings as practical during Functional Performance Testing.

7. Warranty Period

- a) Conduct Final Systems Operation Training.
- b) Prepare Final Cx Report.
- c) Periodically monitor the facility as applicable.
- d) Consult with Owner's facilities personnel relative to issues with system performance and occupancy.
- e) Review record BAS Drawings.
- f) Perform opposite season FPT and optimization of the facility given the actual occupancy.
- g) Conduct End-of-Warranty Assessment.

V. COMMISSIONING PROTOCOLS

A. Cx Coordination

- 1. CA will coordinate the Cx activities throughout the project phases. CA will communicate the requirements via the Design Phase Cx Orientation Meeting in which the initial Cx Plan is presented and reviewed. CA shall communicate the requirements of installation-related commissioning via another kick-off meeting in which the construction phase Cx Plan is presented and reviewed.
- 2. CA will solicit participation of the appropriate Parties and ensure that the tasks are being executed and responsibilities are being met.
- 3. CA will report progress of the Cx activities to the all Parties.
- 4. Notification protocol of scheduled activities will always strive to be communicated with 2 weeks advanced notice. This includes CA task ranging from Design Reviews to Start-up Testing, to Turn-Over Meetings.

B. Management Protocols Relating to Cx

- 1. This Section describes the relationships between the management Parties.
- 2. The CA has been retained by the Owner and subsequently reports to the Owner's Project Manager and/or the Owner's Cx Coordinator. All work directives initiated by the CA will go directly to Owner with no copies to other Parties. Owner will then act upon them as appropriate.

C. Communication Protocols Relating to Cx

1. Cx correspondence shall generally be routed directly between corresponding Parties with copies going to all Parties of the Cx Team. The primary exception to this is when it relates to a work directive.
2. No communication from the CA shall be interpreted as a work directive. All channels for directing work are dictated in the contract documents and the agreements between the applicable Parties. An Issues Log resulting from testing may be requested by the responsible Party to expedite work, but this is not to imply that it is complete or that the identified deficiencies shall be acted upon or how to resolve them. Contractor acting on any Cx deficiency list is doing so voluntarily.
3. Specific types of communications are itemized below. Many of the items included are discussed in further detail elsewhere in the Cx Plan. This presents a brief synopsis of the information flow. Note that these procedures are an initial guide.
 - a) Communication Protocols: These protocols are submitted as a general guide but can be changed at the applicable Cx Orientation or Kick-Off meeting based on mutual agreement with the Owner providing the final approval of any change.
 - b) Cx RFI: This shall be an Action Item. Correspondence is direct between the two parties with copies of requests and responses copied to all parties concerned. Owner shall be copied on all correspondence to and from CA.
 - c) Design Documents for Review: Owner shall distribute these to the CA unless they direct the Architect to forward them directly. Electronic pdf versions of design drawings and the specifications. All documents will be searchable for specific text.
 - d) Design Review Comments: CA shall provide a system to manage CA commentary. The CA shall send a copy directly to the Architect, Owner
 - e) Cx Plan: Developed by CA and distributed to Cx team members in the *Design Phase Cx Orientation Meeting*. CA to update and maintain plan per discussions and agreements throughout the construction and acceptance phase. Plan shall be posted and made available for download at any time throughout the project by the CA.
 - f) Cx Specifications: These are sections authored by the CA to communicate the requirements of the Cx process throughout construction. They are developed by the CA and distributed to the Owner who shall in turn distribute them to the Architect for inclusion in the contract specifications. This occurs at the various phases of design review. Architect may comment, but does not have license to change these specifications without the approval of the CA.
 - g) Submittals and Shop Drawings: Owner shall distribute these to the CA. CA shall edit the project's Systems Matrix to communicate which submittals must be forwarded to CA.
 - h) CA Review Comments on Shop Drawings: Shall be cataloged by the CA and a copy sent directly to the Architect, Owner. Architect to consider and incorporate at their discretion.
 - i) Identified Deficiencies: When the CA identifies a deficiency, CA shall make a good faith assessment of responsible parties. Those parties, as well as Owner shall be notified of the perceived deficiency. This communication is FOR INFORMATION ONLY and is not a direction to resolve the deficiency. Contractor may accept responsibility and resolve the

deficiency voluntarily. If Contractor contests either the deficiency or responsibility for that deficiency, Contractor shall respond to that deficiency indicating disagreement. If responsibility is not agreed to via the Cx dialogue, Architect shall issue a work directive or RFI via the normal contractual channels to resolve the issue.

- j) Requests for Meetings: In general, requests by the Contractor for a meeting with the CA shall be routed through Owner who will then determine the validity. Note that every attempt should be made to deal with Cx issues at regularly scheduled Cx Meetings. Communication protocols will be discussed and established during the Kick-Off meetings.
- k) Control Sequence Modifications: CA shall make every attempt to thoroughly review the sequences during the design phase and address any issues prior to the submittal phase and subsequent approvals. However, the CA and the BAC may incorporate minor changes to the sequence during testing when it is apparent that it improves the control of the equipment but does not fundamentally change the sequence. The time allowed for the BAC to incorporate more significant sequence modifications is addressed in Section 23 08 10. Any and all sequence changes must be thoroughly documented in the record documents, and CA shall notify Architect of the modification.
- l) Scheduling Coordination: CA shall consult directly with the GC to incorporate the Cx tasks in the project schedule. The process logic and integration shall ultimately be the result of collaboration between GC, CA, and subcontractors. The effort will start with CA and GC proposing initial logic. Subcontractors will then join the discussion and work out the final details, (precedent logic and durations).
- m) Notification: Contractor shall notify Owner at least two weeks prior to an anticipated Cx activity or Cx milestone (such as ready for FPT). Owner shall then coordinate the scheduling of the activity (as applicable) between all required parties as applicable. Notification shall be a posted via established protocols which may include emailing to the receiving parties. Receiving parties shall then respond to confirm.
- n) Action List: CA maintains a categorized Action List which tracks the Cx-related Action(Issues) Items. The Action List is a forum for open dialogue intended to expedite resolution of issues. It is not a contractual mechanism for directing work. CA will maintain this list.
- o) Start-Up Documentation: As further described in Section 01 91 00, the CA will provide initial 'generic' Start-Up Documentation (Checklists and Tests) to the Contractor. The Contractor shall synthesize these with the manufacturer-specific start-up requirements and submit these (along with the manufacturer's start-up requirements) to the CA for review and approval. The Contractor has the option of modifying the supplied generic procedures in the delivered format, or by supplementing these with their own procedures and ways to document. The Contractor then executes the final reviewed and approved Start-Up Documentation, completes the documentation and signs it, and submits it. CA subsequently spot checks the procedures and documentation. They are then included in the Commissioning Record.
- p) Functional Performance Test (FPT) Documents: Functional Performance Tests are prepared and completed by the CA. They are developed during the construction phase, typically towards the end of submittal review. The CA forwards the generated FPT forms to the CxC Team for information purposes and to be subsequently distributed by them to the Contractors

and other Cx Team members. Subcontractors approve the FPTs. When developing the FPTs, the CA uses content from the OPR, BOD and construction documents to provide a basis for the testing standard to be used. Throughout the Cx process, the CA maintains a current record of the FPTs and keeps all Cx documents/files up to date for all to access the current progress. Cx distributes hard copies of the testing procedures at completion of any significant stage of Cx.

D. Related Information

1. Commissioning-related requirements are specified in the Sections referenced below. All apply to the work of this Section.
 - a) **Section 01 91 00 – General Commissioning Requirements:** Details the Cx requirements common across all divisions.
 - b) **Section 01 91 13.13 – General Commissioning Requirements for Functional Testing:** Outlines ‘generic’ Functional Testing Procedures required for specific system types subject to the Cx process.
 - c) **Individual Specification Sections:** Individual Sections stipulate installation, start-up, warranty, O&M documentation, and training requirements for the systems and components installed under that Section.
 - d) **Section 22 08 00 –Plumbing Systems Commissioning:** Details the Cx procedures specific to Plumbing Systems work.
 - e) **Section 23 08 00 – HVAC Systems Commissioning:** Details the Cx procedures specific to HVAC work.
 - f) **Section 23 08 10 – Building Automation Systems (BAS) Commissioning:** Details the Cx procedures specific to the Building Automation System.
 - g) **Section 26 08 00 – Electrical Systems Commissioning:** Details the Cx procedures specific to Electrical Systems work.

E. Meetings

1. **Design Phase Cx Orientation Meeting:** CA shall organize and conduct a meeting where the details of the design related protocols are discussed. Minutes will be distributed on this meeting within 14 days. Information discussed in this meeting will be incorporated into an updated Cx Plan. The agenda items for the meeting include:
 - a) Preliminary Cx Plan which shall have been developed at that point.
 - b) Requirements of Cx, including Cx Roles and Responsibilities Matrix, Cx Systems Matrix, OPR, BOD Requirements, etc..
 - c) Responsibilities of the design parties
 - d) Management protocols.
 - e) Required submittals.
 - f) Schedule.
2. **Construction Phase Cx Kick-Off Meeting:** CA shall organize and conduct a meeting with all Parties to the Cx process (including Contractors and their CxC) where the Cx process and requirements will be reviewed and specific management protocols will be determined. Minutes will be distributed within 14 days. Information discussed in this meeting will be incorporated into an updated Cx Plan.
3. **Cx Progress Meetings:** Cx Progress Meetings will be called by the CA as necessary to facilitate and coordinate the Cx process. Typically these will be

monthly during installation, every two weeks during start-up, every week during Acceptance Phase, and then every two weeks until all major issues are resolved.

4. **Commissioned Systems Meeting:** At the end of the Warranty Phase, CA will conduct a meeting to ensure that all the requirements of the Cx process have been met.

VI. DESIGN PHASE COMMISSIONING TASK DEFINITIONS

A. General CA Design Reviews

1. CA will conduct reviews of interim design submissions. These reviews will constitute a conceptual review only against the OPR and BOD and known best practices. **The reviews are not meant to replace existing technical peer review performed by the Architect Team or any other entity.** The following submissions will be reviewed:
 - a) 100% - Schematic Design
 - b) 100% - Design Development
 - c) 50 & 85% - Construction Documents
 - d) Final Project Manual with all Design, Specification and Construction Documents
2. Architect shall send CA one copy of all design-phase documents being submitted including drawings, specifications, calculations, and narrative documents including but not limited to BOD narrative, Room/Zone Data Sheets and the Systems Matrix.
3. CA will review information relating to the systems indicated within in the Scope of Commissioning Services (Cx Plan, Section II).
4. CA will issue comments in writing to the Architect within two weeks of receipt of documents. Review will generally be a conceptual review of key aspects relating to facility operation, capability for efficient automatic control, cost effectiveness, functionality, maintainability, reliability and generally to ensure the OPR has been fully incorporated. Review will not constitute a detailed check of the documents and calculations; however discrepancies, omissions, etc. will be noted wherever found. Further definition of the scope of individual reviews is provided later in this document.
5. Frequently, a question or comment will be solely to document the reasons for (not) implementing an alternative. The Architect response will be incorporated in the OPR.
6. Architect shall respond to all comments within 14 days of receiving them. Document review tracking system shall support dialogue between multiple parties and support tracking the status of the comment. On subsequent review phases, CA shall check for closure of prior phase comments and resend comments until the issue is considered closed by the CA. It is the Architect's prerogative to accept or reject CA comments, however, when a comment is rejected, Architect shall substantiate the reasons for rejecting it.

B. CA Schematic Design Review

1. Schematic Design Review will be completed towards the end of the Schematic Design Phase. CA will generally review the schematic design for conformance

to the Program and concepts outlined in the conceptual design. CA will also review for conformance to the OPR.

2. CA will suggest alternatives for consideration or potential improvements to:
 - a) Cost and construction effectiveness.
 - b) Facilitate commissioning.
 - c) Energy efficiency.
 - d) IAQ
 - e) Required reliability or redundancy.
 - f) Operability.
 - g) Maintainability.
3. Although the CA may identify any non-conformance with codes noted in the course of their review, this will not be a focus of the review.

C. CA DD and CD Phase Reviews

1. The scope of the CA reviews in the Design Development and Construction Documents Phases will include the items in the Schematic Phase and expand to include the following additional issues:
 - a) Adequacy of the BAS design, components, and sequences;
 - b) Component integrity and efficiency;
 - c) Adequacy of Systems Manual or O&M Documentation requirements and training requirements in the individual Specifications;
 - d) Project Scheduling;
 - e) Engineering assumptions and calculations.
2. CA will specifically review for coordination between various specification divisions in the documents relative to the Cx process. CA will ensure that the Cx documents are adequately incorporated, clearly communicated, and coordinated throughout the Divisions.

D. Program and Design Reference Documentation

1. Documentation of the owner's requirements, design concepts, basis of design criteria, and other program requirements facilitates a common understanding of the facility's goals, evolution, constraints, limitations, and assumptions on which it was based. This is dynamic documentation that will change as the facility evolves. It supplements the design, installation, O&M and training information with the background assumptions, parameters, and other issues that define the full design intent of the facility.
2. This Cx Plan stipulates the salient content to be included in the Program Documentation. An organization and format are presented herein, although the Cx Team has flexibility in determining the best configuration that suits a particular project. The following outlines the generally required content for the documentation.
3. Generally the source for the information will be the design team (Architect and Owner); however, the CA will assist with suggested frameworks or formats and may further supplement the information provided by the design team. The CA will typically provide the final bound and formatted document(s) for distribution.
4. **Owner's Program Requirements (OPR):** The OPR is intended to provide the basis from which all design, construction, acceptance, and operational decisions are made. It details the functional requirements of the project,

including systems subject to commissioning. The OPR defines the benchmarks and metrics by which the success of the project is ultimately judged, and evolves through each project Phase. The OPR is typically developed early in the project cycle by the Owner's CA and/or the Architect depending upon the Cx process model chosen. It provides the user needs, requirements, goals, and metrics that are defined by the Owner to be important. The OPR criteria are referenced by and should be the foundation of the BOD narrative written by the Architect. At the end of the project, content of the final OPR may be incorporated into the Systems Manual. The OPR is a required component for LEED-certified projects, and is recommended for all projects subject to the Cx process. The OPR template in the DSM is the foundational document that begins the Cx process for all projects. OPR information includes but is not limited to;

- a) Cx process model.
- b) Sustainability requirements.
- c) Indoor environmental conditions, including temperatures and relative humidity for all occupancy conditions;
- d) Outdoor environmental conditions at the facility location for each season, including design values, bin analysis, extremes and standard deviations, and any other weather information pertinent;
- e) Occupancy, hours, functional use, and degree of activity for all hours of the year;
- f) Building size, mass, orientation, and characteristics
- g) Means for obtaining lighting quality and illumination levels defined for various spaces;
- h) Design heat loading conditions such as maximum internal heat load, occupant density, U values, OA conditions, shading coefficients, etc.;
- i) Design power use densities for miscellaneous power (plug loads);
- j) Summarize the details of sizing, capacity, efficiency, sound power levels, location, service etc. for systems and equipment
- k) Diversity used in sizing;
- l) Ventilation criteria for all operating conditions, including required air change rates (OA and total);
- m) Detailed sequences of operation with expected setpoints, scheduling, control parameters, etc.
- n) Justification for selected approaches versus other alternatives by system and component;
- o) Governing Codes and their salient requirements/restrictions;
- p) HVAC noise and vibration criteria;
- q) Fire and Life Safety Criteria;
- r) Security Criteria

5. **Basis of Design Document (BOD):** The Basis of Design document is developed by the design team, and shall respond to and be consistent with the performance criteria specified in the Owner's Project Requirements. The BOD illustrates the means by which the OPR criteria are to be achieved, documenting the assumptions and parameters used in the design, and documenting the primary thought processes or decisions made that resulted in the selected alternatives. At the end of the project, the final BOD content may be incorporated into the Systems Manual if desired in part or in its entirety. The final BOD (which includes OPR criteria) shall communicate the intent of the design including:

- a) Programming requirements;
 - b) Basic systems overview which includes descriptions and their expected operation (include schematics).
 - c) Functions of key equipment;
 - d) Anticipated occupancies of various spaces;
 - e) Anticipated occupancy schedules;
 - f) Design targets (allowed temperature/humidity ranges, IAQ parameters, light level, noise criteria) for various spaces and uses;
 - g) Maximum anticipated deviation from design targets;
 - h) Performance criteria (efficiency);
 - i) Intended operation and general sequences;
 - j) Budget restrictions;
 - k) Intended redundancy and expectations for operation when systems fail;
 - l) Any specialized operation and maintenance skills and tools anticipated;
 - m) Capabilities and limitations of systems and equipment;
 - n) Degree of security required
6. **Systems Manual:** The Systems Manual is a comprehensive document targeted at giving a new operator a comprehensive overview and insight into the facility. The Systems Manual is created at 95% construction document progress. It uses content of both the OPR and BOD. The Systems Manual is then maintained and updated throughout the project to where the CA submits the final version in concert with the Commissioned Systems training. The content of the Systems Manual shall include (see Section 01 91 00 for further details):
- a) Introduction giving an overview of the document, an overview of when major construction milestones were met, references to other construction and Cx documents, an overview of the Cx process used for the facility and a project directory.
 - b) A description of the general layout of the building and the occupancies contained within it. This should outline the limitations of the use of the spaces and subdivision of it. It should give an overview of the intent of the Architectural design and the limits of its flexibility. If any given areas are designed for various configurations, these should be enumerated.
 - c) Room Data sheets documenting the key design parameters of the various spaces within the building.
 - d) Simplified equipment layout plans that show where the key equipment is located within the facility.
 - e) HVAC Zone descriptions that provide an overview of how each space is controlled by the terminal HVAC equipment. This should deal with the concept of how it works and a simplified sequence of operation. This section should include the key HVAC design parameters for that zone, references to construction, operation and maintenance information relative to the equipment serving the zone, operator adjustable setpoints and the impact of changing them, a listing of systems that are serving those zones, normal ranges for monitored parameters and potential causes and resolutions of excursions from that range, zoning flexibility, and notes on the results of commissioning that zone.
 - f) For each discipline, provide System Descriptions that include the key design criteria, descriptions, schematics, capacity information, references to construction, operation and maintenance information relative to the system, a simplified sequence, a listing of the utilities that are supporting

that system, operator adjustable setpoints and the ramifications of changing them, normal ranges for monitored parameters and potential causes and resolutions of excursions from that range, and notes on the results of commissioning that system.

E. Commissioning Specifications

1. The Commissioning Specifications outline the roles and responsibilities of the Contractors relating to Cx during the Construction, Acceptance, and Warranty Phases.
2. They summarize the tasks that need to be completed in the Start-Up of the systems, the extent of functional performance testing that is required, the requirements for documenting O&M items, and training by the Contractor.
3. Cx requirements occur throughout the entire specification. Cx requirements cannot be effectively stipulated by simply adding on a few sections. All sections must be coordinated with the Cx sections and Cx requirements. CA shall develop Cx specifications for incorporation by the Architect in the Contract Specifications. CA is responsible for coordinating the Architect authored sections with the Cx requirements. CA shall review and edit the construction specifications (provided electronically by the Architect) to ensure a coordinated and comprehensive Cx process is specified. Specifications shall be shared in Microsoft Word format. CA shall use the editing features of Word to illuminate the edits made.

F. Systems Matrix

1. Architect shall develop a Systems Matrix. This shall be a table of systems and equipment that summarizes the information to be included in the construction specifications. It is formatted to make it convenient for the Operators and building managers to review the manufacturer's warranty, factory Start-Ups, training, and attic stock to be included in the construction contract.
2. The rows of the matrix shall be effectively an index of the specifications. The rows will represent systems, and equipment, and associated work products.
3. Columns shall represent a context of information to be associated with the systems. At a minimum the columns shall include:
 - a) Allowed manufacturer's
 - b) Warranty durations listing anything beyond the standard one year warranty
 - c) Factory Start-Up listing the requirement and minimum hours for a factory authorized technician to start up and/or field test the equipment
 - d) Training listing the training requirement associated with the system or equipment.
 - e) Attic Stock listing spares to be provided under the construction contract
 - f) Owner Review which allows Operators to indicate submittals they want to review
 - g) CA Review which allows CA to indicate the submittals they either wish to review and/or those they need for record.
4. The Architect shall develop the Systems Matrix and submit it to the Owner who will distribute it to the Operators. Operators will then review and mark up the Systems Matrix. Architect shall then revise the construction specifications to reflect the requirements of the Operators.

G. Cx Record Matrix

1. CA shall develop and maintain a Cx Record Matrix. This is a matrix that illustrates the progress of various tasks and work products required by the Cx process. The Cx Record Matrix shall be posted and accessible via the Portal for all project members to be able to monitor the progress of the Cx.
2. The Cx Record Matrix shall itemize individual equipment of the same kind. Rows may be grouped to facilitate navigation. The columns shall list individual work products and tasks associated with Cx. The value cell would indicate the status of the task for any given piece of equipment. Representative column headings include:
 - a) Systems Manual
 - b) Generic Start-Up Documentation
 - c) Final Start-Up Documentation
 - d) Functional Performance Tests developed
 - e) Nameplate Data Record
 - f) Training Plan
 - g) Balancing Plan
 - h) Training
 - i) Temporary Conditioning Plan
 - j) O&M Documentation
 - k) Electrical Start-Up
 - l) Mechanical Start-Up
 - m) Control Start-Up
 - n) Balancing
 - o) Functional Performance Testing
 - p) CA Sign Off
 - q) Record Submittals
 - r) Record Drawings
 - s) Seasonal Testing
3. Cx Record Matrix shall be reviewed and updated at each Cx progress meeting.

VII. INSTALLATION PHASE COMMISSIONING TASK DEFINITIONS**A. Construction Phase Cx Kick Off Meeting**

1. CA shall schedule and conduct a *Construction Phase Cx Kick-Off Meeting* near the beginning of construction. The following should be discussed at this meeting:
 - a) CA will present the Cx Plan
 - b) Requirements of Cx
 - c) Responsibilities of the construction Parties
 - d) Management protocols
 - e) Required submittals
 - f) Schedule
 - g) Training and the budget/need for digitally recording training events
 - h) Portal requirements, and how to complete portal assigned items

B. Scheduling Collaboration

1. Concise, detailed and effective project scheduling is an essential element of a successful project. The Construction Acceptance Phase which includes functional performance testing, can take several months. While in an ideal world, the Contractor would “drop off the keys” to the Cx team and give them the entire facility for this period of time, this is rarely a reality. The Acceptance Phase must be tightly integrated into the construction schedule. When scheduled effectively, the net impact of Cx can be a matter of a few weeks. For this to work effectively, the schedule must map out the precedent logic for all parties to move through the closeout process. The closeout will amount to a parade of parties following each other. This path must be carefully mapped out and detailed in the schedule.
2. The baseline schedule logic should be developed early in the construction phase at the latest. The Baseline Schedule cannot be developed until all the subcontractors are on board and all agree to the logic and durations of the tasks. The Cx portion of the construction schedule will ideally be a bottom up exercise involving all subcontractors.
3. The CA shall provide a precedent diagram suggesting logical precedent tracks for a typical system, and for the order in which systems can be completed to minimize the schedule impact of Cx. This logic must be incorporated into the main construction schedule. The Contractor shall develop and maintain the schedule. All subcontractors are consulted and collaborate on the schedule. It is unacceptable to maintain two independent schedules. Obviously the Cx-related tasks should be categorized to facilitate filtering the schedule on Cx items so that reports for Cx meetings are easily processed.
4. Owner and user representatives must understand and agree to the scheduling logic and understand the impact of making changes late in the project. Once the baseline schedule is agreed to, all Parties are responsible for their commitment reflected in the schedule. This means the contractor must bring the appropriate resources to bear on the project to maintain the schedule. The Owner must accept the schedule consequences of late changes. The full process must be facilitated prior to occupancy.
5. Presentation of the updated schedule by the GC shall be an item on the agenda for each Cx progress meeting. Changes to the baseline schedule, necessitated by change orders, must be documented in the applicable change order.
6. Further details of the scheduling are covered in Section 01 91 00.

C. Cx Progress Meetings

1. CA shall schedule and conduct Cx progress meetings at appropriate times throughout the Construction Installation, Construction Acceptance, and Warranty Phases. Agenda items for the meetings shall generally include:
 - a) Review of previous meeting minutes;
 - b) Schedule update;
 - c) Action List Reviews;
 - d) Document Matrix Updates;
 - e) Update Cx Record;
 - f) New issues;
 - g) Coordination and look-ahead until the next meeting.

2. CA shall document minutes of the meeting and distribute per the management protocols agreed to in the *Construction Phase Cx Kick-Off Meeting*.

D. CA Review of Submittals

1. CA shall review submittals relating to key systems or equipment. Review is for Cx facilitation and does not replace the review of the Architect. CA shall not approve compliance with the contract documents however may advise the Architect in this regard.
2. CA shall provide comments on shop drawings and product data to Architect for inclusion in Architect's review.
3. CA may request information to facilitate preparation of FPTs.
4. The following shall be submitted to the CA:
 - a) Shop drawings/product data and manufacturer's start-up relative to all equipment and systems subject to commissioning;
 - b) Contractor's draft of Start-Up Documents for all equipment;
 - c) Draft balancing reports;
 - d) BAS shop drawings;
 - e) Test and balance reports;
 - f) Performance/capacity certifications;
 - g) Factory tests results;
 - h) *Systems Manual* information;
 - i) Warranties.
5. Contractor shall provide one copy of indicated submittals for CA.
6. CA will review and approve Cx-related submittals as they relate to the Cx process. Cx shall not approve conformance to contract documents however may recommend such to the Architect and Owner as applicable.

E. Construction Inspections

1. CA shall conduct construction inspections as deemed appropriate by CA, record observations, and copy Owner and Architect.
2. Architect shall conduct construction inspections specified in Owner - Architect agreement, record observations, and copy Owner and CA.
3. Owner shall provide a team to inspect construction and installations. Owner's inspection team shall be organized by the Owner's representative. This team shall conduct periodic impromptu inspections as well as scheduled inspections, for example close in inspection.

F. Start-Up / Prefunctional Checkout Documentation

1. **Purpose:** Start-Up Documentation (may consist of both Checklists and Tests) document the normal procedure of ensuring that systems are properly installed and ready for functional testing. Checklists and Tests are developed during the Construction Phase by the respective subcontractor in cooperation with the CA. They are completed by the installing or start-up Contractor. The Cx process requires that the Contractor's normal quality control processes (used to prepare systems and equipment for operation, and typically included in a quality construction process) are performed to a high standard of care and thoroughly documented. These procedures are generally what would be done for any good installation. These are performed to all systems and equipment and no

sampling strategy is used. The Cx process requires all Parties to collaborate to establish the optimal standard of care for starting systems and equipment. After the procedures are established, the Contractor performs them and documents them with the Start-Up Documentation.

2. Refer to Section 01 91 00 for further details.
3. Refer to Sections XX 08 00 for generic Start-Up Documentation to be used as minimum requirements.

G. Product Nameplate Data Documentation

1. Contractor shall provide as-installed specific product nameplate data, product numbers, serial numbers, etc. to fully define the asset for Owners use in maintenance management and asset tracking. Refer to Section 01 91 00 for specific details of providing the data.

H. Mechanical-Specific Documentation

1. Contractor shall provide *Temporary Operating and Conditioning Plan* and *Piping Cleaning, Flush, and Fill Plan* per specification requirements.

I. Action List

1. CA shall maintain an Action List tracking Action Items (required information, identified deficiencies, work required, etc.) that relate to Cx. Each Action Item shall be tracked with the Originator, the Parties responsible, due date, the date of closure, and a description of the resolution. Each item shall be categorized for sorting and tracking and for documentation on applicable forms.
2. CA will disseminate this list as appropriate to keep all Parties informed.
3. All Parties indicated as responsible for an Action Item shall respond. Parties shall respond via the Portal if registered; otherwise Parties may respond by email.
4. The originator of an Action Item shall close it and is responsible for recording the resolution. Closing an Action Item amounts to entering the date on which it was addressed.

J. Contractor Notification (System Turn-Over)

1. Contractor shall completely install, thoroughly inspect, start-up, test, adjust, and balance systems and equipment. All activities shall be documented on specified forms. Contractor shall notify Owner in writing that systems are complete and ready for verification and functional performance testing. Owner shall then coordinate and schedule the testing and checkout times.
2. System Turn-Over: Contractor shall notify CA at least 14 days in advance of any tests, start-ups, or training. CA shall witness selected tests and start-ups. Refer to Section 01 91 00 for minimum requirements for Start-Ups and FPTs.

K. Identification and Resolution of Deficiencies or Additional Work Required

1. Any Party can identify deficiencies, including the CA. Those forwarded to the CA will be documented in the Action List. These shall be items of discussion at progress meetings to determine their legitimacy and decide on appropriate action. However, inclusion in the Action List is not a direction to proceed with any resolution or action. Only the Owner, Architect or other Party as stipulated

in the contracts governing the project can direct work. CA has no authority to direct work or authorize change orders.

2. The Party responsible for the deficiency is responsible for its resolution. Direction to proceed with the resolution is given by the Owner, Architect, or other Party as stipulated in the contracts governing the project.

L. Construction Phase Training

1. Adequate and thorough training of the Operators and the facilities staff is vital to effective transition and early occupancy of the building. A key goal of the Cx team is to ensure this is accomplished. For details of the Training Program, see the chapter "Commissioning Program Training Requirements" in this document.
2. The plan for training begins with the Systems Matrix which will summarize the Operator's need for training. This shall then be communicated in the construction documents. During the Construction Phase, the final details of the training shall be detailed in the contractor supplied *Training Plan* submission and approval process as outlined in the specifications.
3. The *Equipment and Systems Training* is covered in the *Training Plan* and specified in the construction documents. Other non-contractor training is covered in this plan.
4. All parties will be involved in the training process. Many of the documents created and gathered throughout the Cx process will be used in training. Detailed requirements for training are include in the construction specifications. Training will be conducted both on site an in a classroom setting as suits the subject matter.
5. All training sessions shall start and end in a classroom setting. All training shall include persistent documentation that will be handed out to all attendees as well as included electronically in the Training Plan. All sessions shall be evaluated by the attendees. GC will be responsible for videotaping the training sessions for later use if included in the contract.
6. In addition to documenting all training sessions, all training sessions must be evaluated by the participants. CA shall develop an evaluation form that assesses the quality of the presentation, the quality of the content, and provides a forum for feedback of items the attendee feels need to be provided or expanded upon. The Contractor organizing the sessions is responsible for distributing the evaluations, ensuring they are completed, and compiling them and forwarding them to the CA.
7. The Training Plan documentation shall be updated upon the successful completion of training sessions with the completed attendance and evaluation forms. GC shall compile all Contractors training documentation. All training documentation must be provided in a PDF format.
8. **Equipment and Systems Training (Multiple Events)**
 - a) **Purpose:** The Contractor (or Manufacturer's Representative) shall provide training to the Owner and Operators on individual systems and equipment only after successful Start-Up. These training events will typically occur over a period of time as multiple events as systems and equipment are ready. These training events cover proper operation, maintenance, repair, and diagnosis of the systems, equipment, and components installed by the Contractor.
 - b) Refer to Section 01 91 00 for specific Contractor requirements.

M. BAS Trending Requirements

1. Trends are historical archives on computer disk that document the operation of the systems and equipment. Trends can be interval recordings of system I/O parameters or Change-of-Value-based trends that record when a system value changes by more than a specified threshold.
2. Trending requirements are typically specified in the Construction Drawings.
3. Trend data reports shall include a single row of column headings and the data in subsequent rows. Each report shall include a date and time column(s). Recorded analog parameters for a given piece of equipment or component shall be trended at 10 minute intervals and binary parameters shall be trended by COV. Data shall be forwarded in one of the following formats.
 - a) Microsoft Access Database (.mdb)
 - b) Microsoft Excel Spreadsheet (.xls)
 - c) Comma Separated Value (.csv or .txt) preferably with quotes delimiting text fields and # delimiting date/time fields
4. Sample times indicated as COV or change of value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When output to the trending file, the latest recorded value shall be listed with any given time increment record. If the BAS does not have the capability to record based on COV, the parameter shall be recorded on 10 minute intervals.
5. Contractor shall provide the CA with required access privileges and processes, and any other information needed to allow the CA access to the trend log data and allow downloading to a remote location. Contractor shall also provide step-by-step written instructions for accessing the data.

VIII. ACCEPTANCE PHASE COMMISSIONING TASK DEFINITIONS**A. Execution of FPTs**

1. Refer to Section 01 91 10
2. Refer to Sections XX 08 00.

B. Acceptance Criteria

1. Acceptance criteria for tests are indicated in Section 01 91 00, Section 01 91 13.13, and in the specification sections applicable to the systems being tested. Unless indicated otherwise, the criteria for acceptance will be that specified with the individual system, equipment, component, or device.

C. Training Documentation Update

1. The Training Plan documentation shall be updated upon the successful completion of training sessions with the completed attendance and evaluation forms. GC shall compile all Contractors training documentation. All training documentation must be provided in a PDF format.

IX. WARRANTY PHASE COMMISSIONING TASK DEFINITIONS

A. General

1. The Warranty Phase will start upon initial Substantial Completion of the facility per the Contract Documents. Commissioning activities may continue throughout this period.

B. Warranty Phase Training

1. Training logistics and requirements are covered in the Construction Phase Cx Task Definition Chapter of this Guide and in the Construction Specifications. This section deals with training events that are typically done in the Warranty Phase. The logistics for this training are the same as for the Construction Phase.

2. Final Systems Operation Training

- a) **Purpose:** Final Systems Operation Training provides the Owner and Operators a training session on whole-building operation. It shall focus primarily on BAS control of building systems and operation and its impact on building performance. System interactions shall be presented and discussed (such as a combined air handler, chiller, boiler, and terminal unit system), along with a detailed presentation of the sequences of operation and their relationship to the BAS. This training shall be conducted by the BAC with assistance from the CA, and shall be attended by the Owner, Operators, Contractor, Design Team, and by any other Cx Team members deemed necessary by the CA or the Owner.
- b) The BAC shall conduct a session to present the final sequences programmed into the control system. The session should present:
 - (1) Control system architecture;
 - (2) Addressing and location of panels;
 - (3) Schematic configuration of the systems;
 - (4) Final programmed sequences. It shall present the written sequences and illustrate the programming that accomplishes those sequences. This session is typically presented on site by the primary BAS technician that managed the installation of the controls at that facility.
- c) The BAC shall use the record Control Shop Drawings as the handout for the training. The audience for the session will be the building operators and managers. The setting should be primarily classroom. Since the presentation will typically need to use a live Operator Interface, BAC shall work out the logistics of projecting the video for an effective presentation.
- d) Refer to Section 01 91 00 for Contractor requirements. Refer to the Installation Phase chapter, Training section of the Cx Plan, for further details on Training Events. Refer to Section 23 08 10 for BAS Contractor requirements.

3. Commissioned Systems Training Event

- a) **Purpose:** This session provides the Owner and Operators a training session on lessons learned from the Cx process and the impact on systems operation. It shall focus primarily on functional operation of building systems and its impact on building performance. System interactions shall be presented and discussed (such as a combined air handler, chilled water, steam, and terminal unit system), along with an overview of the sequences of operation. Review of testing results and

general problems that occurred, issues the Operators should be aware of, and limits of operation.

- b) This training shall be conducted by the CA with assistance from the Architect and possibly the BAC. The target audience is Owner's building managers and Operators, Contractor, and any other Cx Team members deemed necessary by the CA or the Owner.
4. Training Documentation Update
- a) The Training Plan documentation shall be updated upon the successful completion of training sessions with the completed attendance and evaluation forms. GC shall compile all Contractors training documentation. All training documentation must be provided in a PDF format.

C. Work Performed While Under Warranty

1. At the start of the Warranty Period, Contractor is responsible for servicing the equipment and responding to warranty calls. The logistics of how this work is initiated will be part of the management protocols discussed during the *Construction Phase Kick-Off Meeting* and outlined in the specifications. However, a typical scenario will be that the Owner, Occupants or building managers will express any issues to Operators who will be the first responders to the issue. Operators shall make an initial diagnosis as to whether this is a warranty issue. If, in their judgment it is, Operators will have a point of contact to either go through to initiate the call, or copy when directly contacting a limited set of subcontractors.
2. Operators assess responsibility in good faith but bear no responsibility for misdiagnosis. GC must log all warranty calls with a description of the issue, track the status of completion, then indicate how and when the issue was closed.

D. Record Documentation

1. Record documentation shall be provided to the Owner in hard copy, formatted electronic (PDF) copy, and editable electronic copy. Additionally, all data is to be submitted to the Owner's BIM360 system.
2. Record Drawings
 - a) Record drawings are design drawings revised to reflect actual installed conditions. The drawings are provided by the Architect after incorporating As-Built edits from the contractor. These shall be provided in hard copy, electronic format (following owner drafting standards), and printed to PDF format. Owner shall take record documents and maintain them as revisions are made to the facility.
3. Record Specifications
 - a) Record specifications are specifications revised to reflect actual installed equipment. These are provided by the Architect after incorporating all changes during construction. These shall be provided by the Architect in hard copy, formatted electronic as PDF, and editable electronic (Microsoft Word) format.
4. Record Coordination Drawings
 - a) Record coordination drawings are those developed by the Contractor and reviewed by the Architect. These shall be provided in the same format as listed for Record Drawings.
5. Record Control Shop Drawings

- a) Record control shop drawings are basically control shop drawings that are updated to include final point names, addresses, and sequence logic. These shall be provided in hard copy, formatted electronic, and editable electronic formats.
- 6. Record Submittals
 - a) Record submittals are the final approved set of shop drawings and product data that was used by the contractors to order the equipment and approved by the Architect. These shall be provided in whatever format was required during the approval process.
- 7. Balancing Report
 - a) The balancing report is the report produced by the TAB to document the final set flows and adjustments made to the systems. This shall be provided in hard copy and electronic format.
- 8. Cx Record Documentation
 - a) The Cx Record is the documentation of all Cx activities. This is produced and provided by the CA. This shall be provided in formatted electronic format. The Cx Record shall contain at a minimum:
 - (1) Overview of Cx Process (narrative);
 - (2) Listing of Record Documentation, how it was provided and where it was initially stored by Owner;
 - (3) Final Cx Plan;
 - (4) Cx Meeting Minutes;
 - (5) Final Cx Record Matrix;
 - (6) Documentation of all Start-Up activities;
 - (7) Documentation of all Functional Performance Tests;
 - (8) Training Plans without the training content: This will include the training agendas and evaluations.
 - (9) Action List documenting all issues and the final resolution of them.
- 9. Systems Manual
 - a) The Systems Manual is the overview of the systems and zones that is written for the facility operators. This is developed and provided by the CA in hard copy, formatted electronic, and editable electronic format. It also includes the compiled O&M documentation.

E. Opposite Season Testing

- 1. CA shall conduct opposite season testing to check functionality of systems that could not be done within the time of year when the Acceptance Phase occurred. The CA will perform the opposite season functional performance testing to confirm weather extreme related functionality. Review trending of BAS points to assess issues. Document all findings in the Cx Record.

F. Final Facility Assessment (FFA)

- 1. Within 2 months of the end of the Warranty Period, CA shall assess the facility operation and functionality. The scope of the FFA shall be:
 - a) Interview Operators and User Representatives for perspectives on the facility and issues that are not per their needs.
 - b) Perform abbreviated functional testing to assure systems are still performing as documented in the Record Documentation.
 - c) Review trending on the facility.
 - d) Identify any anomalies in the facility and/or any warranty work required.

- e) Review record documentation for accuracy and completeness.
- f) Review renovation/alterations done to the facility to assess whether they were per the stated OPR.
- g) Document all findings of the FFA. Produce an action list for the contractor, and supplement the Systems Manual with further lessons learned.

X. COMMISSIONING PROGRAM TRAINING REQUIREMENTS

A. Cx Training Program Objectives and Requirements

1. The objective of the Cx Training Program is to provide the Owner and Operators with the knowledge to operate and maintain the mechanical and electrical systems in accordance with the OPR and manufacturer's recommendations. Adequate and thorough training of the operators and the facilities staff is vital to effective transition and early occupancy of the building. A key goal of the Cx Team is to ensure this is accomplished. All Parties will be involved in the Cx training process to varying degrees.
2. The Cx Training Program shall be detailed and thoroughly documented. The intent of the documentation is to be able to repeat the training at a later time for new and replacement Owner personnel.
3. This Section of the Cx Plan details the requirements of the Cx Training Program as well as summarizing key Training Events. Specific Contractor requirements pertaining to training are detailed in the specifications.
4. Many of the documents created and gathered throughout the Cx Program, including the OPR and BOD documents, manufacturer's O&M Manuals, and any available portions of the Systems Manual, will be used in training.
5. Contractor requirements associated with Cx-related Training Events are specified in Section 01 91 00. This Section provides details on content, format, qualifications, means, and methods for executing the training.
6. Training not directly associated with Cx-related systems is not covered by this Plan.
7. **Training Means and Methods:** Unless otherwise specified, training should be conducted both on-site and in a classroom setting as suits the subject matter. Training sessions should typically start and end in a classroom setting. Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as might be appropriate. Field demonstrations shall also be conducted to demonstrate the hands-on aspects of the required tasks.

B. Cx Training Program Overview

1. **Training Plan Document:** The Contractor shall develop a Training Plan outlining the Equipment and Systems Training and Final Systems Operation Training events as proposed by the Contractor.
2. **Training Events:** Training Events include all classroom and field-based training sessions that result in the training or transference of Design Team or Contractor knowledge to the Owner. The following Training Events shall be executed as part of the Training Program:
 - a) Design Orientation Training (conducted by Design Team early in Construction Phase);
 - b) Equipment and Systems Training (conducted by the Contractor as single or multiple Events after completion of Start-Up);

- c) *Final Systems Operation Training* (conducted by the Contractor and BAC Representative after completion of *Equipment and Systems Training*);

C. Training Plan Document

1. Contractor shall submit a Training Plan for CA approval. The Training Plan shall include the following elements;
 - a) Summarize all equipment and systems related training events with topics to be covered
 - b) Approximate training duration
 - c) The instructor's name and bone fides
2. When training is completed, the Training Plan must be updated to include the following;
 - a) Training Material used during the session, which may include hand-outs, videos, manuals, etc.
 - b) Completed Sign-In Sheets which include the names of all attendees.
 - c) Completed Course Student Reviews.
3. Refer to the specifications and the DSM Template Cx Documents for details.

D. Contractor Record Training Documentation

1. **Training Documentation Set:** The Contractors shall create and submit to the CA a final Training Documentation Set based upon the completed Training Plan, Contractor supplied Training Documentation, and any other materials the Contractor or Owner teams created or used during the training sessions.
2. Sessions shall be videotaped for later use per Section 01 91 00.
3. Further details on Contractor training documentation requirements are found in Section 01 91 00.

E. Equipment and Systems Training (Multiple Events)

1. **Purpose:** The Contractor (or Manufacturer's Representative) shall provide training to the Owner/Operators on individual systems and equipment only after successful Start-Up has been completed. These Equipment and Systems Training events will typically occur over a period of time as multiple events as systems and equipment are ready. Equipment and Systems Training events cover proper operation, maintenance, repair, and diagnosis of the systems, equipment, and components installed by the Contractor.
2. **Responsibility and Schedule:** Each session shall be led by a contractor or representative with full knowledge of the specific installation and be fully aware of the design rational behind the specific equipment's purpose for being in the project. The trainer must be fully knowledgeable about the equipment being trained. Each training session must be scheduled in advance with at least 14 days prior notice in the construction schedule. These training sessions usually occur after the equipment has been started, but before Acceptance testing has begun. The Owner may permit variance in scheduled activities as each project may vary in the demand of owner representatives.
3. **Attendees:** Typically, the owner representatives that must attend are those from departments that would maintain and/or operate the equipment being trained. As well, any member of the Cx Team may attend. Required attendees include; Contractor CxC, and representatives from the Owner/Operators/Special Facility personnel.

4. Refer to Section 01 91 00 and respective commissioning specifications for details for details on training content and execution requirements.

F. Final Systems Operation Training Event

1. **Purpose:** Final Systems Operation Training provides the Owner and Operators a training session on whole-building operation. It shall focus primarily on BAS control of building systems and operation and its impact on building performance. System interactions shall be presented and discussed (such as a combined air handler, chiller, boiler, and terminal unit system), along with a detailed presentation of the sequences of operation and their relationship to the BAS. and shall be attended by the Owner, Operators, Contractor, Design Team, and by any other Cx Team members deemed necessary by the CA or the Owner.
2. **Responsibility and Schedule:** This training shall be conducted by the BAC with assistance from the CA. The BAC representative must have full knowledge of the specific installation and be fully aware of the design rational behind the specific equipment's purpose for being in the project. The trainer must be fully knowledgeable about the equipment being trained and the installed sequences of operation. Each training session must be scheduled in advance with at least 14 days prior notice in the construction schedule. This training usually occurs after all FPT tasks are complete and just before or at the beginning of the Warranty Phase.
3. **Attendees:** Any Cx Team member is eligible to attend. Required attendees include the Owner/Operators/Special Facility personnel.
4. Refer to Section 01 91 00 and respective commissioning specifications for details for details on training content and execution requirements.

XI. SYSTEMS MANUAL DOCUMENTATION

A. Systems Manual Documentation Set

1. **Definition:** The Systems Manual is the final deliverable from the Cx process, and provides the information needed to understand, operate, and maintain the facility and its systems. It is typically developed by the CA or Architect, but with content provided by the design team and the Contractors. The Systems Manual expands the scope of standard O&M documentation to incorporate additional information developed through the Cx process. The Systems Manual should be the repository of all updates and corrections as they occur (even throughout Occupancy Life Cycle Updates). It is narrative in nature and organized by system types and by area/usage of the facility (if applicable). Systems Manual content typically includes narrative descriptions of the facility and systems, sequences of operation, schematic diagrams, cuts from design drawings and equipment literature, photos, and manual start/stop and emergency operating procedures for important equipment.
2. **Systems Manual Lead Developer Responsibilities:** The lead developer of the Systems Manual shall be the CA, Architect, or GC as specified. The lead developer is responsible for organizing and producing the Systems Manual and for managing the content and contributions from the Parties responsible for providing technical content. The Party responsible for each topic shall assemble, author, develop, coordinate, or otherwise produce the content for that topic as specified below and provide to the lead developer. Requirements as specified include requiring the applicable Contractors to author project-

specific information in a consistent format in addition to submission of standard pre-printed manufacturer's O&M and product information.

3. **Systems Manual Contractor Responsibilities:** Contractor, Subcontractors and Vendors/Factory Representatives shall prepare, organize and submit applicable content for the comprehensive and coordinated Systems Manual as specified. Some of the material required from the Contractors will need to be authored or customized specifically for this project and facility.
4. **Maintenance and Updates of Systems Manual Content:** Contractors shall maintain the applicable Systems Manual content throughout the Warranty Period. All hard copies will be retained at the Owner's facilities or electronically online at a web-based FTP or Internet site. Changes throughout the Warranty Period shall be fully coordinated with the CA.
5. **Systems Manual Format and Submission:** The Systems Manual contents shall be provided in hard copy and electronic format as specified.

XII. CX PROCEDURAL DOCUMENTATION

A. Cx Document Matrix

1. The Document Matrix outlines the documentation required to be created within the Cx process. This document is owned and managed by the CA, it informs all Cx Team Members of what document is owned by whom.

B. Cx Roles and Responsibilities Matrix

1. This document is project specific representation of the Parties and their corresponding responsibilities per Phase of the project. The CA owns this document and Cx Team Members should use this to facilitate their responsibility within the project.

C. Cx Schedule Precedent Diagram

1. This is a simplified Gantt diagram of the Cx process and management requirements developed by the CA to facilitate the construction teams inclusion of the Cx process into the larger construction schedule. Typically this document would be included in the General Requirements Cx Specification 01 91 00. The durations shown are merely estimates and may vary as the project is further scheduled and work tasks defined.

D. Training Plan

1. As defined in the Training chapter above, this document is provided to the Contractors as a template contained within the DSM.

E. Commissioning Plan

1. The document that outlines the intended process for the project. It is the central repository for Cx planning and the primary reference document that guides all Cx Team Members understanding of what this project's Cx process entails. The CA develops the plan at the beginning of the project, and updates through the Warranty Phase. The Owner team then uses and updates the plan through the facility life cycle.

F. Temporary Operation and Conditioning Plan

1. This document outlines the plan to install, start-up, operate and maintain any Contractor installed equipment with the purpose of conditioning a facility that is currently under construction. The Contractor is responsible for creating this

document as a formal submittal for review by the Architect and CA. Any equipment used for temporary construction purposes must be maintained in such a way as to assure the warranty is not threatened nor is the equipment age reduced as a consequence of the use during construction. A template of this form is contained in the DSM to be used as a guideline for the Contractors to use.

G. Clean, Flush and Fill Plan

1. This Plan outlines the clean, flush and fill process proposed for the project. This represents the collaboration between Owner, CA and the participating subcontractors and vendors. The intent of this document is to:
 - a) Coordinate the specification requirements for proper pipe preparation
 - b) Allow the Owner the ability to tailor the focus of the process to best suit their needs
 - c) Document the cleaning and filling processes
 - d) Enforce the standards required by the specifications
2. This plan includes references to documents contained within the project manual, customized drawing markups and calculations, vendor qualifications, and reports and in some cases third party reporting documents.
3. The Contractor owns this plan, and is encourage to use the DSM template as a starting document to create the plan for formal submission to be reviewed by the Architect and CA.

H. Name Plate Data Collection Form

1. This document is to be filled by all Contractors that supply equipment that includes a Name Plate. This form is specifically designed to integrate the data into the Owner Maximo system. The CA owns the process management of the collection, but the Contractors own the data gathering and inserting it into the document.

END OF COMMISSIONING PLAN

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

PROCUREMENT AND CONTRACTING FORMS

DIVISION 50

SECTION 905 - PROPOSAL

Date _____

Mississippi Transportation Commission
Jackson, Mississippi

Sirs: The following proposal is made on behalf of _____
_____ of _____

for constructing the following designated project(s) within the time(s) hereinafter specified.

The plans are composed of drawings and blue prints on file in the offices of the Mississippi Department of Transportation, Jackson, Mississippi.

The Specifications are the current Standard Specifications of the Mississippi Department of Transportation approved by the Federal Highway Administration, except where superseded or amended by the plans, Special Provisions and Notice(s) to Bidders attached hereto and made a part thereof.

I (We) certify that I (we) possess a copy of said Standard and any Supplemental Specifications.

Evidence of my (our) authority to submit the Proposal is hereby furnished. The proposal is made without collusion on the part of any person, firm or corporation. I (We) certify that I (we) have carefully examined the Plans, the Specifications, including the Special Provisions and Notice(s) to Bidders, herein, and have personally examined the site of the work. On the basis of the Specifications, Special Provisions, Notice(s) to Bidders, and Plans, I (we) propose to furnish all necessary machinery, tools, apparatus and other means of construction and do all the work and furnish all the materials in the manner specified. I (We) understand that the quantities mentioned herein are approximate only and are subject to either increase or decrease, and hereby propose to perform any increased or decreased quantities of work at the unit prices bid, in accordance with the above.

I (We) acknowledge that this proposal will be found irregular and/or non-responsive unless a certified check, cashier's check, or Proposal Guaranty Bond in the amount as required in the Advertisement (or, by law) is submitted electronically with the proposal or is delivered to the Contract Administration Engineer prior to the bid opening time specified in the advertisement.

INSTRUCTION TO BIDDERS: Alternate and Optional Items on Bid Schedule.

1. Two or more items entered opposite a single unit quantity WITHOUT DEFINITE DESIGNATION AS "ALTERNATE ITEMS" are considered as "OPTIONAL ITEMS". Bidders may or may not indicate on bids the Optional Item proposed to be furnished or performed WITHOUT PREJUDICE IN REGARD TO IRREGULARITY OF BIDS.
2. Items classified on the bid schedule as "ALTERNATE ITEMS" and/or "ALTERNATE TYPES OF CONSTRUCTION" must be preselected and indicated on bids. However, "Alternate Types of Construction" may include Optional Items to be treated as set out in Paragraph 1, above.
3. Optional items not preselected and indicated on the bid schedule MUST be designated in accordance with Subsection 102.06 prior to or at the time of execution of the contract.
4. Optional and Alternate items designated must be used throughout the project.

I (We) further propose to perform all "force account or extra work" that may be required of me (us) on the basis provided in the Specifications and to give such work my (our) personal attention in order to see that it is economically performed.

I (We) further propose to execute the attached contract agreement (Section 902) as soon as the work is awarded to me (us), and to begin and complete the work within the time limit(s) provided for in the Specifications and Advertisement. I (We) also propose to execute the attached contract bond (Section 903) in an amount not less than one hundred (100) percent of the total of my (our) part, but also to guarantee the excellence of both workmanship and materials until the work is finally accepted.

I (We) shall submit electronically with our proposal or deliver prior to the bid opening time a certified check, cashier's check or bid bond for **five percent (5%) of total bid** and hereby agree that in case of my (our) failure to execute the contract and furnish bond within Ten (10) days after notice of award, the amount of this check (bid bond) will be forfeited to the State of Mississippi as liquidated damages arising out of my (our) failure to execute the contract as proposed. It is understood that in case I am (we are) not awarded the work, the check will be returned as provided in the Specifications.

SECTION 905 -- PROPOSAL (CONTINUED)

I (We) hereby certify by digital signature and electronic submission via Bid Express of the Section 905 proposal below, that all certifications, disclosures and affidavits incorporated herein are deemed to be duly executed in the aggregate, fully enforceable and binding upon delivery of the bid proposal. I (We) further acknowledge that this certification shall not extend to the bid bond or alternate security which must be separately executed for the benefit of the Commission. This signature does not cure deficiencies in any required certifications, disclosures and/or affidavits. I (We) also acknowledge the right of the Commission to require full and final execution on any certification, disclosure or affidavit contained in the proposal at the Commission's election upon award. Failure to so execute at the Commission's request within the time allowed in the Standard Specifications for execution of all contract documents will result in forfeiture of the bid bond or alternate security.

Respectfully Submitted,

DATE _____

Contractor

BY _____
Signature

TITLE _____

ADDRESS _____

CITY, STATE, ZIP _____

PHONE _____

FAX _____

E-MAIL _____

(To be filled in if a corporation)

Our corporation is chartered under the Laws of the State of _____ and the names, titles and business addresses of the executives are as follows:

President

Address

Secretary

Address

Treasurer

Address

The following is my (our) itemized proposal.

Upgrade of Administration Building HVAC Control System & 3rd Floor Space Reallocation, known as State Project No. BWO-9021-25(010) / 503251301 in Hinds County.

Line no.	Item Code	Adj Code	Quantity	Units	Description[Fixed Unit Price]
Roadway Items					
0010	1550-A001		1	Lump Sum	Upgrade of Administration Building HVAC Control System & 3rd Floor Space Reallocation

SECTION 905 - COMBINATION BID PROPOSAL (Continued)

CONDITIONS FOR COMBINATION BID

If a bidder elects to submit a combined bid for two or more of the contracts listed for this month's letting, the bidder must complete and execute these sheets of the proposal in each of the individual proposals to constitute a combination bid. In addition to this requirement, each individual contract shall be completed, executed and submitted in the usual specified manner.

Failure to execute this Combination Bid Proposal in each of the contracts combined will be just cause for each proposal to be received and evaluated as a separate bid.

It is understood that the Mississippi Transportation Commission not only reserves the right to reject any and all proposals, but also the right to award contracts upon the basis of lowest separate bids or combination bids most advantageous to the State.

It is further understood and agreed that the Combination Bid Proposal is for comparison of bids only and that each contract shall operate in every respect as a separate contract in accordance with its proposal and contract documents.

I (We) agree to complete each contract on or before its specified completion date.

COMBINATION BID PROPOSAL

This proposal is tendered as one part of a Combination Bid Proposal utilizing option ____* of Subsection 102.11 on the following contracts:

* Option to be shown as either (a), (b), or (c).

	<u>Project No.</u>	<u>County</u>	<u>Project No.</u>	<u>County</u>
1.	_____	_____	6.	_____
2.	_____	_____	7.	_____
3.	_____	_____	8.	_____
4.	_____	_____	9.	_____
5.	_____	_____	10.	_____

(a) If Combination A has been selected, your Combination Bid is complete.

(b) If Combination B has been selected, then complete the following page.

SECTION 905 - COMBINATION BID PROPOSAL (Continued)

Project Number	Pay Item Number	Unit	Unit Price Reduction	Total Item Reduction	Total Contract Reduction
1. _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	
2. _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	
3. _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	
4. _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	
5. _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	
6. _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	
7. _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	
8. _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	

SECTION 905 - COMBINATION BID PROPOSAL (Continued)

Project Number	Pay Item Number	Unit	Unit Price Reduction	Total Item Reduction	Total Contract Reduction
9. _____ _____	_____ _____	_____ _____	_____ _____	_____ _____	
10. _____ _____	_____ _____	_____ _____	_____ _____	_____ _____	

(c) If Combination C has been selected, then initial and complete ONE of the following.

- _____ I (We) desire to be awarded work not to exceed a total monetary value of \$ _____.
- _____ I (We) desire to be awarded work not to exceed _____ number of contracts.

TO: EXECUTIVE DIRECTOR, MISSISSIPPI DEPARTMENT OF TRANSPORTATION
JACKSON, MISSISSIPPI

CERTIFICATE

If awarded this contract, I (we) contemplate that portions of the contract will be sublet. I (we) certify that those subcontracts which are equal to or in excess of fifty thousand dollars (\$50,000.00) will be in accordance with regulations promulgated and adopted by the Mississippi State Board of Contractors on September 8, 2011.

I (we) agree that this notification of intent DOES NOT constitute APPROVAL of the subcontracts.

_____ (Individual or Firm)	_____ (Address)
_____ (Individual or Firm)	_____ (Address)
_____ (Individual or Firm)	_____ (Address)
_____ (Individual or Firm)	_____ (Address)

NOTE: Failure to complete the above DOES NOT preclude subsequent subcontracts. Subsequent subcontracts, if any, equal to or in excess of fifty thousand dollars (\$50,000.00) will be in accordance with regulations promulgated and adopted by the Mississippi State Board of Contractors on September 8, 2011.

Contractor _____

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
CERTIFICATION

I, _____,
(Name of person signing bid)

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

(Name of Firm, partnership, or Corporation)

do hereby certify under 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. **BWO-9021-25(010)/ 503251301000**

in **Hinds** _____ 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 are not currently under suspension, debarment, voluntary exclusion or determination of ineligibility; nor have a debarment pending; nor been suspended, debarred, voluntarily excluded or determined ineligible within the past three years by the Mississippi Transportation Commission, the State of Mississippi, any other State or a federal agency; nor been indicted, convicted or had a civil judgment rendered by a court of competent jurisdiction in any matter involving fraud or official misconduct within the past three years.

Do exceptions exist and are made a part thereof? Yes / No

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.

All of the foregoing is true and correct.

(1/2016 S)

SECTION 902

CONTRACT FOR **BWO-9021-25(010)/ 503251301000**

LOCATED IN THE COUNTY(IES) OF **Hinds**

STATE OF MISSISSIPPI,
COUNTY OF HINDS

This contract entered into by and between the Mississippi Transportation Commission on one hand, and the undersigned contractor, on the other witnesseth;

That, in consideration of the payment by the Mississippi Transportation Commission of the prices set out in the proposal hereto attached, to the undersigned contractor, such payment to be made in the manner and at the time of times specified in the specifications and the special provisions, if any, the undersigned contractor hereby agrees to accept the prices stated in the proposal in full compensation for the furnishing of all materials and equipment and the executing of all the work contemplated in this contract.

It is understood and agreed that the advertising according to law, the Advertisement, the instructions to bidders, the proposal for the contract, the specifications, the revisions of the specifications, the special provisions, and also the plans for the work herein contemplated, said plans showing more particularly the details of the work to be done, shall be held to be, and are hereby made a part of this contract by specific reference thereto and with like effect as if each and all of said instruments had been set out fully herein in words and figures.

It is further agreed that for the same consideration the undersigned contractor shall be responsible for all loss or damage arising out of the nature of the work aforesaid; or from the action of the elements and unforeseen obstructions or difficulties which may be encountered in the prosecution of the same and for all risks of every description connected with the work, exceptions being those specifically set out in the contract; and for faithfully completing the whole work in good and workmanlike manner according to the approved Plans, Specifications, Special Provisions, Notice(s) to Bidders and requirements of the Mississippi Department of Transportation.

It is further agreed that the work shall be done under the direct supervision and to the complete satisfaction of the Executive Director of the Mississippi Department of Transportation, or his authorized representatives, and when Federal Funds are involved subject to inspection at all times and approval by the Federal Highway Administration, or its agents as the case may be, or the agents of any other Agency whose funds are involved in accordance with those Acts of the Legislature of the State of Mississippi approved by the Governor and such rules and regulations issued pursuant thereto by the Mississippi Transportation Commission and the authorized Federal Agencies.

The Contractor agrees that all labor as outlined in the Special Provisions may be secured from list furnished by

It is agreed and understood that each and every provision of law and clause required by law to be inserted in this contract shall be deemed to be inserted herein and this contract shall be read and enforced as though it were included herein, and, if through mere mistake or otherwise any such provision is not inserted, then upon the application of either party hereto, the contract shall forthwith be physically amended to make such insertion.

The Contractor agrees that he has read each and every clause of this Contract, and fully understands the meaning of same and that he will comply with all the terms, covenants and agreements therein set forth.

Witness our signatures this the ____ day of _____, ____.

Contractor(s)

By _____

Title _____

Signed and sealed in the presence of:
(names and addresses of witnesses)

MISSISSIPPI TRANSPORTATION COMMISSION

By _____

Executive Director

Secretary to the Commission

Award authorized by the Mississippi Transportation Commission in session on the ____ day of _____, _____, Minute Book No. _____, Page No. _____.

Revised 8/06/2003

SECTION 903
PERFORMANCE AND PAYMENT BOND

CONTRACT BOND FOR: BWO-9021-25(010)/ 503251301000

LOCATED IN THE COUNTY(IES) OF: Hinds

STATE OF MISSISSIPPI,
COUNTY OF HINDS

Know all men by these presents: that we, _____
_____, (Contractor)
_____, Principal, a _____

residing at _____ in the State of _____

and _____
_____, (Surety)

residing at _____ in the State of _____,

authorized to do business in the State of Mississippi, under the laws thereof, as surety, effective as of the contract date

shown below, are held and firmly bound unto the State of Mississippi in the sum of _____

(\$ _____) Dollars, lawful money of the United States of America, to be paid to it for which
payment well and truly to be made, we bind ourselves, our heirs, administrators, successors, or assigns jointly and
severally by these presents.

The conditions of this bond are such, that whereas the said _____

principal, has (have) entered into a contract with the Mississippi Transportation Commission, bearing the date of
_____ day of _____ A.D. _____ hereto annexed, for the construction of certain projects(s) in
the State of Mississippi as mentioned in said contract in accordance with the Contract Documents therefor, on file in the
offices of the Mississippi Department of Transportation, Jackson, Mississippi.

Now therefore, if the above bounden _____
_____ in all things shall stand to and abide by and well and truly observe, do keep and perform all and
singular the terms, covenants, conditions, guarantees and agreements in said contract, contained on his (their) part to be
observed, done, kept and performed and each of them, at the time and in the manner and form and furnish all of the
material and equipment specified in said contract in strict accordance with the terms of said contract which said plans,
specifications and special provisions are included in and form a part of said contract and shall maintain the said work
contemplated until its final completion and acceptance as specified in Subsection 109.11 of the approved specifications,
and save harmless said Mississippi Transportation Commission from any loss or damage arising out of or occasioned by
the negligence, wrongful or criminal act, overcharge, fraud, or any other loss or damage whatsoever, on the part of said
principal (s), his (their) agents, servants, or employees in the performance of said work or in any manner connected
therewith, and shall be liable and responsible in a civil action instituted by the State at the instance of the Mississippi
Transportation Commission or any officer of the State authorized in such cases, for double any amount in money or
property, the State may lose or be overcharged or otherwise defrauded of, by reason of wrongful or criminal act, if any, of
the Contractor(s), his (their) agents or employees, and shall promptly pay the said agents, servants and employees and all
persons furnishing labor, material, equipment or supplies therefor, including premiums incurred, for Surety Bonds,
Liability Insurance, and Workmen's Compensation Insurance; with the additional obligation that such Contractor shall
promptly make payment of all taxes, licenses, assessments, contributions, damages,

any liquidated damages which may arise prior to any termination of said principal's contract, any liquidated damages which may arise after termination of the said principal's contract due to default on the part of said principal, penalties and interest thereon, when and as the same may be due this state, or any county, municipality, board, department, commission or political subdivision: in the course of the performance of said work and in accordance with Sections 31-5-51 et seq. Mississippi Code of 1972, and other State statutes applicable thereto, and shall carry out to the letter and to the satisfaction of the Executive Director of the Mississippi Department of Transportation, all, each and every one of the stipulations, obligations, conditions, covenants and agreements and terms of said contract in accordance with the terms thereof and all of the expense and cost and attorney's fee that may be incurred in the enforcement of the performance of said contract, or in the enforcement of the conditions and obligations of this bond, then this obligation shall be null and void, otherwise to be and remain in full force and virtue.

_____ (Contractors) Principal	_____ Surety
By _____	By _____ (Signature) Attorney in Fact
	Address _____ _____ _____
Title _____ (Contractor's Seal)	_____ (Printed) MS Agent
	_____ (Signature) MS Agent
	Address _____ _____ _____
	_____ (Surety Seal)
	_____ Mississippi Insurance ID Number



BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we _____
Contractor

Address

City, State ZIP

As principal, hereinafter called the Principal, and _____
Surety

a corporation duly organized under the laws of the state of _____

as Surety, hereinafter called the Surety, are held and firmly bound unto **State of Mississippi, Jackson, Mississippi**

As Obligee, hereinafter called Obligee, in the sum of **Five Per Cent (5%) of Amount Bid**

Dollars(\$ _____)

for the payment of which sum will and truly to be made, the said Principal and said Surety, bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has submitted a bid for **Upgrade of Administration Building HVAC Control System & 3rd Floor Space Reallocation, known as State Project No. BWO-9021-25(010) / 503251301 in Hinds County.**

NOW THEREFORE, the condition of this obligation is such that if the aforesaid Principal shall be awarded the contract, the said Principal will, within the time required, enter into a formal contract and give a good and sufficient bond to secure the performance of the terms and conditions of the contract, then this obligation to be void; otherwise the Principal and Surety will pay unto the Obligee the difference in money between the amount of the bid of the said Principal and the amount for which the Obligee legally contracts with another party to perform the work if the latter amount be in excess of the former, but in no event shall liability hereunder exceed the penal sum hereof.

Signed and sealed this _____ day of _____, 20____

(Witness)

(Witness)

(Principal) (Seal)

By: _____
(Name) (Title)

(Surety) (Seal)

By: _____
(Attorney-in-Fact)

(MS Agent)

Mississippi Insurance ID Number