

Renovations to Pecan Springs ES
19-0027 PECSP

Project Manual



O'CONNELL ROBERTSON

Project Number: 1818.01
12.14.18

SECTION 00 01 07

SEALS PAGE

ARCHITECT OF RECORD

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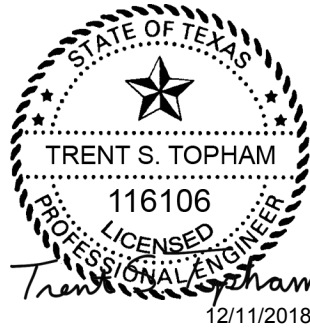
12/10/2018

Architect of Record

Date

MECHANICAL ENGINEER OF RECORD

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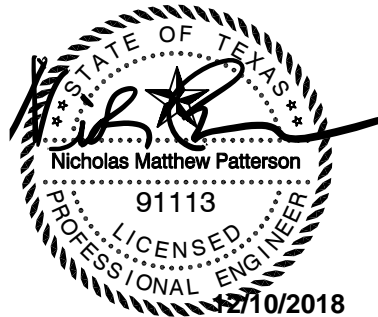
12/11/2018

Mechanical Engineer of Record

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ELECTRICAL ENGINEER OF RECORD

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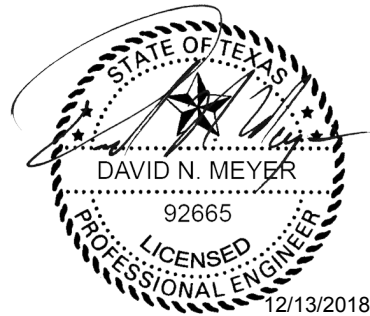
12/10/2018

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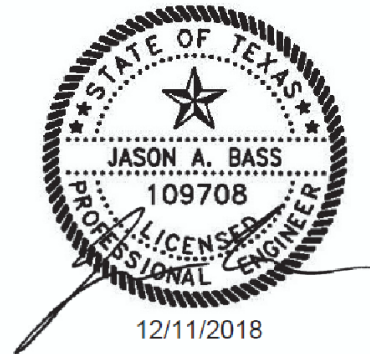


Plumbing Engineer of Record

Date

CIVIL ENGINEER OF RECORD

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Civil Engineer of Record

Date

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SECTION 01 10 00 – SUMMARY OF WORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Project Description.
- B. Work by Owner.
- C. Owner-Supplied Products.
- D. Contractor's Use of Premises.
- E. Coordination.
- F. Warranty of Construction.

1.02 PROJECT DESCRIPTION

- A. The project consists of: Renovations existing elementary school facility to address the six deficiency items identified in the Austin ISD 2017 bond program:
 - 1. Heating and Air-Conditioning – replacement of aged HVAC units
 - 2. Electrical Systems – gear replacement, new fire alarm, new light switches and receptacles, new parking lot light
 - 3. Architectural & Interior Renovations – renovation of teacher lounge and restroom
 - 4. Plumbing – replacement of classroom sinks, water heater, and associated piping and insulation
 - 5. Interior and Exterior Improvements – replacement of flooring, ceilings, and exterior doors/frames
 - 6. Site Drainage – replacement of cracked sidewalks and modifications (new channels and some additional topsoil) to improve site drainage

1.03 WORK BY OWNER

- A. The Owner reserves the right to contract directly with other entities for work not identified as part of the contract.

1.04 OWNER-SUPPLIED PRODUCTS

- A. The Owner will procure specific pieces of equipment as identified on the Drawings and equipment schedules.
- B. The Owner will arrange for delivery and payment of the products to the site, inspect and accept products as in good working order and arrange for manufacturers, warranties, inspections and service.
- C. It shall be the Contractor's responsibility as part of this work to install equipment where

indicated on plans and in accordance with the manufacturer requirements making all required connections to building systems to provide a functional installation and working piece of equipment.

1.05 CONTRACTOR'S USE OF PREMISES

- A. Confine operations at site to areas permitted by law, permits, ordinances, and Contract Documents. Coordinate use of premises under direction of the Owner's Representative.
- B. Do not unreasonably encumber site with materials or equipment. Do not load the structure with weight that will damage or endanger the Work.
- C. Assume full responsibility for protection and safekeeping of products stored on premises. Move any stored products which interfere with operations of Owner. Obtain and pay for use of additional storage or work areas needed for operations.

1.06 COORDINATION

- A. Coordinate Work of the various specification sections to assure efficient and orderly sequence of installation of construction elements, with provisions for accommodating items to be installed by others, and at a later date.
- B. In the event other contractors are doing work in the same area simultaneously with this project, coordinate proposed construction with that of the other contractors.
- C. Verify that characteristics and elements of interrelated operating equipment are compatible; coordinate Work of various sections having interdependent responsibilities for installing, connecting to, and placing in service such equipment.
- D. Coordinate space requirements and installation of mechanical, plumbing, fire protection, and electrical Work which are indicated diagrammatically on drawings. Follow routing shown for pipes, ducts, and conduits as closely as practicable; make runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- E. Resolve piping and conduit interference's by giving precedence to pipelines which require a stated grade for proper operation.
- F. In finished areas, conceal pipes, ducts and wiring in the construction. Coordinate locations of fixtures and outlets with finish elements including equipment furnished by Owner.
- G. Use of explosives will not be permitted.

1.07 WARRANTY OF CONSTRUCTION

- A. For a period of one year from date of substantial completion (or for longer warranty or guarantee periods stipulated elsewhere), warrant that all work conforms to the Contract requirements and is free of any defect of equipment, materials or workmanship. Under the terms of this warranty, remedy at no expense to the Owner, any such failure to conform or any such defect. All movable or adjustable items must remain in proper operating condition throughout the warranty period. Assume responsibility and pay for replacement or repair of adjacent materials or work which may be damaged due to failure of work or repair or replacement of work. This warranty does not apply to work which has been abused or neglected by the Owner.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 20 00 – PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Schedule of Values
- B. Applications for Payment
- C. Change Procedures
- D. Defect Assessment

1.02 SCHEDULE OF VALUES

- A. Submit printed schedule on AIA Form G703 – Continuation Sheet for G702.
- B. Submit Schedule of Values in duplicate within 15 days after date of established Notice to Proceed.
- C. Format: Utilize Table of Contents of this Project Manual. Identify each line item with number and title of major specification Section. Identify site mobilization, bonds and insurance.
- D. Include separately from each line item, direct proportional amount of Contractor's overhead and profit.
- E. Revise schedule to list approved Change Orders, with each Application For Payment.

1.03 APPLICATIONS FOR PAYMENT

- A. Submit five copies of each application on AIA Form G702 – Application and Certificate for Payment and AIA G703 – Continuation Sheet for G702.
- B. Content and Format: Utilize Schedule of Values for listing items in Application for Payment.
- C. Submit updated construction schedule with each Application for Payment.
- D. Payment Period: Submit at intervals stipulated in the Agreement.
- E. Submit with transmittal letter as specified for Submittals in Section 01 33 00 – Submittal Procedures.
- F. Substantiating Data: When Architect/Engineer requires substantiating information, submit data justifying dollar amounts in question. Include the following with Application for Payment:
 - 1. Affidavits attesting to off-site stored products.
 - 2. Construction progress schedules, revised and current as specified in Section 01 33 00 - Submittal Procedures.

1.04 CHANGE PROCEDURES

- A. Submittals: Submit name of individual authorized to receive change documents, and be responsible for informing others in Contractor's employ or Subcontractors of changes to the Work.
- B. Carefully study and compare Contract Documents before proceeding with fabrication and installation of Work. Promptly advise Architect/Engineer of any error, inconsistency, omission, or apparent discrepancy.
- C. Requests for Interpretation (RFI) and Clarifications: Allot time in construction scheduling for liaison with Architect/Engineer; establish procedures for handling queries and clarifications.
 - 1. Use AIA G716 – Request for Information for requesting interpretations.
 - 2. Architect/Engineer may respond with a direct answer on the Request for Interpretation form, AIA G710 – Architect's Supplemental Instruction or Proposal Request AIA G709 – Work Changes Proposal Request.
- D. The Architect/Engineer will advise of minor changes in the Work not involving adjustment to Contract Sum/Price or Contract Time by issuing supplemental instructions on AIA Form G710.
- E. The Architect/Engineer may issue a Proposal Request including a detailed description of proposed change with supplementary or revised Drawings and specifications, a change in Contract Time for executing the change with stipulation of overtime work required and the period of time during which the requested price will be considered valid. Contractor will prepare and submit estimate within 10 days after receipt of Proposal Request.
- F. Contractor may propose changes by submitting a request for change to Architect/Engineer, describing proposed change and its full effect on the Work. Include a statement describing reason for the change, and effect on Contract Sum/Price and Contract Time with full documentation and a statement describing effect on Work by separate or other Contractors. Document requested substitutions in accordance with Section 01 60 00 – Product Requirements
- G. Stipulated Sum/Price Change Order: Based on Proposal Request and Contractor's fixed price quotation or Contractor's request for Change Order as approved by Architect/Engineer.
- H. Unit Price Change Order: For contract unit prices and quantities, the Change Order will be executed on fixed unit price basis. For unit costs or quantities of units of work which are not pre-determined, execute Work under Construction Change Directive. Changes in Contract Sum/Price or Contract Time will be computed as specified for Time and Material Change Order.
- I. Construction Change Directive: Architect/Engineer may issue directive, on AIA Form G713 Construction Change Directive signed by Owner, instructing Contractor to proceed with change in the Work, for subsequent inclusion in a Change Order. Document will describe changes in the Work, and designate method of determining any change in Contract Sum/Price or Contract Time. Promptly execute change.
- J. Time and Material Change Order: Submit itemized account and supporting data after completion of change, within time limits indicated in Conditions of the Contract.

Architect/Engineer will determine change allowable in Contract Sum/Price and Contract Time as provided in Contract Documents.

- K. Maintain detailed records of work done on Time and Material basis. Provide full information required for evaluation of proposed changes, and to substantiate costs for changes in the Work.
- L. Document each quotation for change in cost or time with sufficient data to allow evaluation of quotation.
- M. Change Order Forms: AIA G701/CM Change Order.
- N. Execution of Change Orders: Architect/Engineer will issue Change Orders for signatures of parties as provided in Conditions of the Contract.
- O. Correlation of Contractor Submittals:
 - 1. Promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as separate line item and adjust Contract Sum/Price.
 - 2. Promptly revise progress schedules to reflect change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.
 - 3. Promptly enter changes in Project Record Documents.

1.05 DEFECT ASSESSMENT

- A. Replace the Work, or portions of the Work, not conforming to specified requirements.
- B. If, in the opinion of the Architect/Engineer, it is not practical to remove and replace the Work, the Architect/Engineer will direct appropriate remedy or adjust payment.
- C. The defective Work may remain, but unit sum/price will be adjusted to new sum/price at discretion of Architect/Engineer and Owner.
- D. Defective Work will be partially repaired to instructions of Architect/Engineer, and unit sum/price will be adjusted to new sum/price at discretion of Architect/Engineer and Owner.
- E. Authority of Architect/Engineer to assess defects and identify payment adjustments, is final.
- F. Non-Payment For Rejected Products: Payment will not be made for rejected products for any of the following:
 - 1. Products wasted or disposed of in a manner that is not acceptable.
 - 2. Products determined as unacceptable before or after placement.
 - 3. Products not completely unloaded from transporting vehicle.
 - 4. Products placed beyond lines and levels of required Work.

5. Products remaining on hand after completion of the Work.
6. Loading, hauling, and disposing of rejected products.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 30 00 – ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Coordination and project conditions.
- B. Pre-construction meeting.
- C. Site mobilization meeting.
- D. Progress meetings.
- E. Pre-installation meetings.
- F. Cutting and patching.
- G. Special procedures.

1.02 COORDINATION AND PROJECT CONDITIONS

- A. Coordinate scheduling, submittals and Work of various sections of 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, operating equipment.
- C. Coordinate space requirements, supports, and installation of mechanical and electrical Work 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. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within construction. Coordinate locations of fixtures and outlets with finish elements.
- E. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion.
- F. 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.

1.03 PRE-CONSTRUCTION MEETING

- A. Contractor will schedule meeting after Notice to Proceed.
- B. Attendance Required: Owner, Architect/Engineer and Contractor.
- C. Agenda:

1. Execution of Owner-Contractor Agreement.
 2. Submission of executed bonds and insurance certificates.
 3. Distribution of Contract Documents.
 4. Submission of list of Subcontractors, schedule of values, and progress schedule.
 5. Designation of personnel representing parties in Contract and Architect/Engineer.
 6. Procedures and processing of field decisions, submittals and substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 7. Scheduling.
 8. Scheduling activities of Geotechnical Engineer.
- D. Contractor shall record minutes and distribute copies within four days after meeting to participants, with one copy to Architect/Engineer, Owner and those affected by decisions made.

1.04 SITE MOBILIZATION MEETING

- A. Contractor will schedule meeting at Project site prior to Contractor occupancy.
- B. Attendance Required: Owner, Architect/Engineer, Contractor, contractor's superintendent and major subcontractors.
- C. Agenda:
1. Use of premises by Owner and Contractor.
 2. Temporary utilities provided by Owner.
 3. Survey and building layout.
 4. Security and housekeeping procedures.
 5. Schedules.
 6. Application for payment procedures.
 7. Procedures for testing.
 8. Procedures for maintaining record documents.
 9. Requirements for start-up of equipment.
 10. Inspection and acceptance of equipment put into service during construction period.
- D. Record minutes and distribute copies within four days after meeting to participants, with one copy to Architect/Engineer and Owner and those affected by decisions made.

1.05 PROGRESS MEETINGS

- A. Contractor shall schedule and administer meetings throughout progress of the Work at maximum monthly intervals.
- B. Make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.
- C. Attendance Required: Job superintendent, major subcontractors and suppliers, Owner, Architect/Engineer, as appropriate to agenda topics for each meeting.
- D. Agenda:
 - 1. Review minutes of previous meetings.
 - 2. Review of Work progress.
 - 3. Field observations, problems, and decisions.
 - 4. Identification of problems impeding planned progress.
 - 5. Review of submittals schedule and status of submittals.
 - 6. Review of off-site fabrication and delivery schedules.
 - 7. Maintenance of progress schedule.
 - 8. Corrective measures to regain projected schedules.
 - 9. Planned progress during succeeding work period.
 - 10. Coordination of projected progress.
 - 11. Maintenance of quality and work standards.
 - 12. Effect of proposed changes on progress schedule and coordination.
 - 13. Other business relating to Work.
- E. Record minutes and distribute copies within four days after meeting to participants, with one copy to Architect/Engineer and Owner and those affected by decisions made.

1.06 PRE-INSTALLATION MEETINGS

- A. When required in individual specification sections, convene pre-installation meetings at Project site prior to commencing work of specific section.
- B. Require attendance of parties directly affecting, or affected by, Work of specific section.
- C. Notify Architect/Engineer four days in advance of meeting date unless otherwise noted in the individual specification sections.
- D. Prepare agenda and preside at meeting:
 - 1. Review conditions of installation, preparation and installation procedures.

2. Review coordination with related work.
- E. Record minutes and distribute copies within four days after meeting to participants, with one copy each to Architect/Engineer, Owner and those affected by decisions made.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 CUTTING AND PATCHING

- A. Employ skilled and experienced installer to perform cutting and patching.
- B. Execute cutting, fitting and patching including excavation and fill, to complete Work and to:
 1. Fit the several parts together, to integrate with other Work.
 2. Uncover Work to install or correct ill-timed Work.
 3. Remove and replace defective and non-conforming Work.
 4. Remove samples of installed Work for testing.
 5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.
- C. Execute work by methods to avoid damage to other Work, and to provide proper surfaces to receive patching and finishing.
- D. Cut masonry and concrete materials using masonry saw or core drill.
 1. Prior to cutting concrete and masonry construction, locate and map the following items using a Ferrosan or other approved method to measure the size and depth of the embedded material and to map the position and arrangement of the embedded material:
 - a. Reinforcing steel
 - b. Prestressed or post-tension tendons
 - c. Steel conduit
 - d. Steel embedments
- E. Restore Work with new products in accordance with requirements of Contract Documents.
- F. Fit Work tight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.
- G. Maintain integrity of wall, ceiling or floor construction; completely seal voids.
- H. At penetrations of fire-rated walls, partitions, ceiling or floor construction, completely seal voids with firestop material in accordance with Section 07 84 00 and appropriate UL

Design Number.

- I. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.
- J. Identify hazardous substances or conditions exposed during the Work to Architect/Engineer for decision or remedy.

3.02 SPECIAL PROCEDURES

- A. Materials: As specified in product sections; match existing with new products for patching and extending work.
- B. Employ skilled and experienced installer to perform alteration work.
- C. Cut, move or remove items as necessary for access to alterations and renovation Work. Replace and restore at completion.
- D. Remove unsuitable material not marked for salvage, including rotted wood, corroded metals, and deteriorated masonry and concrete. Replace materials as specified for finished Work.
- E. Remove debris and abandoned items from area and from concealed spaces.
- F. Prepare surface and remove surface finishes to permit installation of new work and finishes.
- G. Close openings in exterior surfaces to protect existing work from weather and extremes of temperature and humidity.
- H. Remove, cut, and patch Work in manner to minimize damage and to permit restoring products and finishes to specified condition.
- I. Refinish existing visible surfaces to remain in renovated rooms and spaces, to specified condition for each material, with neat transition to adjacent finishes.
- J. Where new Work abuts or aligns with existing, provide smooth and even transition. Patch Work to match existing adjacent Work in texture and appearance.
- K. When finished surfaces are cut so that smooth transition with new Work is not possible, terminate existing surface along straight line at natural line of division and submit recommendation to Architect/Engineer for review.
- L. Where change of plane of 1/8 inch or more occurs, request instructions from Architect/Engineer.
- M. Trim existing doors to clear new floor finish. Refinish trim to specified condition.
- N. Patch or replace portions of existing surfaces which are damaged, lifted, discolored or showing other imperfections.
- O. Finish surfaces as specified in individual product sections.

END OF SECTION

SECTION 01 33 00 – SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Submittal procedures.
- B. Construction progress schedules.
- C. Proposed products list.
- D. Product data.
- E. Shop Drawings.
- F. Samples.
- G. Design data.
- H. Test reports.
- I. Certificates.
- J. Manufacturer's instructions.
- K. Manufacturer's field reports.
- L. Erection Drawings.
- M. Construction photographs.
- N. Architect's action.

1.02 SUBMITTAL PROCEDURES

- A. Transmit each submittal with Architect/Engineer accepted form.
- B. Assemble complete submittal package into a single file incorporating submittal requirements of a single Specification Section.
- C. Name file with Specification Number and Sequence Number, including alphabetic revision identifier.
 - 1. File name shall use the Specification Section Number followed by a dash and then the Sequential Number (088000-001). Resubmittals shall include an alphabetic suffix after the original sequence number (088000-001A).
- D. Sequentially number transmittal forms and provide index page after transmittal. On Index page provide index of items included in submittal with page numbers where items are located. Identify options requiring selection by Architect/Engineer.
- E. Identify Project, Contractor, subcontractor and supplier; pertinent Drawing and detail number, and specification section number, appropriate to submittal on transmittal form.

- F. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents.
 - 1. Submittals which do not contain this stamp shall be returned to the contractor without any action taken by the Architect/Engineer.
- G. Incomplete submittals will be returned without review with a request to resubmit when complete.
- H. Schedule submittals to expedite Project, and deliver to Architect/Engineer at business address. Coordinate submission of related items.
- I. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of completed Work.
- J. Allow space on submittals for Contractor and Architect/Engineer review stamps.
- K. When revised for resubmission, identify changes made since previous submission.
- L. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.
- M. Submittals not requested will not be recognized or processed.

1.03 CONSTRUCTION PROGRESS SCHEDULES

- A. Submit initial schedules within 15 days after date established in Notice to Proceed. After review, resubmit required revised data within ten days.
- B. Submit revised Progress Schedules with each Application for Payment.
- C. Distribute copies of reviewed schedules to Project site file, subcontractors, suppliers, and other concerned parties.
- D. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.
- E. Submit computer generated horizontal bar chart with separate line for each major portion of Work or operation, identifying first work day of each week.
- F. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate early and late start, early and late finish, float dates, and duration.
- G. Indicate estimated percentage of completion for each item of Work at each submission.
- H. Submit separate schedule of submittal dates for shop drawings, product data, and samples, including Owner furnished products and dates reviewed submittals will be required from Architect/Engineer. Indicate decision dates for selection of finishes.
- I. Indicate delivery dates for Owner-furnished products.
- J. Revisions to Schedules:

1. Indicate progress of each activity to date of submittal, and projected completion date of each activity.
2. Identify activities modified since previous submittal, major changes in scope, and other identifiable changes.
3. Prepare narrative report to define problem areas, anticipated delays, and impact on Schedule. Report corrective action taken, or proposed, and its effect including effect of changes on schedules of separate contractors.

1.04 PROPOSED PRODUCTS LIST

- A. Within 15 days after date of Notice to Proceed, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.05 PRODUCT DATA

- A. Product Data: Submit to Architect/Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
- B. Submit either electronic copies or one hard copy.
- C. Mark each copy to identify applicable products, models, options and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- E. After review, produce copies and distribute in accordance with Submittal Procedures article and for record documents described in Section 01 70 00 – Execution and Closeout Requirements.

1.06 SHOP DRAWINGS

- A. Shop Drawings: Submit to Architect/Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
- B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- C. When required by individual specification sections, provide Shop Drawings signed and sealed by professional engineer responsible for designing components shown on Shop Drawings.
 1. Include signed and sealed calculations to support design.
 2. Submit drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
 3. Make revisions and provide additional information when required by authorities

having jurisdiction.

- D. Submit either electronically or in the form of one reproduction.
- E. After review, produce copies and distribute in accordance with Submittal Procedures article and for record documents described in Section 01 70 00 – Execution and Closeout Requirements

1.07 SAMPLES

- A. Samples: Submit to Architect/Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
- B. Samples for Selection as Specified in Product Sections:
 - 1. Submit to Architect/Engineer for aesthetic, color or finish selection.
 - 2. Submit samples of finishes from full range of manufacturers' standard colors, in custom colors selected, textures, and patterns for Architect/Engineer selection.
- C. Submit samples to illustrate functional and aesthetic characteristics of Products, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
- D. Include identification on each sample, with full Project information.
- E. Submit number of samples specified in individual specification sections; Architect/Engineer will retain one sample.
- F. Reviewed samples which may be used in the Work are indicated in individual specification sections.
- G. Samples will not be used for testing purposes unless specifically stated in specification section.
- H. After review, produce duplicates and distribute in accordance with Submittal Procedures article and for record documents purposes described in Section 01 70 00 – Execution and Closeout Requirements.

1.08 DESIGN DATA

- A. Submit for Architect/Engineer's knowledge as contract administrator or for Owner.
- B. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.09 TEST REPORTS

- A. Submit for Architect/Engineer's knowledge as contract administrator or for Owner.
- B. Submit test reports for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.10 CERTIFICATES

- A. When specified in individual specification sections, submit certification by manufacturer,

installation/application subcontractor, or Contractor to Architect/Engineer, in quantities specified for Product Data.

- B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or Product, but must be acceptable to Architect/Engineer.

1.11 MANUFACTURER'S INSTRUCTIONS

- A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, startup, adjusting and finishing, to Architect/Engineer for delivery to Owner in quantities specified for Product Data.
- B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.12 MANUFACTURER'S FIELD REPORTS

- A. Submit reports for Architect/Engineer's benefit as contract administrator or for Owner.
- B. Submit report in duplicate within 5 days of observation to Architect/Engineer for information.
- C. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.13 ERECTION DRAWINGS

- A. Submit drawings for Architect/Engineer's benefit as contract administrator or for Owner.
- B. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.
- C. Data indicating inappropriate or unacceptable Work may be subject to action by Architect/Engineer or Owner.

1.14 CONSTRUCTION PHOTOGRAPHS

- A. Provide digital images of site and construction throughout progress of Work.
- B. Each month submit digital images with Application for Payment.
- C. Digital Images: Label CD or Flash drive with Project Name, contract number, Month taken.
- D. Submit a computer disk with all digital images sorted in chronological sequence.

1.15 ARCHITECT'S ACTION

- A. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Architect will review each submittal and mark to indicate action taken. The Architect's action will be taken with such reasonable promptness as to cause no delay in the Work or in the activities of the Owner, Contractor or separate

contractors, while allowing sufficient time in the Architect's professional judgment to permit adequate review and return promptly.

1. Compliance with specified characteristics is the Contractor's responsibility.

B. Submittal Actions:

1. No Exceptions Taken: The submittal is acceptable as submitted and no changes are necessary. No re-submittal is required.
2. Exceptions Noted: The submittal is generally acceptable; however, all notations marked on the submittal must be addressed. No re-submittal is required.
3. Exceptions Noted, Resubmit: The submittal is generally acceptable; however, all notations marked on the submittal must be addressed and re-submitted for review. Submit new, clean drawings or data.
4. Rejected: The submittal does not conform with the Contract Documents and must be re-submitted.
5. For Record Only: Submittal required or submitted for record. No action is required.
6. Pending Additional Information: Submittal lacked Information that was required per the specifications. Submit the requested information for review.
7. Provide Sustainable Information: The submittal lacked the required Sustainable Information. Submit the required Sustainable Information for review.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

INDOOR AIR QUALITY MANAGEMENT

SECTION 01 35 46

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protection of heating, ventilating, and air conditioning systems.
2. Reducing emissions through source control.
3. Pathway interruption.
4. Housekeeping.
5. Scheduling.
6. Indoor Air Quality Management Plan.

B. Related Sections:

1. **01 81 13 Sustainable Construction Requirements**

1.2 REFERENCES

- A. American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- B. Sheet Metal and Air Conditioning Manufacturer's Association International (SMACNA) - IAQ Guidelines for Occupied Buildings Under Construction.

1.3 SUBMITTALS

A. Indoor Air Quality Management Plan:

1. Submit Indoor Air Quality Management Plan for review within ten days after date of Notice to Proceed. Plan should address key issues for IAQ protections such as scheduling, source control, HVAC protection pathway interruption, and housekeeping. Include:
 - a. Procedures for implementing requirements of SMACNA IAQ Guideline.

- b. Substitution procedures for products that are responsibility of Contractor and proposed source control implementation measures to minimize building contamination.
 - c. Construction sequencing and storage plans for protection of stored on-site or installed absorptive materials against moisture absorption and contamination.
 - d. Filter media change schedule. Minimum MERV filtration media per Section 3.1
 - e. Contact Information including name, phone number, and email address of Contractor's personnel responsible for instructing workers and overseeing and documenting results of Indoor Air Quality Management Plan.
2. If required, revise and resubmit plan within ten days after receipt of comments.
 3. Distribute copies of approved Indoor Air Quality Management Plan to concerned parties.
- B. Photographs: Document indoor air quality management measures including protection of ducts, on-site storage, and protection of installed absorptive materials. Provide date stamped photographs for at least three separate site visits.

1.4 QUALITY ASSURANCE

- A. Review and discuss Indoor Air Quality Management Plan implementation and progress at Preconstruction Conference and Progress Meetings.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Designate specific storage areas to facilitate protection of stored absorptive materials.
- B. Clearly identify storage area. Keep clean and orderly; prevent contamination of materials.
- C. Monitor storage areas for contamination; correct problems and implement preventative measures.
- D. Store materials off ground on pallets or skids. Keep materials covered and protected until ready for installation.

1.6 TRAINING

- A. Provide training of indoor air quality management methods to be used at appropriate stages of Project.
- B. Include Indoor Air Quality plan and implementation as an agenda item to Pre-Construction meeting as well as Pre-Installation meetings.
- C. Require participation of all subcontractors and include as agenda item to subcontractor meetings.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 IMPLEMENTATION

- A. During construction, meet or exceed SMACNA minimum requirements for heating, ventilating, and air conditioning system protection, source control, pathway interruption, housekeeping, and scheduling.
- B. Protect stored on-site or installed absorptive materials from moisture damage and volatile organic compound contamination through construction sequencing and proper storage.
- C. If air handlers are used during construction, use filtration media with minimum MERV of 8.
- D. Replace filtration media MERV of 13 just prior to occupancy.
Provide photos documenting filtration change prior to occupancy.
- E. Heating, Ventilating, and Air Conditioning System Protection:
 - 1. Keep duct systems including supply air, return air, and exhaust air and associated equipment including air handlers, variable air volume boxes, silencers, fans, and filter boxes, clean and uncontaminated.
 - 2. Seal taps and open ends not actively being worked on with plastic and tape.
 - 3. Provide 1 inch polyester filter media over return and exhaust air inlets during construction and until Substantial Completion.
 - 4. Ensure that temporary and permanent filters are in place at openings

before running fans.

F. Source Control:

1. For temporary and ancillary materials used in construction, follow requirements of similar products in Divisions 2 through 49 to minimize indoor air quality impacts.
2. Use nontoxic formulations and implement other control measures to minimize building contamination.

G. Pathway Interruption: Isolate areas where work is being performed to prevent contamination of clean spaces.

H. Housekeeping:

1. Implement cleaning activities concentrating on heating, ventilating, and air conditioning systems and building space to remove contaminants prior to occupancy.
2. Protect materials from weather and store in clean area prior to unpacking.
3. Clean coils, air filters, and fans before performing testing and balancing.

I. Scheduling:

1. Sequence construction activities to reduce absorption of and volatile organic compounds by materials.
2. Complete applications of wet and odorous materials before installing absorptive materials.

3.2 DOCUMENTATION

A. Prepare and submit documentation as required to meet the requirements of the Sustainability Rating System chosen for the project:

1. Austin ISD Sustainability Scorecard.
2. Austin Energy Green Building.
3. LEED.

END OF SECTION 013546

SECTION 01 40 00 – QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Quality control and control of installation.
- B. Tolerances.
- C. References.
- D. Manufacturers' field services.
- E. Labeling.
- F. Examination.
- G. Preparation.

1.02 QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. When manufacturers' instructions conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.03 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. **Do not permit tolerances to accumulate.**
- B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

1.04 REFERENCES

- A. For products or workmanship specified by association, trade or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.
- C. Obtain copies of standards where required by product specification sections.
- D. When specified reference standards conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.
- E. Neither contractual relationships, duties, nor responsibilities of parties in Contract nor those of Architect/Engineer shall be altered from Contract Documents by mention or inference otherwise in reference documents.

1.05 MANUFACTURERS' FIELD SERVICES

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment and as applicable, and to initiate instructions when necessary.
- B. Submit qualifications of observer to Architect/Engineer 30 days in advance of required observations. Observer subject to approval of Architect/Engineer.
- C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.
- D. Refer to Section 01 33 00 – Submittal Procedures “Manufacturers' Field Reports” article.

1.06 LABELING

- A. Attach label from agency approved by authority having jurisdiction for products, assemblies and systems required to be labeled by applicable code.
- B. Label Information: Include manufacturer's or fabricator's identification, approved agency identification and the following information, as applicable, on each label:
 - 1. Model number.
 - 2. Serial number.
 - 3. Performance characteristics.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
- B. Verify existing substrate is capable of structural support or attachment of new Work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Verify utility services are available, of correct characteristics, and in correct locations.

3.02 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer or conditioner prior to applying new material or substance in contact or bond.

END OF SECTION

SECTION 01 45 23 – CONCRETE IN-SITU RELATIVE HUMIDITY AND PH TESTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Provide in-situ concrete relative humidity and surface pH testing to all concrete specified to be covered with floor coverings. Includes concrete placed on and above grade
- B. Testing shall take place after allowing concrete to dry for a minimum of 90 days. Testing to be scheduled no less than one and no more than three weeks prior to scheduled flooring installation.

1.02 RELATED SECTIONS

- A. Section 09 30 00 – Tiling.
- B. Section 09 65 00 – Resilient Flooring.

1.03 REFERENCES

- A. ASTM F2170-11 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In-Situ Probes
- B. ASTM F710-05 – Standard Practice for Preparing Concrete Floors and Other Monolithic Floors to Receive Resilient Flooring.

1.04 SUBMITTALS

- A. Report all test results in chart form listing test dates, time, depth of test well, in-situ temperature, relative humidity and pH levels.
- B. List test locations on chart and show same on floor plan.
- C. Deliver results in duplicate for distribution to Architect and General Contractor.

1.05 QUALITY ASSURANCE

- A. Independent Testing Agency
 - 1. Certified by the International Concrete Restoration Institute as a Tier 2 concrete moisture-testing technician.
 - 2. Other agency with verifiable experience
- B. Digital Meter and Calibrated Humidity probes
 - 1. Minimum two-point probe calibration
- C. Wide range pH paper, and distilled or de-ionized water.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Humidity and Temperature probe kit as manufactured by Vaisala or equal.
- B. pH test paper as manufactured by Micro Essential Laboratory or equal.

PART 3 EXECUTION

3.01 QUANTIFICATION OF RELATIVE HUMIDITY

- A. The test site should be maintained at the same temperature and humidity conditions as those anticipated during normal occupancy. These temperature and humidity levels should be maintained for 48 hours prior and during test period. If meeting this criteria is not possible, then minimum conditions should be 75 ± 10 degrees F and 50 ± 10 percent relative humidity. When a building is not under HVAC control, a recording hygrometer or data logger shall be in place recording conditions during the test period. A transcript of this information must be included with the test report.
- B. The number of in-situ relative humidity test sites is determined by the square footage of the facility. Perform three tests for the first 1,000 square feet and one additional test for each additional 1,000 square feet.
- C. Determine the thickness of the concrete slab, typically from construction documents.
- D. Utilizing a roto-hammer drill test holes to the appropriate depth as follows:
 - 1. Slab drying from top only (slab on grade, slab on metal deck) drill-to depth from top of slab 40 percent of slab thickness.
 - 2. Slab drying from top and bottom (elevated structural slab not poured in metal deck) drill-to depth from top of slab 20 percent of slab thickness.
 - 3. Hole diameter shall not exceed outside diameter of the insertable test sleeve by more than 0.04 inch. Drilling operation must be dry.
- E. Vacuum all concrete dust from test hole.
- F. Insert a hole liner, or sleeve, to the full depth of test hole, assuring that the liner is capped or plugged at the end protruding from the concrete surface.
- G. Permit the test site to acclimate or equilibrate for 72 hours prior to taking relative humidity readings.
- H. Remove the sleeve plug and place a probe into the sleeve assuring that it reaches the bottom of the test hole. The test probe must be at temperature equilibration with the concrete slab.
- I. Read and record temperature and relative humidity at the test site.

3.02 QUANTIFYING PH LEVEL

- A. At or near the relative humidity test site perform pH test.
 - 1. Place several drops of water onto the concrete surface to form a puddle

approximately 1 inch in diameter.

2. Allow the water to set for approximately 60 seconds.
 3. Dip the pH paper into the water and remove immediately, compare color to chart provided by paper supplier to determine pH reading
- B. Record and report results.

END OF SECTION

SECTION 01 57 13 - TEMPORARY EROSION AND SEDIMENTATION CONTROL

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Texas Department of Transportation (TxDOT) Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, adopted November 1, 2014.
- C. City of Austin (COA), Standard Specifications Manual, current edition.

1.02 SUMMARY

- A. Section includes specifications for the following temporary erosion and sedimentation controls:
 - 1. Stabilized construction entrance
 - 2. Silt fence
 - 3. Mulch Sock
- B. Construction within public rights-of-way shall be governed by the City of Austin (COA), Standard Specifications Manual, current edition, unless otherwise noted.
- C. Related Sections:
 - 1. Section 311000 "Site Clearing".

1.03 SUBMITTALS

- A. Stabilized Construction Entrance
 - 1. Source, type and gradation of rock
- B. Silt Fence
 - 1. Source, manufacturer, characteristics and test data for the silt fence fabric
 - 2. Manufacturer, characteristics and test data for the posts and wire fence
- C. Mulch Sock
 - 1. Copy of lab analysis verifying that mulch material meets product requirements below.

PART 2 PRODUCTS

2.01 STABILIZED CONSTRUCTION ENTRANCE

- A. Aggregate for construction shall conform to the following gradation:

Aggregate Gradation Chart (TEX 401-A, % Retained per sieve)		
US 8 inch (SI 200 mm)	US 5 inch (SI 125 mm)	US 2 inch (SI 50 mm)
0	90-100	100

2.02 SILT FENCE

- A. Fabric
 - 1. The silt fence fabric shall be of nonwoven polypropylene, polyethylene or polyamide thermoplastic fibers with non-raveling edges. The silt fence fabric shall be non-biodegradable, inert to most soil chemicals, ultraviolet resistant, unaffected by moisture or other weather conditions, and permeable to water while retaining sediment. The silt fence fabric shall be supplied in rolls a minimum of 36 inches (0.9 meter) wide.
 - 2. The fabric shall meet the requirements presented in Table 1, when sampled and tested in accordance with the methods indicated herein.
- B. Posts
 - 1. Posts shall be steel Tee or Y-posts, not less than 4 feet (1.22 meters) in length with a minimum weight of 1.25 pounds per foot (1.86 kilograms per meter) with a minimum Brinell Hardness of 143. Hangers shall be adequate to secure fence and fabric to posts. Posts and anchor plates shall conform to ASTM A-702. Caps are required.
- C. Wire Fence
 - 1. Wire fence shall be welded wire fabric 2 in. x 4 in. 12.5 SWG, wire diameter 0.099 in (±0.005 in.).

Silt Fence Fabric Requirements		
Physical Properties	Method	Requirements
Fabric Weight in ounces per square yard	TEX-616-J	5.0 minimum
Equivalent Sieve Opening Size: US Standard	CW-02215	40 to 100
Mullen Burst Strength: lbs. per sq. inch (psi)	ASTM D-3786	280 minimum
Ultraviolet Resistance; % Strength Retention	ASTM D-1682	70 minimum

2.03 MULCH SOCK

- A. Mulching material can be manufactured on or off the project site and may consist of:
 - 1. Shredded bark
 - 2. Stump grindings
 - 3. Composted bark
- B. The mulch shall have the following composition:
 - 1. Wood chips shall be produced from a 3-inch minus screening process (equivalent to TxDOT item 161, Compost, Section 1.6.2.B Wood Chip Requirements).
 - 2. Large portions of silts, clays, or fine sands are not acceptable.
 - 3. The pH of the mulch shall be between 5.5 and 8.5.
 - 4. The organic matter content shall be greater than or equal to 25% on a dry weight basis.
- C. Mulch material must be free of refuse, physical contaminants, and material toxic to plant growth. It is not acceptable for the mulch material to contain ground construction debris, biosolids, manure, or recyclable material.
- D. Prior to placement, a representative sample of the mulching material must be tested and certified by the project engineer or his/her designee and accepted by the city inspector.
- E. The sock material mesh opening shall be equal to or less than 3/8 inch (10 mm) and the material tensile strength shall be equal to or greater than 202 psi (14.2 kg/cm²)

PART 3 EXECUTION

3.01 STABILIZED CONSTRUCTION ENTRANCE

- A. All trees, brush, stumps, obstructions and other objectionable material shall be removed and disposed of in a manner that will not interfere with the excavation and construction of the entrance as indicated on the Drawings. The entrance shall not drain onto the public right of way or shall not allow surface water runoff to exit the construction site.
- B. When necessary, vehicle wheels shall be cleaned to remove sediment prior to entrance onto public right of way. When vehicle washing is required, it shall be done on an area stabilized with crushed stone, which drains into an approved sediment trap or sediment basin. All sediment shall be prevented from entering any storm drain, ditch or watercourse through use of sand bags, gravel, boards, silt fence or other methods approved by the Engineer.
- C. The entrance shall be maintained in a condition, that will prevent tracking or disposition of sediment onto public right of way. This restriction may require periodic top dressing with additional stone as conditions demand, as well as the repair and/or cleanout of any measures used to trap sediment. All sediment that is spilled, dropped, washed or tracked onto public right of way must be removed immediately.

3.02 SILT FENCE

- A. The silt fence fabric shall be securely attached to the posts and the wire support fence with the bottom 12 inches (300 mm) of the material buried in a trench a minimum of 6 inches (150 mm) deep and 6 inches (150 mm) wide to prevent sediment from passing under the fence. When the silt fence is constructed on impervious material, a 12-inch (300-mm) flap of fabric shall be extended upstream from the bottom of the silt fence and weighted to limit particulate loss. No horizontal joints will be allowed in the silt fence fabric. Vertical joints shall be overlapped a minimum of 12 inches (300 mm) with the ends sewn or otherwise securely tied.
- B. The silt fence shall be a minimum of 24 inches (0.6 meter) high. Posts shall be embedded a minimum of 12 inches (300 mm) in the ground, placed a maximum of 8 feet (2.4 meters) apart and set on a slight angle toward the anticipated runoff source. When directed by the Engineer, posts shall be set at specified intervals to support concentrated loads.
- C. Per OSHA §1926.701, "all protruding reinforcing steel, onto and into which employees could fall, shall be guarded to eliminate the hazard of impalement". Caps must be large enough to dissipate the forces of impact to prevent impalement from a reasonably foreseeable fall distance. It should be noted that the use of impalement protection caps is but one method of protection; covers or wooden troughs can be another means of meeting the guarding requirement.
- D. The silt fence shall be repaired, replaced, and/or relocated when necessary or as directed by the Engineer. Accumulated silt shall be removed when it reaches a depth of 6 inches.

3.03 MULCH SOCK

- A. Use 12 or 18 inch diameter mulch socks for all sediment control applications. This diameter of mulch sock material has proven to be the most consistent for all sediment control applications (TxDOT, April 2006).

- B. Install mulch socks per Figure 1.4.5.F in the City of Austin Environmental Criteria Manual.
- C. Mulch socks should be used at the base of slopes no steeper than 2:1 and should not exceed the maximum spacing criteria provided in the following table.

Slope	Max. Slope Length Between 18 in. Dia. Sock (ft)	Max. Drainage Area (sf) per 100 ft of Sock	Slope	Max. Slope Length Between 12 in. Dia. Sock (ft)	Max. Drainage Area (sf) per 100 ft of Sock
100:1 - 50:1	100	10,000	100:1 - 50:1	100	6,000
50:1 - 30:1	75	7,500	50:1 - 30:1	40	4,000
30:1 - 25:1	65	6,500	30:1 - 25:1	30	3,000
25:1 - 20:1	50	4,800	25:1 - 20:1	25	2,600
20:1 - 10:1	25	2,600	20:1 - 10:1	15	1,300
10:1 - 5:1	15	1,300	10:1 - 5:1	10	1,000
5:1 - 2:1	10	1,000	5:1 - 2:1	5	500

- D. Place mulch socks at a 5 ft or greater distance away from the toe of the slopes to maximize space available for sediment deposition.
- E. When placed on level contours, sheet flow of water should be perpendicular to the mulch sock at impact and unconcentrated.
- F. Install mulch socks using rebar (#5 minimum with safety caps) a minimum of 48 inches in length placed on 2-ft centers. In order to prevent the movement or floating of the mulch sock during rain events or construction operations, install steel posts on alternating sides of the sock. Drive the posts into the ground to a minimum depth of 24 inches, leaving less than 12 inches of post above the exposed mulch sock.
- G. In order to prevent water flowing around the ends of the mulch socks, point the ends of the socks up slope.
- H. In order to prevent water from flowing between the gaps at adjacent ends of mulch socks, overlap the ends of adjacent mulch socks a minimum of 12 inches. Never stack mulch socks on top of one another.
- I. Mulch Socks should be placed using 'smiles' and 'j-hooks'. See ECM Section 1.4.5 G (Silt Fence)
- J. For steeper slopes, an additional mulch sock can be constructed on the top of the slope and within the slope area as determined by specific field conditions. Multiple mulch socks are recommended on steeper slopes.
- K. Do not use mulch socks in areas of concentrated flow as they are intended to control sheet flow only.

END OF SECTION

SECTION 01 60 00 – PRODUCT REQUIREMENTS

PART1 GENERAL

1.01 SECTION INCLUDES

- A. Products.
- B. Product delivery requirements.
- C. Product storage and handling requirements.
- D. Product options and substitutions:
 - 1. Substitution Request Form, Bidding Phase.
 - 2. Substitution Request Form, After Execution of Contract.

1.02 PRODUCTS

- A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.

1.03 PRODUCT DELIVERY REQUIREMENTS

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement or damage.

1.04 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect products in accordance with manufacturers' instructions.
- B. Store with seals and labels intact and legible.
- C. Store sensitive products in weather-tight, climate-controlled, enclosures in an environment favorable to product.
- D. For exterior storage of fabricated products, place on sloped supports above ground.
- E. Provide bonded off-site storage and protection when site does not permit onsite storage or protection.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- G. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.
- H. Provide equipment and personnel to store products by methods to prevent soiling,

disfigurement or damage.

- I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.05 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Standard of Quality:

1. Where one manufacturer or material is called for, listed, or otherwise designated by the Drawings or specification, the intent is not to limit competition or to write a closed specification, but rather to set a standard of quality. Where one manufacturer is called for, it shall be deemed to be followed by the words "equivalent" and contractors may, unless otherwise stated, offer any material, process or article which shall be substantially equal or better in every respect to that so indicated or specified by delivering to the Architect a completed substitution request in accordance with this section. If the material, process or article offered by the contractor in the substitution request is not in the best judgment of the Architect/Owner, substantially equal or better in every respect to that specified, then the Contractor shall furnish any material, process or article specified.
2. Unless otherwise specified, all materials shall be the best of their respective kind and shall be in all cases fully equal to approved samples.
3. With the written approval of the Owner and the Architect as provided below, other manufacturers or materials may be used provided there is not decrease in the quality of the finished product. The Contractor shall assume responsibility for certification of equal quality on substitutions, and shall provide the same warranty for substituted items as for those originally specified.

B. Substitutions:

1. Notwithstanding the use in the specifications of the term "or equal," or other such expressions as applied to a material, manufactured article or process, the item specifically designated shall be used unless a substitute, has been approved in writing by the Architect or Owner, and they shall have the right to require the use of such specifically designated materials, articles or processes.
2. Proposals for substitutions will be considered only until seven business days prior to the date of bid opening. Subsequently, substitutions will be considered only at the discretion of the Owner and the Architect, or if circumstances beyond the control of the Contractor cause a product to become unavailable.
3. Make requests for substitutions on attached Substitution Request Form.

C. Contractor's Options:

The Contractor may exercise the following options regarding substitutions for specified products and materials.

1. For products specified only by reference standard or by description only, select any product by any manufacturer which meets those standards. A substitution request form will not be required.

2. For products specified by naming several manufactures, select any product or manufacturer named.
3. For products specified by naming one or more manufacturers, but with provisions for substitutions, the Contractor must submit written request for substitution of any product not specifically named.
4. For products specified by naming only one manufacturer, substitutions will be reviewed for approval at the discretion of the Architect and the Owner, upon written request for substitution.
5. Substitutions will not be considered when they are indicated or implied on shop drawings or product data submittals without separated written request, or when acceptance will require any revision of Contract Documents.
6. Architect will notify Contractor in writing of acceptance or rejection of proposed substitution within ten business days of bid closing.
7. Only one request for substitution will be considered for each product. When a substitution is rejected, provide material or product as specified.

D. Contractor's Responsibilities:

1. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
2. A request constitutes a representation that Bidder:
 - a. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
 - b. Will provide same warranty for Substitution as for specified product.
 - c. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
 - d. Waives claims for additional costs or time extension which may subsequently become apparent.
 - e. Will reimburse Owner and Architect/Engineer for review or redesign services associated with re-approval by authorities having jurisdiction.
3. In making written request for substitutions, Contractor represents that proposed product or material has been investigated and determined equal or superior in all respects to that specified. Contractor shall provide same warranty for substituted products and materials as for products or materials specific, and shall coordinate installation of accepted substitutions into Work, making such changes as may be required for Work to be complete in all respects.
4. The Contractor waives all claims for additional costs arising from or related to the subsequent installation of substituted items.

E. Replacement:

1. Within the warranty period, should an accepted substitution prove to be defective or otherwise unsatisfactory for the function intended, it shall be replaced at no cost to the Owner with the material or equipment originally specified.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SUBSTITUTION REQUEST

BIDDING PHASE

PROJECT: **Renovations to Pecan Springs ES** PROJECT NO.: **19-0027 PECSP**
Austin Independent School District

TO (ARCHITECT):
O'Connell Robertson

FROM (BIDDER):

HEREBY REQUESTS ACCEPTANCE OF THE FOLLOWING PRODUCT OR SYSTEMS AS A SUBSTITUTION IN ACCORD WITH PROVISIONS OF THE BIDDING DOCUMENTS:

1. SPECIFIED PRODUCT OR SYSTEM:

Substitution request for (Generic Description): _____

Specification Section No. _____ Article(s) _____ Para.(s) _____

2. SUPPORTING DATA:

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

Sample is attached

Sample will be sent if requested

3. QUALITY COMPARISON:

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

Maintenance Service Available: yes no

Spare Parts Source: _____

4. PREVIOUS INSTALLATIONS:

Identification of similar projects on which proposed substitution was used: (Attach list)

Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

5. REASON FOR NOT GIVING PRIORITY TO SPECIFIED ITEMS:

6. EFFECT OF SUBSTITUTION:

Proposed substitution affects other parts of Work: No Yes (If yes, explain)

Substitution requires dimensional revision or redesign of structure or M & E Work:

No Yes (If yes, attach complete data.)

7. BIDDER'S/SUPPLIER'S STATEMENT OF CONFORMANCE OF PROPOSED SUBSTITUTION TO CONTRACT REQUIREMENT:

I/we have investigated the proposed substitution. I/we:

- believe that it is equal or superior in all respects to specified product, except as stated above; and
- will provide the same warranty as specified for specified product; and
- have included complete implications of the substitution; and
- will pay redesign and other costs caused by the substitution which subsequently become apparent; and
- will pay costs to modify other parts of the Work as may be needed, to make all parts of the Work complete and functioning resulting from the substitution.
- warrant and represent to the Owner and the Architect that the proposed substitution does not infringe on any patents or other rights held by others, or that a license has been or will be obtained timely from the holders of such rights for the use of the substitute as proposed; and acknowledge that by accepting this substitution neither the Architect nor the Owner makes any warranty or representation to the Contractor or any Subcontractor regarding the existence or potential for such infringement.

Bidder/Supplier: _____

Date: _____

By: _____

Answer all questions and complete all blanks - use "NA" if not applicable.

REVIEW AND ACTION:

- Resubmit substitution request:
- Provide more information in following categories: _____

- Sign Bidder's/Supplier's Statement of Conformance.
- Substitution is accepted.
- Substitution is accepted, with the following comments: _____

- Substitution not accepted.
- No action taken. Substitution Request received less than **7 business** days prior to date set for receipt of bids.

Architect's Signature

Date

SUBSTITUTION REQUEST

AFTER EXECUTION OF CONTRACT

PROJECT: **Renovations to Pecan Springs ES** PROJECT NO.: **19-0027 PECSP**
Austin Independent School District

TO (ARCHITECT):
O'Connell Robertson

FROM (CONTRACTOR):

HEREBY REQUESTS ACCEPTANCE OF THE FOLLOWING PRODUCT OR SYSTEMS AS A SUBSTITUTION IN ACCORD WITH PROVISIONS OF DIVISION ONE OF SPECIFICATIONS:

1. SPECIFIED PRODUCT OR SYSTEM:

Substitution request for (Generic Description): _____

Specification Section No. _____ Article(s) _____ Para.(s) _____

2. SUPPORTING DATA:

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

Sample is attached

Sample will be sent if requested

3. QUALITY COMPARISON:

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

Maintenance Service Available: yes no

4. PREVIOUS INSTALLATIONS:

Identification of similar projects on which proposed substitution was used: (Attach list)

Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

5. REASON FOR NON-AVAILABILITY OF SPECIFIED ITEM:

Attach affidavit, certification or other data as proof of non-availability.

Strikes

Discontinuance of production

Lockouts

Proven shortage

Bankruptcy

Similar occurrences (explain below)

6. EFFECT OF SUBSTITUTION:

Proposed substitution affects other parts of Work: No Yes (If yes, explain)

Substitution changes Contract Time: No Yes Add/Deduct _____ day

Substitution requires dimensional revision or redesign of structure or M & E Work:

No Yes (If yes, attach complete data.)

Saving or credit to Owner, if any, for accepting substitution: \$ _____

7. CONTRACTOR'S STATEMENT OF CONFORMANCE OF PROPOSED SUBSTITUTION TO CONTRACT REQUIREMENT:

I/we have investigated the proposed substitution. I/we:

- believe that it is equal or superior in all respects to specified product, except as stated above;
- will provide the same warranty as specified for specified product;
- have included complete cost data and implications of the substitution;
- will pay redesign and special inspection costs caused by the use of this product;
- will pay additional costs to other contractors caused by the substitution;
- will coordinate the incorporation of the proposed substitution in the Work;
- will modify other parts of the Work as may be needed, to make all parts of the Work complete and functioning;
- waive future claims for added cost to Contract caused by the substitution;
- warrant and represent to the Owner and the Architect that the proposed substitution does not infringe on any patents or other rights held by others, or that a license has been or will be obtained timely from the holders of such rights for the use of the substitute as proposed; and acknowledge that by accepting this substitution neither the Architect nor the Owner makes any warranty or representation to the Contractor or any Subcontractor regarding the existence or potential for such infringement.

Contractor: _____ Date: _____

By: _____

Answer all questions and complete all blanks - use "NA" if not applicable.

ARCHITECT'S REVIEW AND ACTION:

- Resubmit substitution request:
- Provide more information in following categories: _____

- Sign Contractor's Statement of Conformance.
- Submit proof of non-availability.
- Substitution is accepted.
- Substitution is accepted, with the following comments: _____

- Substitution not accepted.

Architect's Signature

Date approval from the A/E.

FINAL CLEANING

SECTION 017400

PART 1 GENERAL

1.1 REQUIREMENTS INCLUDED

- A. Final cleaning of project.

1.2 RELATED REQUIREMENTS

- A. Document – General Conditions: Cleaning up.
- B. Section 017700 – Contract closeout: Closeout procedures.
- C. Section 017419- Construction Waste Management

1.3 DESCRIPTION

- A. Execute cleaning prior to inspection for substantial completion of each designated portion of the work.

PART 2 PRODUCTS

2.1 CLEANING MATERIALS

- A. Use materials which will not create hazards to health or property, and which will not damage surfaces.
- B. Use only materials and methods recommended by manufacturer of material being cleaned.
- C. Refer to AISD's Green Cleaning Program for least hazardous materials and methods.

PART 3 EXECUTION

3.1 CLEANING

- A. In addition to removal of debris and cleaning specified in other sections, clean interior and exterior exposed-to-view surfaces.
- B. Remove temporary protection and labels not required to remain.

- C. Clean finishes until free of dust, stains, films and other foreign substances.
- D. Clean transparent and glossy materials to a polished condition; remove foreign substances. Polish reflective surfaces to a clear shine.
- E. Vacuum carpeted and similar soft surfaces clean.
- F. Clean and damp mop resilient and hard-surface floors as specified.
- G. Clean plumbing fixtures and food services equipment to a sanitary condition.
- H. All ventilation equipment and air handling units used during construction shall be equipped with minimum MERV 8 filtration media during construction per Section 013546 INDOOR AIR QUALITY MANAGEMENT.
- I. Clean permanent filters of ventilating equipment and replace disposable filters when units have been operated during construction. In addition, thoroughly clean ducts, blowers and coils when units have inadvertently been operated without filters during construction.
- J. Clean light fixtures and lamps.
- K. Maintain cleaning until substantial completion.
- L. Remove waste, foreign matter and debris from roofs, gutters, areaways and drainage systems consistent with Section 017419- Construction Waste Management.
- M. Remove waste, debris and surplus materials from site consistent with Section 017419- Construction Waste Management.. Clean grounds; remove stains, spills and foreign substances from paved areas and sweep clean. Rake other exterior surfaces clean.
- N. Owner will complete waxing after substantial completion. Provide access and coordinate with Owner's personnel at a time agreeable to both parties.

END OF SECTION 017400

OPERATION AND MAINTENANCE DATA

SECTION 017500

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Specifications and other Conditions of the contract apply to this section.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Format and content of manuals.
 - 2. Schedule of submittals.

1.3 RELATED SECTIONS

- A. Section 013300 – Submittals: Submittals procedures.
- B. Section 014300 – Quality Control Services: Test and balance reports.
- C. Individual Specifications Sections: Specific requirements for operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Prepare instructions and data by personnel experienced in maintenance and operation of described products.

1.5 FORMAT

- A. Prepare data in the form of an instructional manual.
- B. Binders: Commercial quality; 8 ½" X 11"; D-side three-ring; durable plastic covers; maximum 2" ring size.
- C. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of project; identify subject matter of contents.
- D. Provide tabbed indexes for each separate product and system, with typed description of product and major component parts of equipment.

- E. Text: Manufacturer's printed data, or typewritten data on 20-lb paper.
- F. Drawings:
 - 1. Provide sketches and small drawings up to 11" x 17" in size, 3-hole punched, folded if necessary, with reinforced tab. Bind in with text.
 - 2. Larger drawings to be bound together for each system or product.
- G. Contents: Prepare a Table of Contents for each volume, with each product or system description identified, in three parts as follows:
 - 1. Part 1: Directory, listing names, addresses and telephone numbers of Project Manager, Architect/Engineer, contractor, subcontractors and major equipment suppliers.
 - 2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by Specification Section. For each category, identify names, addresses and telephone numbers of Subcontractors and suppliers. Identify the following:
 - a. Significant design criteria.
 - b. List of equipment.
 - c. Parts list for each component.
 - d. Operating instructions.
 - e. Maintenance instructions for equipment and systems.
 - f. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
 - 3. Part 3: Project documents and certificates, including the following:
 - a. Shop drawings and product data.
 - b. Air and water balance reports.
 - c. Certificates.
 - d. Photocopies of warranties and bonds.

1.6 MANUAL FOR MATERIALS AND FINISHES

- A. Building Products, Applied Materials and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Provide information for reordering custom manufactured products.
- B. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- C. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition and details of installation. Provide recommendations for inspections, maintenance and repair.
- D. Additional Requirements: As specified in individual Product Specification Sections.
- E. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.
- F. The O&M Manual will include all of that O&M data referenced or addressed in the Divisions 2 to 49 Sections.

1.7 MANUAL FOR EQUIPMENT AND SYSTEMS

- A. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.
- B. Panelboard Circuit Directories: Provide electrical service characteristics, controls and communications, typed or by label machine.
- C. Include color-coded wiring diagrams as installed.
- D. Operating Procedures: Include start-up, break-in and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instruction.

- E. Maintenance Requirements: Include routine procedures and guide for troubleshooting; disassembly, repair and assembly instruction; and alignment, adjusting, balancing and checking instructions.
- F. Provide servicing and lubrication schedule, and list of lubricants required.
- G. Include manufacturer's printed operation and maintenance instructions.
- H. Include Sequence of Operation by controls manufacturer.
- I. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- J. Provide control diagrams by controls manufacturer as installed.
- K. Provide Contractor's coordination drawings with color-coded piping diagrams as installed.
- L. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- M. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- N. Include test and balancing reports.
- O. Additional Requirements: As specified in individual Product Specification Sections.
- P. Provide a listing in Table of Contents for design data, with tabbed indexes and space for insertion of data.

1.8 SUBMITTALS

- A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of work. Architect/Engineer will review draft and return one copy with comments.
- B. For equipment or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.
- C. Submit one copy of completed volumes 45 days prior to Substantial Completion. This copy will be reviewed and returned (after final inspection) with Architect/Engineer's comments. Revise content of all document sets as required prior to final submission.

- D. Submit two sets of revised final volumes in final form within ten days after final inspection. Final release of retainage by the Owner is contingent, among other things, upon receipt and approval by the Architect/Engineer of all O&M manuals due the Owner by the Contractor. Final payment will not be made until such time as all manuals have been submitted and approved.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

Not Applicable

END OF SECTION 017500

WARRANTIES AND BONDS

SECTION 017600

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Warranty and Bonds.
- B. Form and Preparation of Submittals.
- C. Time and Schedule of Submittals.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General Conditions and other Division-1 Specification Sections, apply to this Section.
- B. AISD - Invitation to Bid; AISD – Instructions to Bidders: Bid Bonds.
- C. AISD – General Conditions: Performance Bond and Labor and Material Payments bonds, Warranty, and Correction of Work.
- D. Section 017700 – Contract Closeout: Contract closeout procedures.
- E. Section 017500 – Operation and Maintenance Data.
- F. Sections 075100 and 075250 – Bituminous Roofing.
- G. Specific requirements for warranties or guarantees for the Work and products and installation that are specified to be warranted or guaranteed, are included in the individual Sections of Division-2 through 49. Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

1.3 WARRANTY

- A. The Contractor shall deliver to the Owner, upon completion of all Work under the contract, his written guarantee, made out to the Owner and in a form satisfactory to the Owner, guaranteeing all of the Work under the Contract be free from faulty materials in every particular and free from

improper workmanship and against injury from proper and usual wear, and agreeing to replace or to re-execute without cost to the Owner such Work as may be found improper, and to make good all damage caused to the other Work or materials, due to such required replacement or re-execution. This guarantee shall be made to cover a period of ONE (1) YEAR from the date of Substantial Completion of all Work under the Contract, as evidenced by the Architects final Certificate of Payment and completion, or for a longer period or time where so stipulated in the Contract Documents.

- B. The Contractor shall arrange to have his Performance Bond run for a period of ONE (1) YEAR after the Date of Completion of the construction Work to cover his guarantee, as set forth herein.
- C. Neither the final certificate, nor payment, nor any provision in the Contract Documents shall relieve the Contractor of responsibility for neglect or faulty materials or workmanship during the period covered by the warranty.
- D. When defective workmanship and/or materials are discovered requiring repairs to be made under this warranty, all such repair work shall be done by the Contractor at his own expense **within** TEN (10) DAYS after written notice of such defect has been given by the Owner. Should the Contractor fail to repair or correct such defective workmanship and/or materials within TEN (10) DAYS after being notified, the Owner may make the necessary repairs and charge the Contractor with the actual cost of all labor and material required.

1.4 FORM OF SUBMITTALS

- A. Provide two copies, bound in commercial quality, letter-sized three-ring binders with hardback, cleanable plastic covers.
- B. Label cover of each binder with type or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible principal.
- C. Table of Contents, neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the Specification Section in which specified, and the name of the product or work item.
- D. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing.

- E. Provide full information, using separate typed sheets as necessary. List Subcontractor, Supplier and Manufacturer, with name, address and telephone number of responsible principal.

1.5 PREPARATION OF SUBMITTALS

- A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers and manufacturers, within ten days after completion of the applicable item or work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Substantial Completion is determined.
- B. Verify that documents are in proper form, contain full information and are notarized. Retain warranties and bonds until time specified for submittal.

PART 2 PRODUCTS (not applicable)

PART 3 EXECUTION

3.1 SCHEDULE OF WARRANTIES

- A. Schedule: Provide warranties and bonds on products and installations as specified in, but not limited to the following Sections:

(Architect/Engineer to list what warranties and bonds will be required.)

END OF SECTION 017600

CONTRACT CLOSEOUT

SECTION 017700

PART 1 GENERAL

1.1 REQUIREMENTS INCLUDED

- A. Administrative provisions for final acceptance.

1.2 RELATED REQUIREMENTS

- A. Documents – General Conditions: Fiscal provisions and additional administrative requirements.
- B. [Section 013546 – Indoor Air Quality Management](#)
- C. Section 017400 – Final cleaning.
- D. [Section 017419 – Construction Waste Management](#)
- E. Section 017839 – Project record documents.
- F. Section 017500 – Operation and maintenance data.
- G. Section 017600 – Warranties and bonds.
- H. [Section 018113 – Sustainable Construction Requirements](#)
- I. Section 071843 – Spare Parts and maintenance materials.

1.3 FINAL COMPLETION

- A. When contractor considers work complete, submit written certification that:
 - 1. Contract documents have been reviewed.
 - 2. Work has been inspected for compliance with contract documents.
 - 3. Equipment and systems have been tested, adjusted and balanced, and are fully operational.
 - 4. Operation of systems has been demonstrated to Owner's personnel.
 - 5. Work is complete and ready for final inspection.
- B. Should Architect/Engineer's or Project Manager's inspection find work incomplete, he will promptly notify contractor in writing, listing observed deficiencies.

- C. Contractor shall remedy deficiencies and send a second certification of final completion.
- D. When Architect/Engineer and Project Manager find work is complete, they will consider closeout submittals.

1.4 CLOSEOUT SUBMITTALS

- A. Evidence of compliance with requirements of governing authorities:
 - 1. Certificate of occupancy.
 - 2. Certificates of inspection required for mechanical and electrical systems.
- B. [IAQ Management Procedures: Under provisions of Section 013546.](#)
- C. [Construction Waste Management Documentation: Under provisions of Section 017419.](#)
- D. Project record documents: Under provisions of Section 017839.
- E. Operation and maintenance data: Under provisions of Section 017500.
- F. Warranties and bonds: Under provisions of Section 017600.
- G. Spare parts and maintenance materials: Under provisions of Section 017843.
- H. Keys and keying schedule: Under provisions of Section 087100.
- I. Evidence of payment and release of liens: In accordance with conditions of the contract.
- J. Consent of surety of final payment.
- K. Certificates of insurance for products and completed operations: In accordance with Conditions of the contract.
- L. Contractor shall provide documentation that final City of Austin Permits have been closed out.

1.5 WARRANTIES

- A. Provide notarized copies.
- B. Execute and assemble documents from subcontractors, suppliers and manufacturers.
- C. Provide table of contents and assemble two copies in two (2) three-ring binders with durable plastic covers.
- D. Submit prior to final application for payment.

- E. For items of work delayed beyond date of substantial completion, provide updated submittal listing date of acceptance as start of warranty period.

1.6 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification section.
- B. Deliver to project site and place in location as directed, obtain receipt prior to final payment.

1.7 CLOSEOUT PROCEDURES

- A. Submit written certification that contract documents have been reviewed, work has been inspected, and that work is complete in accordance with contract documents and ready for Architect / Engineer's and Project Manager's inspection.
- B. Provide submittals to Architect/Engineer and Owner that are required by governing or other authorities.
- C. Submit final Application for Payment identifying total adjusted contract sum, previous payments, and sum remaining due.

1.8 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

1.9 PROJECT RECORD DOCUMENTS

- A. Maintain on site, one set of the following Record Documents, and record actual revisions to the work:
 - 1. Contract drawings.
 - 2. Project Manual.
 - 3. Addenda
 - 4. Change Orders and other modifications to the contract.
 - 5. Reviewed shop drawings, product data and samples.
- B. Store Record Documents separate from documents used for construction.

- C. Record information concurrent with construction progress.
- D. Project Manual: Legibly mark and record at each product section description of actual products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternatives utilized.
 - 3. Changes made by addenda and modifications.
- E. Record Documents and shop drawings: Legibly mark each item to record actual construction including:
 - 1. Measured depths of foundations in relation to finish main floor datum.
 - 2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the work.
 - 4. Field changes of dimension and detail.
 - 5. Details not on original contract drawings.
- F. Submit documents to Architect/Engineer for review and for upgrade to electrical media. This is additional services to A/E contract.

1.10 APPLICATION OF FINAL PAYMENT

- A. Submit application for final payment in accordance with provisions of conditions of the contract.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

Not Applicable

END OF SECTION 017700

PROJECT RECORD DOCUMENTS

SECTION 017839

PART 1 - GENERAL

1. 01 REQUIREMENTS INCLUDED

- A. Maintenance of Record Documents and Samples.
- B. Submittal of Record Documents and Samples.

1. 02 RELATED REQUIREMENTS

- A. Document AISD/GCC - General Conditions:
- B. Section 017700 – Contract Closeout procedures.
- C. Section 017700 – Contract Closeout: Operation and maintenance data.
- D. Individual Specifications Sections: Manufacturer’s certificates and certificates of inspection.

1. 03 MAINTENANCE OF DOCUMENTS AND SAMPLES

- A. In addition to requirements in General Conditions, Maintain at the site for Owner one record copy of:
 - 1. Contract Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Reviewed shop drawings, product data, and samples.
- B. Store Record Documents and samples in Field Office apart from documents used for construction. Provide files, and secure storage for Record Documents and samples.
- C. Label and file record Documents and samples in accordance with Section number listings in Table of Contents of this Project Manual. Label each document “PROJECT RECORD” in neat, large, printed letters.
- D. Maintain Record Documents in a clean, dry and legible condition. Do not use Records Documents for construction purposes.

- E. Keep Record Documents and samples available for inspection by Architect/Engineer.

1. 04 RECORDING

- A. Record information on a set of black line opaque drawings, and in a copy of a Project Manual.
- B. Provide felt tip marking pens, maintaining separate colors for each major system, for recording information.
- C. Record information concurrently with construction progress. Do not conceal any work until required information is recorded.
- D. Construct Drawings and Shop Drawings: Legibly mark each item to record actual construction, including:
 - 1. Measured depths of elements of foundation in relation to finish first floor datum.
 - 2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of construction.
 - 4. Field changes of dimension and detail.
 - 5. Details not on original Contract Drawings.
- E. Other Documents: Maintain manufacturer's certifications, inspection certifications, and field test records, required by individual Specifications sections.

1. 05 SUBMITTALS

- A. At Contract closeout, deliver Record Documents and samples under provisions of Section 017710
- B. Transmit with cover letter in duplicate, listing:
 - 1. Date.

2. Project title and number.
3. Contractor's name, address, and telephone number.
4. Number and title of each Record Document.
5. Signature of Contractor or authorized representative.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION 017839

SPARE PARTS AND MAINTENANCE MATERIALS

SECTION 017843

PART 1 - GENERAL

1. 01 REQUIREMENTS INCLUDED

- A. Products required.
- B. Storage and delivery of products.

1. 02 RELATED REQUIREMENTS

- A. Section 017710 – Contract Closeout; Contract closeout procedures.
- B. Section 017710 – Contract Closeout; Operation and maintenance data.
- C. Individual Specifications Sections: Specific spare parts and materials required.

1. 03 PRODUCTS REQUIRED

- A. Provide quantities of products, spare parts, maintenance tools, and maintenance materials specified in individual sections to be provided to Owner, in addition to that required for completion of Work.
- B. Products: Identical to those installed in the Work. Include quantities in original purchase from manufacturer to avoid variations in manufacture.

1. 04 STORAGE MAINTENANCE

- A. Store products with products to be installed in the work under provisions of Section 016000.
- B. After delivery of products to site, maintain spare products in same space and condition as products to be installed in the work.
- C. Maintain spare products in original containers with labels intact and legible, until delivery to Owner.

1. 05 DELIVERY

- A. Coordinate with Owner: Deliver spare products and maintenance material to owner at Project site and obtain receipt from the school staff prior to final acceptance by the Owner.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION 017843

SECTION 01 91 13**GENERAL COMMISSIONING REQUIREMENTS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.
- B. Related Sections:
 - 1. Division 22 Section "Commissioning of Plumbing Systems" for commissioning process activities for plumbing systems, assemblies, equipment and components.
 - 2. Division 23 Section "Commissioning of Mechanical Systems" for commissioning process activities for mechanical systems, assemblies, equipment, and components.
 - 3. Division 23 Section "Commissioning of Building Automation Systems" for commissioning process activities for control systems.
 - 4. Division 26 Section "Commissioning of Electrical Systems" for commissioning process activities for electrical systems, assemblies, equipment, and components.

1.3 DEFINITIONS

- A. Approval: Acceptance that a piece of equipment or system has been properly installed and is functioning in tested modes according to Contract Documents.
- B. Basis of Design (**BoD**): A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process. Describes systems, components, conditions, and methods chosen to meet design intent.
- C. Building Commissioning: A joint team effort to ensure that all mechanical equipment, controls, and systems function together properly to meet the design intent, to document system performance parameters for fine-tuning of control sequences and operational procedures, and to ensure that personnel are adequately trained to operate systems.
- D. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

- E. Commissioning Authority (**CxA**): Independent agent hired by Owner and not associated with Contractor or its subcontractors, Architect or its sub-consultants, or Owner's Contracting Officer Technical Representative or its staff or consultants. Under Owner's direction, and not Contractor's direction, CA will direct and coordinate day-to-day commissioning activities without assuming oversight responsibilities.
- F. Commissioning (**Cx**) Process: A process that encompasses and coordinates the traditionally separate functions of system documentation, equipment start-up, control system calibration, testing and balancing, training and performance testing. Commissioning requirements do not supersede other requirements of the specifications, but may expand on some of them.
- G. Commissioning Team: Consists of a Commissioning Authority retained by the Owner, Owner's Representative, major equipment suppliers and Contractors/subcontractors.
- H. Contractor (**GC**): Representatives from the general contractor, with whom Owner is contractually obligated to carry out overall planning, coordination, and control of project from inception to completion in accordance with contract documents.
- I. Deferred Functional Tests: Functional tests performed later, after Substantial Completion, due to partial occupancy, equipment, seasonal requirements, design, or other Site conditions that disallow test from being performed.
- J. Design Intent: Dynamic document that provides explanation of ideas, concepts, and criteria that are considered to be important to Owner. Initially, outcome of programming and conceptual design phases.
- K. Design Team: Representatives from the Architect's and/or Engineer's office responsible for the design and contract administration of the project.
- L. Functional Test: Test of dynamic function of systems, as opposed to components, under full operation in various modes through all control system's sequences of operation using manual (direct observation) or monitoring methods following prescribed test procedures in sequential written form.
- M. Owner's Project Requirements (**OPR**): A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.
- N. Pre-functional Checklist: List, provided by Commissioning Authority to installer, of items to inspect and elementary component tests to conduct to verify proper installation of equipment prior to functional testing.
- O. Sampling: Functionally testing only a fraction of total number of identical or near identical pieces of equipment.
- P. Seasonal Commissioning: Testing of equipment that can be done only during periods of peak heating or cooling, when HVAC equipment is operating at full-load or heavy-load conditions.
- Q. Simulated Condition: Condition created for purpose of testing response of system.

- R. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- S. Trending: Monitoring using building control system.

1.4 COMMISSIONING TEAM

- A. Members Appointed by GC: Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of GC, including Project superintendent and all subcontractors, installers, suppliers, specialists, etc. who are responsible for installing systems under this project.
- B. Members Appointed by Owner:
 - 1. Owner's Project Manager;
Department of Construction Management
Austin Independent School District
812 San Antonio, Suite 200
Austin, Texas 78701
Phone: 512-414-8940
 - 2. Owner's Service Center Personnel:
Mechanical Supervisor
Electrical Supervisor
Plumbing Supervisor
Energy Management Dept.
 - 3. Commissioning Authority (CxA):
ACR Engineering, Inc.
907 S Congress Avenue
Austin, TX 78704
Contact: Ricardo Troncoso
Phone (office): 512-440-8333
Phone (mobile): 512-563-3493
E-mail: rtroncoso@acreng.com
 - 4. Architect:
Project Specific
 - 5. MEP Engineer:
Project Specific
 - 6. General Contractor/Construction Manager at Risk:
Project Specific

1.5 RESPONSIBILITIES

- A. Responsibilities of the CxA during the Construction Phase include, but are not limited to the following:
1. Review submittals for equipment & systems to be commissioned. Issue comments to Owner and Design Team.
 2. Review Facility Automation System (FAS) submittals and participate in review meeting with Owner, Design Team and GC.
 3. Prepare project-specific pre-functional/installation checklists and deliver to GC.
 4. Field-verify pre-functional/installation checklists completed by Contractor.
 5. Document and track resolution of installation deficiencies via a Commissioning Log.
 6. Participate in point-to-point third-party verification of HVAC controls.
 7. Participate in third-party sequence testing/verification of HVAC controls.
 8. Verify that GC has delivered O&M's and as-built drawings related to commissioned systems.
 9. Document and track resolution of controls systems deficiencies via a Commissioning Issues Log.
 10. Upon Owner request, assist in the resolution of issues related to commissioned systems.
 11. Prepare a Summary Commissioning Report outlining systems commissioned, findings and resolutions.
- B. Contractor: Responsibilities of the Contractor (GC) as related to Commissioning Process include, but are not limited to the following:
1. Provide to CxA copies of submittals for all systems to be commissioned.
 2. Schedule and facilitate submittal review meeting for Facility Automation System / HVAC Controls.
 3. Manage distribution of pre-functional/installation checklists to sub-contractors.
 4. Require sub-contractors to complete pre-functional/installation checklists.
 5. Verify completion of pre-functional/installation checklists by sub-contractors.
 6. Request field-verification of completed pre-functional checklists by CxA.
 7. Provide written notification to CxA that all aspects of controls work are complete in accordance with specifications.
 8. Provide as-built controls O&M documentation to Owner, Design Team, and CxA.
 9. Coordinate participation of qualified sub-contractor personnel in third-party point-to-point testing of controls.
 10. Coordinate participation of qualified sub-contractor personnel in third-party sequence testing of controls.
 11. Coordinate correction of deficiencies identified in Cx Log as directed by Design Team.
 12. Provide written notification to CxA when all items on the Cx Log have been corrected as directed by Design team.
 13. Coordinate sub-contractor participation in verification of correction to items on Cx Log.
 14. Provide O&M and as-built documentation for all commissioned systems –including TAB report when required.
 15. All costs associated with the participation of GC, Sub-Contractors, Design Professionals, and Equipment Vendors in the Commissioning Process shall be included as part of the Construction Contract.

- C. Owner's Representative: Responsibilities of the Owner's Representative as relate to Commissioning Process include, but are not limited to the following:
1. Manage contracts of Architect/Engineer, CxA and GC.
 2. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions.
 3. Provide final approval for completion of commissioning Work.
 4. Warranty Period: Ensure that seasonal or deferred testing and deficiency issues are addressed.
- D. Design Team: Responsibilities of the Design Team as related to the Construction Phase Commissioning Process include, but are not limited to the following:
1. Perform normal submittal review, construction observation, record drawing preparation, and operations and maintenance data preparation, as required by Contract Documents.
 2. Review Commissioning Authority's submittal review comments and issue directive to GC and/or Design Professionals as deemed applicable.
 3. Coordinate resolution of system deficiencies identified during commissioning, as required by Contract Documents. Review Commissioning Issues Logs and issue directives to GC and/or Design Professionals as applicable.
 4. Assist, along with GC, in clarifying operation and control of commissioned equipment in areas where specifications, control drawings, or equipment documentation are not sufficient for writing detailed testing procedures.
 5. Prepare and submit final as-built design intent documentation for inclusion in Operation and Maintenance Data Manual, and review and approve Operation and Maintenance Data Manual.
 6. Review Commissioning Report and issue directive to resolve all outstanding deficiencies prior to project close-out.
 7. Warranty Period: Coordinate resolution of design non-conformance and design deficiencies identified during warranty period commissioning.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL

A. Authority

1. The Commissioning Authority carries out his responsibilities as the Owner's authorized agent in accordance with plans, specifications, and contractual requirements.
2. CxA reports deficiencies found to the GC, Design Team and Owner.
3. The Design Team evaluates deficiencies and issues directive to GC to remedy CxA's deficiencies lists, in accordance with contract documents.
4. No change in scope work is to take place without express written consent of Owner. Any deficiencies identified by CxA that are deemed by Design Team to be outside of the scope of work shall be discussed with Owner for consideration.
5. GC and CxA are to copy Architect on all correspondence related to the commissioning process.

B. Participation In The Commissioning Process

1. GC shall attend meetings related to Commissioning process and arrange for attendance by subcontractors and vendors prior to commissioning of their systems, at the discretion of CxA.
2. Provide skilled technicians to start and test all systems, and place systems in complete and fully functioning service in accordance with contract documents and design intent.
3. Provide skilled technicians, experienced and familiar with systems being commissioned, to assist CxA in commissioning process.
4. Participate in field-verification of pre-functional checklists with subcontractor and CxA.
5. Coordinate with sub-Contractors and equipment vendors/representatives to set aside adequate time to address Pre-Functional Checklists, Functional Testing, Operations and Maintenance Training, and associated coordination meetings.

C. Work Prior To Testing

1. Upon completion of submittal review, CxA shall issue pre-functional/installation checklists for review by GC and subcontractors. GC and sub-contractors shall review checklists applicable to their specific systems and requests clarifications from CxA.
2. If deemed necessary (and at CxA's option) a pre-commissioning meeting will be scheduled to review the commissioning process and checklists with GC, sub-contractors, Owner, and Design Team.
3. Prior to pre-functional and functional testing, CxA will conduct site inspections at critical times and issue Cx Field Reports with observations on installation deficiencies so that they may be addressed by Design Team as deemed appropriate
4. GC shall complete all phases of the work so the systems can be started, tested, adjusted, balanced, and otherwise commissioned.
5. GC shall verify requirements of Divisions 22, 23 and 26 outlining responsibilities for start-up of equipment with obligations to complete systems, including all sub-systems so that they are fully functional.
6. A minimum of seven (7) days prior to equipment start-up GC shall notify CxA of proposed start-up date. CxA may elect to witness start-up of equipment. Witnessing of normal manufacturer start-up by CxA does not replace third-party commissioning activities.

D. Pre-functional checks and functional performance tests

1. The GC shall provide all materials, services, and labor required to operate equipment and/or system in order to perform the pre-functional checks and functional performance tests. A pre-functional check or functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating commissioning team member of which participation is specified is not present for the test. The GC shall reimburse the Owner and A/E for all costs associated with effort lost due to tests that are aborted. These costs shall include salary, travel costs and per diem (where applicable).
2. Functional performance tests may sometimes duplicate the checking, testing, and inspection methods established in related Sections. Where checking, testing, and inspection methods are not specified in other Sections, methods shall be established which will provide required information. Testing and verification required by this section shall be performed during the Commissioning phase. Requirements in related Sections are

independent from the requirements of this Section and shall not be used to satisfy any of the requirements specified in this Section without the approval of CxA.

3. Follow start-up and initial checkout procedures listed in article titled "RESPONSIBILITIES" in Part 1, and additional requirements specified in this Section. Divisions 22, 23 and 26 have startup responsibilities and are required to complete systems and sub-systems so systems are fully functional, meeting design requirements of Contract Documents. Commissioning procedures and functional testing do not relieve or lessen this responsibility or shift this responsibility, in whole or in part, to Commissioning Agent or Owner.

E. Work To Resolve Deficiencies

1. Complete corrective work in a timely manner to allow expeditious completion of commissioning process. If deadlines pass without resolution of identified problems, Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs thus incurred will be GC's responsibility.

3.2 PRE-FUNCTIONAL CHECKLISTS

A. General

1. Pre-functional checklists are used as a tool to ensure and document that equipment and systems are properly connected and operational, and installed in accordance with specifications, drawings, manufacturer's requirements, and all applicable codes.
2. Checklists ensure that functional performance testing (in-depth checkout) may proceed without unnecessary delays.
3. Performance of pre-functional checklists, startup, and checkout shall be directed and executed by subcontractor or vendor. Only individuals that have direct knowledge and who witnessed that line item task on pre-functional checklist was performed shall initial or check item off.
4. Each piece of equipment and major distribution system receives full pre-functional checkout. No sampling strategies are used.
5. Pre-functional checkout for given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of given system.

B. Pre-functional Checklists

1. Pre-functional performance tests shall be documented in a checklist format, as prepared and provided by CxA, for each piece of equipment. Each checklist shall be initialed by GC, verifying that all items on checklist have been addressed and completed.
2. Commissioning Pre-functional checklists are not to preclude GC from applying his own construction inspection checklists.
3. All system elements shall be checked to verify that they have been installed, adjusted, and calibrated properly, that all connections have been made correctly, and that it is ready to function as specified. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, control sequence, and other conditions which may cause damage.
4. Verify that tests, meter readings and specific electrical characteristics agree with those required by equipment or system manufacturer.

5. All discrete elements and sub-systems shall be adjusted and shall be checked for proper operation. Verify wiring and support components for equipment are complete and tested.
6. CxA third-party verification of pre-functional checklists will NOT take place at the time as equipment start-up or contractor's checklist verification.
7. Do not place equipment or system in continuous operation prior to pre-functional testing verification by CxA.
8. When pre-functional checklists for a particular system or subsystems are completed, GC will request verification by CxA. GC and subcontractors shall accompany CxA during pre-functional checklist verification.
9. If during pre-functional checklist verification, CxA finds a significant number of deficiencies, GC shall have all the checklists associated with similar system redone.

3.3 SYSTEM START-UP

- A. GC will arrange for start-up of operating equipment and systems after (or at the same time as) pre-functional testing and prior to scheduling pre-functional checklist verification by CxA.
- B. Start-up of equipment and systems shall be performed only by a manufacturer's representative, or person(s) who are specifically manufacturer-approved. All start-up personnel shall be trained and authorized, experienced and knowledgeable in the operations of such equipment and systems.
- C. Coordinate schedule for start-up of various equipment and systems so that subsystems required for major systems operation are tested first.
- D. Manufacturer's start-up reports must be submitted to CxA prior to scheduling third-party pre-functional checklist verifications.

3.4 FUNCTIONAL TESTING

- A. The objective of Functional Testing is to demonstrate that each system is operating according to documented design intent and Contract Documents, through all possible modes of operation.
- B. GC and sub-Contractors shall include in bid proposal all costs associated with preparation and execution of Testing Procedures for all systems to be commissioned.
- C. Functional testing is intended to begin upon completion of each system and after pre-functional checklists have been completed. Functional testing may proceed prior to completion of systems or sub-systems at discretion of Commissioning Authority. Beginning system testing before completion does not relieve GC from fully completing system, including pre-functional checklists as early as possible.
- D. GC and sub-Contractors shall provide detailed Testing Procedures that will allow all items on checklists to be verified.
- E. Testing shall be conducted under specified operating conditions as recommended or approved by Commissioning Authority.

- F. A Functional Performance Test shall be performed on each complete system. Each function shall be demonstrated to the satisfaction of Commissioning Authority in accordance with proposed test procedures developed to demonstrate compliance with specifications.
- G. Each Functional Test shall be witnessed and signed off by Commissioning Authority upon satisfactory completion. Functional Test is not to be considered complete until Owner accepts Commissioning Authority's recommendation for completion.
- H. All elements of system shall be tested to demonstrate that total systems satisfy all requirements of these specifications. Testing shall be accomplished on hierarchical basis. Test each piece of equipment for proper operation, followed by each subsystem, followed by the entire system, followed by any inter-ties to other major systems.
- I. Notification, Scheduling Of Functional Testing and Re-Testing
 - 1. Notify CxA and Owner, in writing, of request for scheduling Functional Testing. Submit request no fewer than five days prior to desired date for beginning functional testing.
 - a. GC must certify that systems and equipment are functioning satisfactorily, according to specifications and design intent, prior to requesting Functional Testing. Upon receipt of such certification, CxA will schedule with GC a time for the particular system test.
 - 1) CxA will attempt to schedule Functional Testing when convenient for GC and his vendors, and to minimize lost time to GC.
 - b. GC will resolve all deficiencies identified during initial test prior to submitting request, in writing, for re-testing. Such request for re-testing shall certify that GC has resolved all deficiencies, or list reason why any deficiencies remain which cannot be resolved.
 - c. CxA will re-test to ensure that all deficiencies have been resolved.
 - 1) Deficiencies that were not detected in first Functional Test, but are discovered in subsequent re-testing, are to be resolved by GC as if they had been discovered in initial testing.
- J. Functional Testing Requirements And Procedures
 - 1. GC and sub-Contractors shall perform tests in the presence of CxA. Tests not witnessed by CxA shall not be considered complete.
 - 2. To facilitate Functional Testing, when requested by CxA, GC shall provide services of personnel to accompany CxA for the duration of Functional Testing, including any follow-up testing. Such personnel must be experienced, qualified, and intimately familiar with the system being tested.
 - a. Participation by representative(s) of direct digital controls (DDC) systems is of particular importance in Functional Testing. All systems which are controlled and/or monitored by DDC are to be thoroughly tested, point by point, through all modes of

- operation, with the assistance of manufacturer's representative. DDC graphics, setpoints, and programming are to be included as a part of Functional Testing as well.
- b. GC must provide services of personnel to accompany CxA for equipment and systems which may pose particular health and safety concerns, such as boilers.
 - c. Should he fail to provide representative to accompany CxA during Functional Testing, GC continues to bear full responsibility for equipment warranty. Owner and CxA will not be held responsible for damage to equipment, or other actions which might impact warranty, when performing Functional Testing of systems where GC has not provided authorized accompanying representative to operate equipment.
3. Each system shall be operated through all modes of operation including, but not limited to seasonal, occupied, unoccupied, warm-up, cool-down, part-load, and full-load, where system response is specified.
 - a. For multiple units, sampling strategy established by Commissioning Authority and subject to approval of Owner may be used.
 - b. Verification of each sequence in sequences of operation is required.
 - c. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, and the like, shall also be tested.
 4. Where possible, inspections carried out on systems by local Authorities Having Jurisdiction (AHJ) may serve as Functional Testing for purposes of Commissioning.
 - a. CxA will accompany AHJ during testing procedures required by AHJ.
 - b. It is responsibility of GC to arrange for testing by AHJ and to coordinate with CxA to find mutually convenient times for testing. Provide CxA a minimum of four days in advance of intent to schedule testing by AHJ.
 - c. CxA will issue a separate report on results of testing.
 - d. CxA reserves the right to require additional testing, should testing by AHJ not adequately cover all system components in all modes of operation.
 5. Functional Testing is to be dedicated solely to testing of equipment and systems, and not to resolution of deficiencies. Deficiencies identified during testing process must be corrected by GC at a time other than during Functional Testing.
 6. Within six days of performing functional test, CxA will issue test report with findings a list of deficiencies that must be addressed by GC or sub-Contractors.
 7. Commissioning Authority shall submit a Final Report to Owner recommending acceptance or non-acceptance of individual system components as well as the systems as a whole.

K. Re-Testing And Failure To Remedy Deficiencies

1. Despite GC's best efforts to ensure systems are problem-free, it is expected that some deficiencies will be found during initial inspection of Pre-functional Checklist, and during initial Functional Testing; such deficiencies are expected to be minimal.
2. It is GC's responsibility to remedy identified deficiencies, both in Pre-functional Checklist and in Functional Testing phases of work, in a timely and thorough manner.
3. It is GC's responsibility to ensure that all deficiencies are corrected prior to requesting a re-inspection or re-test of systems and equipment. Do not request re-inspection or re-test until deficiencies are corrected.

- a. At his discretion, CxA may agree to re-testing systems or equipment where deficiencies remain which are beyond GC's control to resolve expeditiously.
 - b. Typically such re-testing of incomplete systems and equipment will take place only if remaining deficiencies are minor in scope and nature, and are of such nature that they cannot be resolved in a timely manner (such as those due to difficulties in obtaining parts, or where Owner has requested a change that has delayed work, etc.)
4. CxA will carry out a second re-inspection or re-test of systems and equipment subsequent to receiving GC's request.
 - a. If CxA finds deficiencies identified in initial inspection or test have not been remedied (with exception of un-resolvable deficiencies in 3.b. above), and such remaining deficiencies are significant enough to require additional inspection or re-testing, GC will be back-charged for CxA's expenses, and time at a rate of \$120 per hour, for a third and any subsequent re-inspections and re-tests.

3.5 DEFERRED TESTING

- A. "Seasonal Commissioning" pertains to testing during peak heating or cooling seasons when HVAC equipment is operating at full-load or heavy-load conditions. Initial commissioning will be done as soon as contract work is completed, regardless of season. Seasonal Commissioning under full- or heavy-load conditions other than the current season will be handled at later time by GC and CxA.
 1. If adequate load may be artificially placed upon heating or cooling equipment, CxA, at his discretion, may perform functional testing during non-peak load periods.
 2. GC is to provide services of personnel and participate in seasonal testing process in the same manner as he would in non-seasonal testing.
 3. Until off-season commissioning can be accomplished, Owner may retain an amount from GC's payment sufficient to cover the cost of off-season testing.
- B. Unforeseen Deferred Tests: If any check or test cannot be completed due to building structure, required occupancy condition, or other reason, execution of checklists and functional testing may be delayed upon approval of Owner. Tests shall be conducted in same manner as seasonal tests, as soon as possible. Services of required parties will be negotiated. Make final adjustments to Operation and Maintenance Manuals and record drawings due to unforeseen deferred tests.
 1. GC is to provide services of personnel and participate in deferred testing in the same manner as he would for normal commissioning.
 2. Until deferred testing can be accomplished, Owner may retain an amount from GC's payment sufficient to cover the cost of deferred testing.

3.6 TRAINING

- A. The following requirements are in addition to operation and maintenance requirements specified elsewhere in this specifications manual. GC shall be responsible for training coordination and scheduling, and ultimately to ensure that training is completed.
- B. Scheduling

1. Organize training to fit Owner's schedule and to optimize the learning experience. Limit continuous sessions to no more than four hours, or otherwise only as approved by Owner and/or Architect.
2. Provide an outline of the proposed training agenda for review by Owner and CxA a minimum of 10 days prior to proposed date for training session.
3. Provide CxA a minimum 5 days advance notice of intent to carry out a training session.
4. The CxA will not be required to attend all training sessions for building personnel, but will attend selected sessions and monitor progress and content.
5. No training will take place prior to successful completion of Functional Testing.

C. Training Materials

1. Develop Training Manuals to meet requirements of individual equipment specification sections.
2. Operating and Maintenance Manuals alone are NOT considered training manuals. O&M Manuals may be used as reference, but shall not be considered to meet requirements for training materials.
3. Develop a detailed outline showing how training program will be organized, including classroom and hands-on training as required by individual specifications sections.
4. Provide with training materials, a quick-reference "how-to" index which will allow operators to easily access information included in Training Manuals and/or O&M Manuals. This reference will include, as a minimum; routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions.
5. Refer to individual equipment or system specifications for minimum material to be covered as part of the training program.

D. Documentation

1. All training sessions are to be fully documented. Document:
 - a. Basic information on training session (name of system, time, date, and location of training, name of presenter, length of training session, etc.).
 - b. Names of persons who attended the training session (provide a sign-in sheet).
 - c. Signature from authorized Owner's representative indicating that training took place and was satisfactory.
2. Provide CxA copy of sign-in sheet with training session documentation.

3.7 O&M MANUALS

- A. Provide operation and maintenance manuals as specified in section 017700 Closeout Submittals, and as outlined in individual sections of Divisions 22, 23 and 26.
- B. Provide CxA with a single copy of Operation and Maintenance Manuals for review. CxA's copy of O&M manuals shall be submitted through Design Team.
- C. CxA shall review O&M Manuals and submit comments through Design Team.

3.8 SYSTEMS TO BE COMMISSIONED

- A. Refer to commissioning specifications sections in Related Sections, including the following:
 - 1. 220100 – COMMISSIONING OF PLUMBING SYSTEMS
 - 2. 230100 - COMMISSIONING OF MECHANICAL SYSTEMS
 - 3. 230926c – COMMISSIONING OF BUILDING AUTOMATION SYSTEMS
 - 4. 260100 - COMMISSIONING OF ELECTRICAL SYSTEMS

END OF SECTION 01 91 13

SECTION 02 41 19 – SELECTIVE STRUCTURE DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Demolishing designated building equipment and fixtures.
- B. Demolishing designated construction.
- C. Cutting and alterations for completion of the work.
- D. Protecting items designated to remain.
- E. Removing demolished materials.

1.02 RELATED SECTIONS

- A. Section 01 30 00 – Administrative Requirements: Coordination and project requirements.
- B. Section 01 77 00 – Contract Closeout: Project record documents.

1.03 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures: Requirements for submittals.
- B. Submit each item listed below for information only.
 - 1. Proposed dust-control measures.
 - 2. Proposed noise-control measures.
 - 3. Schedule of selective demolition activities indicating the following:
 - a. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.
 - b. Interruption of utility service.
 - c. Coordination for shutoff, capping and continuation of utility services.
 - d. Detailed sequence of selective demolition and removal work to ensure uninterrupted progress of Owner's onsite operations.
 - e. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed work.
 - f. Locations of temporary partitions and means of egress.
- C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by selective demolition operations.

1.04 SUBMITTALS FOR CLOSEOUT

- A. Section 01 77 00 – Contract Closeout : Requirements for submittals.
- B. Project Record Documents: Accurately record actual locations of capped utilities and subsurface structural electrical or mechanical conditions.

1.05 REGULATORY REQUIREMENTS

- A. Conform to current building code for demolition work, dust control, products requiring electrical disconnection and re-connection.
- B. Obtain required permits from authorities.
- C. Do not close or obstruct egress width to any building or site exit.
- D. Do not disable or disrupt building fire or life safety systems without three days' prior written notice to Owner.
- E. Conform to procedures applicable when hazardous or contaminated materials are discovered.
- F. Comply with governing EPA notification regulations before starting selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.06 SEQUENCING

- A. Section 01 10 00 – Summary of Work: Work sequence and Drawings.
- B. Activity sequencing schedule to be coordinated with Owner and Architect prior to commencement of Work.

1.07 SCHEDULING

- A. Section 01 30 00 – Administrative Requirements: Requirements for scheduling.
- B. Describe demolition removal procedures and schedule.
- C. Coordinate with the Owner to establish a time period to perform noisy, malodorous or dusty work.

1.08 PROJECT CONDITIONS

- A. Conduct demolition to minimize interference with adjacent and occupied building areas. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.
- B. Schedule tie-ins to existing systems to minimize disruption.
- C. Coordinate work to ensure fire sprinkler, fire alarms, smoke detectors, emergency lighting, exit signs and other life safety systems remain in full operation in occupied areas.
- D. Cease operations immediately if structure appears to be in danger and notify Architect/Engineer. Do not resume operations until directed.
- E. Owner assumes no responsibility for actual condition of buildings to be selectively demolished.
 - 1. Conditions existing at time of inspection for bidding purposes will be maintained by Owner as far as practical.
- F. Storage or sale of removed items or materials on-site will not be permitted.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical or structural elements that conflict with the intended function or design are encountered, investigate and measure the nature and extent of the conflict. Promptly submit a written report to the Architect.
- E. Survey the condition of the building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during selective demolition.
- F. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.02 UTILITY SERVICES

- A. Notify affected utility companies before starting work and comply with their requirements.
- B. Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to governing authorities.
 - a. Provide not less than 72 hours' notice to Owner if shutdown of service is required during changeover.
- C. Utility Requirements: Locate, identify, disconnect and seal or cap off indicated utility services serving building to be selectively demolished.
 - 1. Owner will arrange to shut off indicated utilities when requested by Contractor.
 - 2. Arrange to shut off indicated utilities with utility companies.
 - 3. Where utility services are required to be removed, relocated or abandoned, provide bypass connections to maintain continuity of service to other parts of the building before proceeding with selective demolition.

4. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve or plug and seal the remaining portion of pipe or conduit after bypassing.

3.03 PREPARATION

- A. Drain, purge or otherwise remove, collect and dispose of chemicals, gases, explosives, acids, flammables or other dangerous materials before proceeding with selective demolition operations.
- B. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks and other adjacent occupied and used facilities.
 1. Do not close or obstruct streets, walks or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
- C. Conduct demolition's operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around selective demolition area.
 1. Erect temporary protection, such as walls, fences, railings, canopies and covered passageways where required by authorities having jurisdiction.
 2. Protect existing site improvements, appurtenances and landscaping to remain.
 3. Provide temporary weather protection, during interval between demolition and removal of existing construction, on exterior surfaces and new construction to ensure that no water leakage or damage occurs to structure or interior areas.
 4. Protect walls, ceilings, floors and other existing finish work that are to remain and are exposed during selective demolition operations.
 5. Cover and protect furniture, furnishings and equipment that have not been removed.
- D. Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise.
 1. Construct dustproof partitions of not less than nominal 4-inch studs, 5/8-inch gypsum wallboard with joints taped on occupied side, and 1/2-inch fire-retardant plywood on the demolition side.
 2. Insulate partition to provide noise protection to occupied areas.
 3. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.
 4. Protect air-handling equipment.
 5. Weatherstrip openings.
- E. Provide and maintain interior and exterior shoring, bracing or structural support to preserve stability and prevent movement, settlement or collapse of building to be selectively demolished.

- F. Procedures for work in occupied sterile areas of a surgery suite shall be coordinated with Owner. All materials, tools and equipment shall be cleaned prior to use in these areas.
- G. Layout cuts in post-tensioned concrete elements to avoid cutting concrete within 12 inches of any stressing tendon. Notify Architect 72 hours before cutting post-tensioned concrete.
- H. Provide appropriate temporary signage including signage for exit or building egress.
- I. Do not close or obstruct building egress path.
- J. Do not disable or disrupt building fire or life safety systems without 72 hours' prior written notice to Owner.

3.04 POLLUTION CONTROLS

- A. Use water mist, temporary enclosures and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations.

Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding and pollution.
- B. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 1. Remove debris from elevated portions of building by chute, hoist or other device that will convey debris to grade level.
- C. Clean adjacent structures and improvements of dust, dirt and debris caused by selective demolition operations. Return adjacent areas to condition existing before start of selective demolition.

3.05 SELECTIVE DEMOLITION

- A. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition work above each floor or tier before disturbing supporting members on lower levels.
 - 2. Neatly cut openings and holes plumb, square and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 - 3. Cut or drill from exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression device during flame-cutting operations.

5. Maintain adequate ventilation when using cutting torches.
 6. Remove decayed, vermin-infested or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 8. Locate selective demolition equipment throughout the structure and remove debris and materials so as not to impose excessive loads on supporting walls, floors or framing.
 9. Dispose of demolished items and materials promptly. Onsite storage or sale of removed items is prohibited.
 10. Return elements of construction and surfaces to remain to condition existing before start of selective demolition operations.
- B. Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain, using power-driven masonry saw or hand tools; do not use power-driven impact tools.
- C. Remove no more existing roofing than can be covered in one day by new roofing. See applicable Division 7 section for new roofing requirements.
- D. Remove air-conditioning equipment without releasing refrigerants.

3.06 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
- B. Burning: Do not burn demolished materials.

3.07 CLEANING

- A. Sweep the building broom clean on completion of selective demolition operation.
- B. Change filters on air-handling equipment on completion of selective demolition operations.

END OF SECTION

SECTION 03 30 53 - MISCELLANEOUS CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Texas Department of Transportation (TxDOT) Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, adopted November 1, 2014.
- C. City of Austin (COA), Standard Specifications Manual, current edition.

1.02 SUMMARY

- A. Section includes cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Construction within public rights-of-way shall be governed by the City of Austin (COA), Standard Specifications Manual, current edition, unless otherwise noted.
- C. Related Sections:
 - 1. Section 312000 "Earth Moving" for subgrade preparation, excavation, and backfill.
 - 2. Section 321313 "Concrete Paving" for concrete pavement and flatwork.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture.

PART 2 PRODUCTS

2.01 FORMWORK

- A. Furnish formwork and formwork accessories according to ACI 301.

2.02 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
- C. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.
- D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

2.03 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I.
 - a. Fly Ash: ASTM C 618, Class C or F.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Normal-Weight Aggregate: ASTM C 33, graded, 1-1/2-inch (38-mm) nominal maximum aggregate size.
- C. Lightweight Aggregate: ASTM C 330, 1-inch (25-mm)] nominal maximum aggregate size.
- D. Water: ASTM C 94/C 94M.

2.04 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.05 RELATED MATERIALS

- A. Vapor Retarder: Plastic sheet, ASTM E 1745, Class A or B.
- B. Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick; or plastic sheet, ASTM E 1745, Class C.
- C. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

2.06 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth or cotton mats.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.

- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.07 CONCRETE MIXTURES

- A. Comply with ACI 301 (ACI 301M) requirements for concrete mixtures.
- B. Normal-Weight Concrete: Prepare design mixes, proportioned according to ACI 301 (ACI 301M), as follows:
 - 1. Minimum Compressive Strength: 3600 psi at 28 days.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 - 3. Slump Limit: 5 inches, plus or minus 1 inch (25 mm).
 - 4. Air Content: Maintain within range permitted by ACI 301 (ACI 301M).

2.08 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 - 1. When air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
 - 1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 - 2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
 - 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 EXECUTION

3.01 FORMWORK

- A. Design, construct, erect, brace, and maintain formwork according to ACI 301 (ACI 301M).

3.02 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.03 VAPOR RETARDERS

- A. Install, protect, and repair vapor retarders according to ASTM E 1643; place sheets in position with longest dimension parallel with direction of pour.
 - 1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended adhesive or joint tape.

3.04 STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.05 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Locate and install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
- C. Isolation Joints: Install joint-filler strips at junctions with slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 - 1. Extend joint fillers full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.

3.06 CONCRETE PLACEMENT

- A. Comply with ACI 301 (ACI 301M) for placing concrete.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M).
- C. Consolidate concrete with mechanical vibrating equipment.

3.07 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding 1/2 inch (13 mm).
 - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch (3 mm).
 - 1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.
- C. Rubbed Finish: Apply the following rubbed finish, defined in ACI 301 (ACI 301M), to smooth-formed finished as-cast concrete where indicated:
 - 1. Smooth-rubbed finish.
 - 2. Grout-cleaned finish.
 - 3. Cork-floated finish.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.08 FINISHING UNFORMED SURFACES

- A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.
 - 1. Do not further disturb surfaces before starting finishing operations.
- C. Scratch Finish: Apply scratch finish to surfaces indicated and surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes, unless otherwise indicated.
- D. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, fluid-applied or direct-to-deck-applied membrane roofing, or sand-bed terrazzo.
- E. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.
- F. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- G. Nonslip Broom Finish: Apply a nonslip broom finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.09 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 (ACI 301M) for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure formed and unformed concrete for at least seven days by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests: Perform according to ACI 301 (ACI 301M).
 1. Testing Frequency: One composite sample shall be obtained for each day's pour of each concrete mix exceeding 5 cu. yd. (4 cu. m) but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
 2. Testing Frequency: One composite sample shall be obtained for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mix placed each day.

3.11 REPAIRS

- A. Remove and replace concrete that does not comply with requirements in this Section.

END OF SECTION

SECTION 06 10 53 – MISCELLANEOUS CARPENTRY

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Miscellaneous nailers. Blocking in roof openings.
- B. Concealed wood blocking for support of wall-hung equipment, fixtures, accessories and where shown on Drawings.
- C. Wood treatment
- D. Separation sheet.
- E. Rigid wall backing plates.

1.02 RELATED SECTIONS

- A. Section 07 62 00 – Sheet Metal Flashing and Trim: Fasteners used to secure sheet metal flashing to treated wood nailers, blocking, curbs and cants.

1.03 REFERENCES

- A. APA American Plywood Association.
- B. SPIB – Southern Pine Inspection Bureau.
 - 1. SPIB – Standard Grading Rules for Southern Pine Lumber.
- C. American Society for Testing and Materials (ASTM):
 - 1. ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 2. ASTM B695 – Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
 - 3. ASTM F1667 – Standard Specification for Driven Fasteners: Nails, Spikes and Staples.
- D. American Wood-Preservers' Association (AWPA)
 - 1. AWPA Standard P5 – Standard Waterborne Preservatives.
 - 2. Standard M4, Care of Preservative Treated Wood Products.
 - 3. AWPA Standard U1 – Use Category System.
 - 4. AWPA E12 – Standard Method of Determining Corrosion of Metal in Contact with Treated Wood.

- E. U.S. Department of Commerce National Institute of Standards and Technology:
 - 1. DOC PS1 – Construction and Industrial Plywood.
 - 2. DOC PS2 – Performance Standard for Wood-Based Structural-Use Panels.
 - 3. DOC PS 20 – American Softwood Lumber Standard.
- F. Wood Blocking at Grab Bars:
 - 1. Grab bars shall be designed to resist a single concentrated load of 250 pounds applied in any direction at any point.

1.04 QUALITY ASSURANCE

- A. Lumber Grading Agency: Certified by DOC PS 20.
- B. Plywood Grading Agency: Certified by APA/EWA.
- C. Pressure-Treated Wood Treatment Facility: Provide treated materials that have been produced under an ALSC recognized quality assurance program.
- D. Wood Treatment Plant Qualifications: Wood treatment plant experienced in performing work of this section which has specialized in the treatment of wood similar to that required for this project and a plant licensed by treatment manufacturer.
- E. Apply label from agency approved by authority having jurisdiction to identify each fire retardant treated material.
- F. Treated Material: All preservative-treated wood members shall bear an end tag or permanent ink stamp indicating the following:
 - 1. Identification of the inspection agency.
 - 2. Identification of the standard to which the material was treated.
 - 3. Identification of the treating facility.
 - 4. Identification of the preservative and retention.
 - 5. Identification of the end use for which the product is suitable.

1.05 SUBMITTALS

- A. Submit product data under provisions of Section 01 30 00.
- B. Wood treatment data as follows, including chemical treatment manufacturer's instruction for handling, storing, installing and finishing treated materials:
 - 1. For preservative-treated materials, provide manufacturer's test results based on AWPA E12-94 Standard Test Method of Determining Corrosion of Metal In Contact With Treated Wood.
- C. Warranty of chemical treatment manufacturer for each type of treatment.

- D. Fasteners: Provide manufacturer's recommendations for types of fasteners to be used with treated materials.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Keep materials under cover and dry. Protect from weather and contact with damp or wet surface. Stack lumber, plywood and other panels. Provide for air circulation within and around stacks and temporary coverings. Store materials off the ground
- B. Allow materials exposed to incidental moisture to dry thoroughly prior to covering with vapor- or moisture-retarding finish materials.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Lumber in accordance with DOC PS 20 and as follows:
 - 1. Softwood Lumber: Southern Pine species, #2 grade.
 - a. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified.
 - b. Provide dressed lumber S4S, surfaced four sides.
 - c. Moisture content: Kiln dried to 19 percent maximum moisture content at time of dressing for lumber not to receive wood preservative or fire retardant treatment.
- B. Plywood in accordance with DOC PS 1 and as follows:
 - 1. Exterior
 - a. Not Exposed: APA rated all veneer plywood sheathing, exterior, Group 1 minimum 5 plies, of thickness shown on Drawings.
 - b. Moisture content of panels at time of shipment shall not exceed 18 percent.
 - 2. Interior
 - a. Not Exposed: APA rated all veneer plywood sheathing, exposure 1, Group 1, minimum 5 plies, of thickness indicated on Drawings.
 - b. Moisture content of panels at time of shipment shall not exceed 18 percent.
- C. Separation Sheet: Provide only membranes with the ability to withstand temperatures over 240 degrees F.
 - 1. Grace Construction Products/Grace Ice & Water Shield HT.
 - 2. Carlisle Coatings and Waterproofing/WIP 300 HT.
- D. Wood blocking at grab bars floor-mounted cabinets and wall-hung cabinets:
 - 1. Provide a rigid wall backing system; Backit as manufactured by The Steel

Network.

2. Substitutions Permitted: Provide test reports verifying system will resist the following loads in accordance with the International Building Code:
 - a. Resist a minimum of 200 lbs. of concentrated load or 50 lbs. per linear foot in any direction.
 - b. Resist a concentrated load of 250 lbs.
3. Material: ASTM A653, Grade 33, 33 ksi minimum yield strength, 45 ksi minimum tensile strength, G-60 hot-dipped galvanized coating. Material thickness 20 gauge, 33 mil.

2.02 ANCHORAGE AND FASTENING MATERIALS

- A. Select proper type, size, material and finish for each application. Comply with the following:
 1. Nails and Staples: FS FF-N-105.
 2. Wood Screws: FS FF-S-111.
 3. Bolts and Studs: FS FF-B-575.
 4. Nuts: FS FF-N-836.
 5. Washers: FS FF-W-92.
 6. Lag Screws or Lag Bolts: FS FF-B-561.
 7. Masonry Anchoring Devices: For expansion shields, nails and drive screws comply with FS FF-S-325.
 8. Toggle Bolts: FS FF-B-588.
 9. Bar or Strap Anchors: ASTM A575 carbon steel bars.
- B. Fasteners and Anchors: All fasteners and anchors used in contact with preservative-treated wood and in high humidity locations (lumber and plywood) shall be labeled as appropriate for use with the specified wood treatments and shall be:
 1. Screws, nails and small bolts: Stainless steel Type 304 or 316, size and type to suit condition.
 2. 1/4-inch diameter and larger bolts: Hot-dipped galvanized per ASTM A153.
 3. Fasteners with proprietary anti-corrosion coatings may be submitted for use with treated wood, size and type to suit location. When submitted, the fastener manufacturer shall furnish specific information regarding the performance of their products in the specified treated wood and any precautions or special instructions that may be applicable.
 4. Anchors: Expansion shield and lag bolt type for anchorage to concrete and hollow

masonry. Bolts or ballistic fasteners for anchorages to steel and concrete.

5. Masonry Concrete Screws: Tapcon, Hilti-Kwik-Con II. 1/4-inch diameter, tapered flat head, minimum 1-3/4 inch embedment.
 - a. At preservative-treated material, provide Type 410 stainless steel 1/4-inch diameter by 2-3/4 inches long masonry fastener with a torx hex washer head (THWH), minimum 1-3/4 inch embedment. Note: Fastener head shall be counter sunk.
 - b. Provide manufacturer's matching carbide-tipped drill bits to install fasteners.
6. At all non-treated provide hot-dipped galvanized per ASTM A153, size and type to suit location.

2.03 PRESERVATIVE-TREATED MATERIALS

- A. Water-Borne Preservative: Ca-C, copper azole Type C.
- B. Lumber shall be Southern Pine treated with copper azole, Type C, in accordance with AWPA Standard U1, Commodity Specification A, to the requirements of Use Category 3B.
- C. Plywood shall be treated with copper azole, Type C, in accordance with AWPA Standard U1, Commodity Specification F, to the requirements of Use Category 3B.
- D. Moisture Content: Drying after treatment as follows:
 1. Lumber: 19 percent maximum.
 2. Plywood: 18 percent maximum.

PART 3 EXECUTION

3.01 FRAMING

- A. Set members level and plumb, in correct position.
- B. Place horizontal members crown side up.
- C. Securely attach carpentry work. Use fasteners of appropriate type and length. Coordinate with applicable specification section for size and spacing of fasteners.
- D. Separate all surfaces of preservative-treated wood in contact with the following materials using the sheet materials specified in Article 2.01, Paragraph C. The separations sheet shall be installed continuously. Separation sheet materials which are not self-adhesive shall be fastened to the treated wood/plywood using stainless steel nails.
 1. Structural and non-structural steel (galvanized and ferrous).
 2. Metal flashings and metal trim.

3.02 NAILERS

- A. Install nailers at all open eaves and edges, where wood cants are installed, where wood curbs are installed and where shown on Drawings. Nailers shall be treated wood blocks the same thickness as the roof insulation and shall be a minimum of 5-1/2 inches wide, unless otherwise noted on the Drawings.
- B. Secure wood nailers to roof structure in accordance with the current edition of ANSI/SPRI ES-1.
 - 1. Bottom nailers: Where the nailers are secured to the wood roof deck, install the bottom nailer to the wood deck with two rows of No. 10 steel wood screws spaced at 12 inches o.c. At corner regions, space screws at 6 inches o.c. Each wood nailer shall have at least two fasteners. A fastener shall be located approximately 4 inches but not less than 3 inches from each end.
 - a. Screws installed in preservative-treated wood shall be:
 - 1) Stainless steel type 304 or 316;
 - 2) Proprietary anti-corrosion coatings which have been recommended by manufacturer for use with preservative-treated materials.
 - 2. Top nailers: Secure top nailers to bottom nailer with annular ring shank nails. Nails shall be long enough to penetrate 1-1/4 inches into the bottom nailer and each additional nailer layer. Provide two rows staggered spaced at 12 inches o.c. maximum. Spacing shall not exceed 6 inches, at corner regions. Withdrawal resistance should be 100 lb per nail.
 - a. Nails installed in preservative-treated wood shall be:
 - 1) Stainless steel type 304 or 316;
 - 2) Proprietary anti-corrosion coatings which have been recommended by manufacturer for use with preservative-treated materials.
 - C. Lightweight Concrete and Gypsum Panels:
 - 1. Nailers shall not be fastened to lightweight concrete or gypsum decks. Anchor all nailers to the building structural members per this section.

3.03 SCHEDULING

- A. Roof nailers, roof blocking:
 - 1. Southern pine species for lumber, preservative treated.
 - 2. Group 1, exterior grade for plywood, preservative treated.
- B. Concealed wood blocking in interior metal stud partitions for supporting washroom accessories, door stops, toilet partitions, wall-hung equipment, markerboards, tackboards, projection screens, acoustic wall panels, steel support brackets, etc:
 - 1. Southern pine species for lumber, untreated. Wood blocking or nailers on metal stud framing shall be bolted to framing.
- C. Concealed wood blocking in interior metal stud partitions for supporting grab bars, handrails, bench seats, floor-mounted cabinets and wall-hung cabinets.

1. 2 by 6 Southern pine, untreated, installed with Backit rigid wall backing. Provide an approved hot-dipped galvanized screw fastener in each guide hole in the rigid wall backing plate.

END OF SECTION

SECTION 06 41 13 – WOOD-VENEER-FACED ARCHITECTURAL CABINETS

PART 1 GENERAL

1.01 SUMMARY

- A. Base and wall cabinets, laminated, factory finished.
- B. Countertops.
- C. Cabinet hardware.
- D. Preparation for installing utilities.
- E. Shelving.
- F. Definitions of Casework Items:
 - 1. Exposed Surfaces:
 - a. Exposed exterior surfaces, defined as all exterior surfaces exposed to view, include:
 - 1) All surfaces visible when doors and drawers are closed, including knee spaces.
 - 2) Underside of cabinet bottoms over 42 inches above the finished floor, including cabinet bottoms behind light valances and the bottom edge of light valances.
 - 3) Cabinet tops under 80 inches above the finished floor, or if 80 inches and over and visible from an upper building level or floor.
 - 4) Front edges of stretchers, ends, divisions, tops, and bottoms.
 - 5) Sloping tops of cabinets that are visible.
 - b. Exposed interior surfaces, defined as all interior surfaces exposed to view in open casework or behind transparent doors, include:
 - 1) Shelves, including edgebanding.
 - 2) Divisions and partitions (Front edge is an exposed surface).
 - 3) Interior face of ends (sides), backs and bottoms (including pull-outs). Also included are the interior surfaces of cabinet top members 36 inches or more above the finished floor.
 - 4) Interior face of door and applied drawer fronts.
 - c. Semi-exposed surfaces, defined as those interior surfaces only exposed to view when doors or drawers are opened, include:
 - 1) Tops and bottoms of shelves, including front edge banding (Front edge is an exposed surface).
 - 2) Divisions and partitions (Front edge is an exposed surface).
 - 3) Interior face of ends (sides), backs and bottoms (including a bank of drawers). Also included are the interior surfaces of cabinet top members 36 inches or more above the finished floor.
 - 4) Drawer sides, sub-fronts, backs and bottoms.
 - 5) The underside of cabinet bottoms between 24 inches and 42 inches above the finished floor.

- 6) Security and dust panels or drawer stretchers.
- d. Concealed surfaces, defined as those exterior or interior surfaces that are covered or not normally exposed to view include:
 - 1) Toe space unless otherwise specified.
 - 2) Sleepers, stretchers and solid sub-tops.
 - 3) The underside of cabinet bottoms less than 24 inches above the finished floor.
 - 4) The flat tops of cabinets 80 inches or more above the finished floor, except if visible from an upper floor or building level.
 - 5) The three non-visible edges of adjustable shelves.
 - 6) The underside of countertops, knee spaces and drawer aprons.
 - 7) The faces of cabinet ends of adjoining units that butt together.
- G. Finish by Surface Definition:
 1. Exposed Exterior Surfaces:
 - a. Transparent finish: Wood species; cut and match as specified.
 2. Exposed Interior Surfaces, Custom Grade:
 - a. Transparent finish: Wood of same species as exposed exterior surface.
 3. Semi-Exposed Surfaces:
 - a. Transparent finish: Wood of a compatible species to the exposed exterior surface.
 4. Concealed Surfaces: Manufacturer's option.
- H. Cabinet Construction:
 1. Frameless construction where the front edge of the cabinet body components are edge-banded.
- I. Cabinet and door/drawer:
 1. Flush overlay, Figure 10-057 of the Architectural Woodwork Standards, 2nd Edition.

1.02 RELATED SECTIONS

- A. Section 06 10 53 – Miscellaneous Carpentry: Securing wall and floor mounted cabinets to wood blocking.

1.03 REFERENCES

- A. American National Standards Institute:
 1. ANSI A156.9 - Cabinet Hardware.
- B. Architectural Woodwork Institute:

1. AWI – Architectural Woodwork Standards, current edition.
- C. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 2. ASTM D1037 – Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials.
 3. ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
- D. Composite Panel Association (CPA) Environmentally Preferable Product (EPP) Grademark Program.
- E. Scientific Certification Systems (SCS).
- F. Federal Specification Unit:
1. FS A-A-1936 - Adhesive, Contact, Neoprene Rubber.
- G. Hardwood Plywood and Veneer Association:
1. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood.
 2. HPVA HPH – Hardwood Plywood Handbook.
 3. HPVA VSG – Veneer Species Guide.
- H. National Electrical Manufacturers Association:
1. NEMA LD 3 - High Pressure Decorative Laminates.
- I. National Fire Protection Association:
1. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.
- J. Woodwork Institute:
1. WI - Manual of Millwork.
- 1.04 SUBMITTALS
- A. Section 01 33 00 – Submittal Procedures.
- B. Submit product data for each type of product specified in this section and incorporated into items of casework.
- C. Shop Drawings: Indicate materials, component profiles and elevations, assembly methods, joint details, fastening methods, accessory listings, hardware location, and schedule of finishes.

1. Show locations and sizes of furring, blocking and hanging strips specified in Section 06 10 53.
- D. Samples: Submit three 12-inch by 12-inch size samples, illustrating each cabinet finish specified. Samples shall be on material representative of that used for the project.
- 1.05 QUALITY ASSURANCE
- A. Perform work in accordance with AWI Custom quality, as the minimum standard unless a higher standard of construction is specified throughout this specification.
- 1.06 DELIVERY, STORAGE AND HANDLING
- A. Deliver, store and handle products to site under provisions of Specification Section 01 60 00 – Product Requirements and AWI Section 2 – Care and Storage.
- B. Protect units from moisture damage.
- C. Environmental Conditions: Obtain and comply with woodwork manufacturer's and installer's coordinated advice for optimum temperature and humidity conditions for woodwork during its storage and installation. Do not install woodwork until these conditions have been attained and stabilized from date of installation through remainder of construction period.
- 1.07 FIELD MEASUREMENTS
- A. Verify that field measurements are as indicated on shop drawings.

PART 2 PRODUCTS

2.01 HARDWOOD LUMBER

- A. Graded in accordance with AWI: Average moisture content of 6-8 percent, species yellow poplar, plain sawn.
- B. Graded in accordance with AWI: Average moisture content 6-8 percent, species yellow birch natural, plain sawn.

2.02 SHEET MATERIALS

- A. Veneer Core Plywood: HPVA HP-1
1. Veneer core type: A non-telegraphing 5-ply hardwood manufactured with type II adhesive. At counter tops provide non-telegraphing 5-ply hardwood manufactured with type I adhesive.
 2. Certifications:
 - a. Composite Wood Evaluation: Composite wood, as defined by the California Air Resources Board (CARB) Airborne Toxic Measure to Reduce Formaldehyde Emissions from Composite Wood Products Regulation shall be documented to have low formaldehyde emissions that meet CARB ATCM for formaldehyde requirements for ultra-low-

- b. emitting formaldehyde (ULEF) resins or no added formaldehyde resins.
FSC Certified.

2.03 LUMBER

- A. Lumber Base: Pressure-treated lumber.

2.04 VENEER

- A. Species: **Note:** Use one species for the entire project, unless otherwise noted.
 - 1. Close-Grain Hardwoods:
 - a. Maple
- B. Layout Requirements for Grained or Pattern Faces:
 - 1. Flush panel door and drawer fronts, custom grade: Doors, drawer fronts and false fronts shall run and match vertically within each cabinet unit.
- C. Veneer Face Grade Requirements:
 - 1. Exposed Exterior, Transparent Finish: Wood species, cut and match as specified, Grade A in accordance with ANSI/HPVA HP-1 definitions and characteristics.
 - 2. Exposed Interior, Transparent Finish:
 - a. Wood shall be of the same species as the exposed exterior surface.
 - b. Grade B in accordance with ANSI/HPVA HP-1 definitions and characteristics.
 - 3. At inside face of door and drawer fronts, transparent finish:
 - a. Wood shall be of the same species and cut as the exposed exterior surface.
 - b. Grade B in accordance with ANSI/HPVA HP-1 definitions and characteristics.
 - 4. Semi-exposed surfaces, Transparent Finish:
 - a. Solid wood, veneer of minimum HPVA Grade C of compatible species to exposed surface.
 - 5. Concealed Surface: Manufacturer's option.
- D. Veneer Cut, Close-Grain Hardwood:
 - 1. Maple:
 - a. Quartered
- E. Veneer Match:
 - 1. General:

- a. Doors, drawer fronts and false fronts shall run and match vertically within each cabinet unit.
2. Matching of Adjacent Wood – Veneer Leaves:
 - a. Book match
3. Matching of Wood Veneer Leaves Within a Panel Face:
 - a. Running match

2.05 MANUFACTURERS – PLASTIC LAMINATE

- A. Refer to finish schedule for manufacturer.

2.06 LAMINATE MATERIALS

- A. Plastic Laminate: High Pressure Decorative Laminate, NEMA LD3, Current Edition, for type; color, pattern, and finish indicated.
 1. General Purpose, Horizontal and High Usage Exposure: NEMA Standard HGS, nominal thickness 0.048 inches.
 2. Unfinished Backing Sheet: NEMA Standard BKL, nominal thickness 0.020 inches.

2.07 ACCESSORIES

- A. Contact Adhesive and Sealants for LEED v4 for Schools:
 1. All adhesives and sealants installed in the building interior (defined as inside the weatherproofing system and applied onsite) must meet the testing and product requirements of the California Department of Public Health Standard Method v1.1-2010. In addition to meeting the above requirements all adhesives and sealants shall comply with the following standard:
 - a. Interior contact adhesive and sealants: Maximum volatile organic compound content in accordance with SCAQMD 1168, amended January 7, 2005.
 - 1) Contact adhesive: Maximum VOC 80 g/L.
 - 2) Special purpose contact adhesive: Maximum VOC 250 g/L.
 - 3) Architectural sealants: Maximum VOC content 250 g/L.
 - 4) Architectural sealant primers: Maximum VOC content:
 - a) Non-porous: 250 g/L
 - b) Porous: 775 g/L
- B. Veneer core water proof edge sealer:
 1. Two part epoxy system as manufactured by The West System.
 - a. Part A, West System 105 Epoxy Resin.
 - b. Part B, West System 206 Slow Hardener.
 - c. VOC Content: The combined VOC content is 9.59 g/L less than 100 g/L. for waterproofing sealers in accordance with SCAQMD Rule 1113, Architectural Coatings, amended June 3, 2011,.

- C. Edging: As noted.
- D. Fasteners: Size and type to suit application.
 - 1. To secure base cabinets to preservative treated wood plywood, use hot-dipped galvanized fasteners complying with ASTM A153 or Type 304 or 316 stainless-steel fasteners.
- E. Bolts, Nuts, Washers, Lags, Pins and Screws: Of size and type to suit application; finish in exposed locations. Shall match finish of hardware. **Note:** The use of drywall screws is not permitted. Use heavy shank steel screws.
- F. Concealed Joint Fasteners: Threaded steel.
- G. Dowels: Minimum 5/16 inch by 1 3/16 inches.
- H. Dowel Screw: Minimum 9/32 inch by 2 inches.
- I. Biscuits: #30.

2.08 HARDWARE

- A. Hardware: Shall conform to ANSI/BHMA A156.9, "American National Standard for Cabinet Hardware" and BIFMA, "Business and Institutional Furniture Manufacturers' Association," Current Edition.
- B. Shelf Supports for 5mm Hole: Knappe and Vogt #345 NP.
 - 1. Shelf support shall meet ANSI/BHMA A156.9 Grade 1 requirements and test standard.
- C. Drawer and Door Pulls: 4 inch center to center aluminum pull 7005-28A.
- D. Hinges:
 - 1. ANSI/BHMA A156.9 Grade 1 performance and permanent set test requirements and as follows: Heavy-duty wraparound, conventional flush overlay five-knuckle style, with interlaying leaves capable of 270-degree swing. Hinge shall be constructed of 0.090-inch minimum thickness steel with hospital tipped non-removable pin.
 - 2. Use two per door for doors up to 48 inches in height, three per door for doors up to 84 inches high, four per door for doors over 84 inches high.
 - 3. Finish: US26D.
 - 4. Install hinges with specifically engineered screws. Wood screws are not permitted.
- E. Cabinet Locks: Best 1E7E4 Keyed to room in which locking cabinet is located, unless otherwise noted.
 - 1. Unless noted otherwise provide one lock at each cabinet door and drawer.

2. At cabinet drawers, verify keying requirements for each drawer with Owner.
- F. Spring-Loaded Elbow Catch: H'A'FELE #245.74.200. Provide one catch on the inactive leaf of each pair of doors noted to be locked.
- G. Drawer Slides:
 1. All drawer slides shall be tested in accordance with ANSI/BHMA A156.9 and in accordance with BIFMA standards.
 2. Box and File Drawers: Accuride 7432, 100 lb. load rating, side mounting, steel ball bearing, full extension, for drawer widths up to 24 inches wide and drawer depths deeper than 6 inches.
 - a. Finish: Clear zinc (ROHS compliant)
- H. Magnetic Catch: Knappe & Vogt 918 ALUM.
- I. Door Bumpers: Clear plastic bumpers.

2.09 FABRICATION

- A. Casework, Laminate: Shall conform to the design and details shown of the Drawings, and shall meet the requirements for casework as defined in the Architectural Woodwork Standards current edition, Section 10 – Casework, for Custom Grade woodwork for wood veneer finish.
 1. Construction Style:
 - a. Flush Overlay Style: Provide base, and wall units with drawer fronts, doors and fixed panels (if any) overlaying and concealing frames and sides of cabinet bodies, Architectural Woodwork Standards, Construction Frameless – Flush Overlay.
 - b. Panel components shall be of balanced construction.
 2. Cabinet Construction:
 - a. Wood Cabinets: Wood-veneer facings conforming to Architectural Woodwork Standards, Section 10 – Casework.
 - 1) Exposed exterior surfaces finish: Refer to Article 2.04, C, 1.
 - 2) Exposed interior surfaces finish: Refer to Article 2.04, C, 2.
 - 3) At inside face of door and drawer fronts: Refer to Article 2.04, C, 3.
 - 4) Semi-exposed surfaces finish: Refer to Article 2.04, C, 4.
 - 5) Drawer sides, back and sub-fronts:
 - a) Minimum 15/32 inch thick.
 - b) Material: Single-species solid lumber or 7- or 9-ply hardwood plywood with no inner voids.
 - 6) Concealed surface: Refer to Article 2.04, C, 5.

- b. Joinery and Fastening of Case Body Members. Refer to Architectural Woodwork Standards, Section 10. Case body members shall be joined in accordance with Architectural Woodwork custom grade standards as listed below:
- 1) Exposed Ends (finished ends on casework shall be integral, not applied secondarily): Rabbeted or plowed to receive backs. Horizontal members, excluding countertops shall not extend beyond the exposed end.
 - 2) Concealed Ends: Rabbeted or plowed to receive backs.
 - 3) Cabinet Backs: Where non-plowed/dadoed in shall be screwed to the case body, divisions and/or fixed shelves at a maximum of 4 inches on center.
 - 4) Cabinet Backs: Where plowed/dadoed-in with a minimum shoulder of 1/2 inch shall be securely nailed or stapled to the case body at a maximum of 4 inches on center.
 - 5) No nails, screws or other fastenings may be visible on exposed or semi-exposed surfaces.
 - 6) Rails or top panels must be provided where case will have a separate top, in order to permit concealed fastening of the separate top through such rails.
 - 7) Anchor Strips: Minimum 1/2-inch thick lumber or panel product, min. 2 1/2 inches width; securely glued and mechanically attached to cabinet body members at 4 inches on center on the wall side of the cabinet back-top and bottom for wall hung and floor mounted standing cabinets. Cabinet heights over 60 inches require an intermediate anchor strip.
- c. Component Construction: Wall and base cabinet.
- 1) Doors: 3/4-inch thick veneer core with wood veneer on both sides. Refer to Article 2.04, C, 1 and 3.
 - a) Edging: Match exposed surface.
 - b) No cabinet door shall be more than 24 inches wide and 84 inches high.
 - c) Stop silencers to be installed at the top and bottom of all hinged doors on the hinge side.
 - d) Doors shall stop, as applicable, against the cabinet body at the bottom, sides and top stretcher. At single and paired doors below a drawer, a rail, stretcher or partition shall be provided.
 - e) Wrap-around hinges, as applicable, shall be let into the edge of the door to maintain proper gap clearance. Exposed door edges resulting from the notching for hinges shall be painted or stained to match.
 - f) Locking pairs:
 - i. Provide an elbow catch/latch and a stop block on the inactive leaf. Stop block shall be adequate to prevent the latch of the elbow catch/latch from being defeated by applying vertical pressure on the door.
 - 2) Drawer Fronts: 3/4-inch thick veneer core with wood veneer on both sides. Refer to Article 2.04, C, 1 and 3.

- a) Edging: Match exposed surface.
 - b) Secure to drawer box sub-front with pan/binder head, countersunk flathead or ovalhead screws with a minimum of two screws at each end a maximum of 1 1/2 inches from inside corners of the drawer box and a maximum of 12 inches on center.
 - c) False fronts shall be securely attached to the cabinet body.
- 3) Exposed End Panels: 3/4-inch thick veneer core with wood veneer. Refer to Article 2.04, C, 1 and 2, for exposed exterior and interior and 2.04, C, 1 and 4, for exposed exterior and semi-exposed surfaces.
- a) Edging: Match exposed surface.
- 4) Concealed end panels (Faces of cabinet ends of adjoining units that butt together): 3/4-inch thick veneer core. Finish: Manufacturer's option.
- a) Edging: Match exposed surface.
- 5) Division Panels: 3/4-inch thick veneer core.
- a) At semi-exposed surfaces, provide wood veneer. Refer to Article 2.04, C, 4.
 - b) At exposed surfaces, provide wood veneer. Refer to Article 2.04, C, 1 and 2.
 - c) Edging: Match exposed surface.
- 6) Base Cabinet Bottoms: 3/4-inch thick veneer core. At semi-exposed panels, refer to Article 2.04, C, 4. At exposed panels, provide wood veneer. Refer to Article 2.04, C, 1 and 2.
- a) Edging: Match exposed surface.
- 7) Tops of Wall-Hung Cabinets and Tall Cabinets: 3/4-inch thick veneer core with wood veneer. Refer to Article 2.04, C, 1 and 2, for exposed exterior and interior surfaces and 2.04, C, 4 and 5, for semi-exposed and concealed surfaces.
- a) Edging: Match exposed surface.
- 8) Bottoms of Wall-Hung Cabinets: 3/4-inch thick veneer core with wood veneer. Refer to Article 2.04, C, 1 and 2.
- a) Edging: Match exposed surface.
 - b) When unsupported do not exceed 48 inches in length. Over 48 inches provide center support.
- 9) Security and Dust Panels: 1/2-inch thick veneer core.
- a) Furnish above locked doors and drawers, only if each drawer or door is keyed differently.
 - b) Where front and rear stretchers are provided, the panel may be 1/4-inch thick and let into the stretchers.

- 10) Stretchers (Only Required to Base Cabinets with Separate Countertops):
 - a) Solid stock: $\frac{3}{4}$ -inch thick by 2 inches wide.
 - b) Provide stretchers at both the front and back of the cabinet body except at sink compartments, which may run front to back.
 - c) In lieu of stretchers a panel member of $\frac{3}{4}$ inch veneer core which runs the full length and depth of the cabinet opening may be used.
 - d) At drawer banks where the total drawer opening height exceeds 30 inches provide an intermediate front stretcher.
- 11) Drawer Boxes (Sides, Backs, Sub-Fronts): $\frac{1}{2}$ -inch thick, single-species solid hardwood lumber with a hardness rating of medium or better per Appendix B, Section 3 – Lumber of the standards, factory finished with minimum one seal coat and one top coat, sides, backs and sub-fronts. Joints to be multiple dovetailed. All joints shall be securely glued.
- 12) Drawer Bottom: Minimum $\frac{13}{64}$ -inch veneer core plywood
- 13) Note: Where drawer exceeds 30 inches in width, or bottom-mount hardware is required, the drawer bottom shall be a minimum of $\frac{1}{2}$ inch thick veneer core plywood. The drawer bottom shall be plowed into drawer sides, back and sub-fronts $\frac{1}{4}$ inch, and securely glued to form a rigid unit. Provide a minimum $\frac{3}{8}$ inch standing shoulder on sides, back and sub-front.
- 14) Drawer Hardware, Locks:
 - a) Drawer slides to operate smoothly.
 - b) Provide closing stops at the rear of both drawer sides, unless such is built into the slides to prevent the drawer from impacting the cabinet body.
 - c) Spring-loaded tip-down stop to be provided (design permitting) to prevent the drawer from pulling out of the cabinet, unless such is built into the drawer slides.
 - d) At locked banks of drawers where each drawer is keyed differently provide security or dust panels. Coordinate with locks specified in the hardware section of this specification.
- 15) Base and Wall Cabinet Back: Minimum $\frac{1}{4}$ -inch thick veneer core with wood veneer. At exposed exterior provide $\frac{1}{2}$ inch thick veneer core. Refer to Article 2.04, C, 1 and 2, at exposed exterior and interior surfaces and Article 2.04, C, 4 and 5, at semi-exposed and concealed surfaces.
- 16) Aprons: $\frac{3}{4}$ -inch thick veneer core with wood veneer. Refer to Article 2.04, C, 1 and 5, for exposed exterior and concealed surfaces.
 - a) Edging at bottom: Match exposed surface.
- 17) Fixed Shelves: $\frac{3}{4}$ -inch thick with wood veneer. Refer to Article 2.04, C, 2, for exposed interior surface and Article 2.04, C, 4, for semi-exposed surfaces. Grain to run length of shelf. Dividers to

match exposed or semi-exposed surface.

- a) Edging: Match exposed surface.
- b) Shelves shall be fixed to ends, dividers and backs.
- c) Shelves over 48 inches in length shall have a center support.

- 18) Adjustable Shelves: $\frac{3}{4}$ -inch thick veneer core with wood veneer for spans up to 35 inches, 1 inch for spans up to 44 inches. Refer to Article 2.04, C, 2 for exposed interior surfaces and Article 2.04, C, 4 for semi-exposed surfaces. Grain to run length of shelf.

NOTE: Thickness and span of shelves is based on the following:

Load: 50 lbs. per sq. ft.
MOE of material: Minimum 750,000 minimum.
Maximum load 200 lbs. on any one shelf.

- a) Edging: Match exposed surface.
- b) Length of shelf, maximum $\frac{1}{8}$ inch less than inside cabinet width except where shelf-support clips require notching. Ends may exceed $\frac{1}{8}$ inch provided both ends are banded and the total clearance between shelf clips is a maximum of $\frac{1}{8}$ inch.
- c) Depth of shelf to be based on formula in the AWI Standards:
- d) Shelves shall be supported on cleanly bored holes at a maximum of 2 inches on center with shelf rests .
 - i. Centerline of rests shall not exceed a minimum of 1 inch to a maximum of 4 inches from the front and back of cabinet body.
 - ii. Support placement shall not conflict with hinge placement.
 - iii. Dimension between the centerline of the rest shall not be less than 60% of the shelf depth.
 - iv. Bored shelf hole support systems shall extend vertically to within 6 inches of the interior top or bottom of the cabinet.

- 19) Toe Kick: 1 $\frac{1}{2}$ -inch thick by 4 inch high preservative treated lumber.

d. Countertops (Plastic Laminate):

- 1) Exposed surfacing material: HGS high-pressure laminate.
- 2) Substrate: $\frac{3}{4}$ -inch veneer core plywood. Seal all edges of veneer core plywood at sink cutout with two part epoxy water-proof sealer. Sand veneer core plywood with an 80 grit sandpaper prior to applying sealer. Apply water-proof sealer in three coats.
- 3) Nominal thickness at edge 1 $\frac{1}{2}$ inches.
- 4) Provide standard unfinished backing sheet BKL.
 - a) Front edge: 3 mm PVC.

e. Backsplash and Sidesplash (Plastic Laminate):

- 1) Exposed surfacing material: HGS high pressure laminate.
- 2) Substrate: $\frac{3}{4}$ inch thick veneer core plywood. .

- 3) Exposed Ends: HGS high-pressure laminate.
 - 4) Backside of all splashes shall have a backing sheet.
 - 5) Assembly 1, wall mount, jobsite assembled.
-
- B. Shop assemble casework for delivery to site in units easily handled and to permit passage through building openings.
 - C. Install edging as specified in one piece for full length of component.
 - D. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.
 - E. Apply plastic laminate finish in full uninterrupted sheets. Fit corners and joints hairline; securing with glue and concealed bolt type fasteners. Locate counter butt joints minimum 2 feet from edge of sink cutouts.
 - F. Cutouts in plastic laminate countertops shall have a minimum 1/4-inch radius at all inside corners.

2.10 FACTORY FINISHING

- A. All products provided in this section shall be factory finished using Section 5 of the Architectural Woodwork Standards Finish System 5 – Varnish, Catalyzed for Transparent Finish.
- B. Finish shall be AWS Premium Grade.
- C. Casework requires all exposed and semi-exposed surfaces to be finished.
 1. All six faces of cabinet doors shall receive the same number of coats to prevent warping and/or twisting.
- D. Fillers shall be used at open-pore woods to create a full finish. Fillers shall be applied before sealers and top coats.
- E. Concealed casework surfaces that abut walls, floors and ceilings shall receive sanding sealer or self-seal system.
- F. Sheen: Satin.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.

3.02 INSTALLATION

- A. Install casework plumb, level, true and straight with no distortions. Shim as required using concealed shims. Install to a tolerance of 1/8 inch to 8 feet 0 inches for plumb and level (including tops); and with no variations in flushness of adjoining surfaces.

- B. Toe Base Height:
1. Casework shall be installed level. Shimming of toe base shall not exceed 1/2 inch. Floor variations exceeding 1/2 inch shall be brought to the attention of the General Contractor. Do not proceed with installation of casework until the floor has been corrected.
- C. Scribe and cut casework to fit adjoining work and refinish cut surfaces or repair damaged finish at cuts.
- D. Anchor casework to anchors or blocking built in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation. Attach countertops securely to base units.
1. Casework Wall Anchorage:
 - a. Continuous Blocking or Backing: Provide minimum 2" x 6" nominal wood or 6" x 16 gage metal track notched at each stud at locations shown on the casework shop drawings. Coordinate with Section 06 10 53 for plate used with 2 x 6.
 - b. Anchorage fasteners shall be neatly installed through the back and anchor strip, at the top and bottom of each cabinet body (wall hung and base cabinets) and at intermediate height of cabinets over 60 inches tall.
 - c. Fastener to be a minimum 3 1/2 inch x #10 diameter screw with a surface-bearing head. Achieve a minimum of 1 1/2 inch penetration into the wall studs, blocking or masonry. The use of drywall or bugle-head screws is prohibited.
 - d. Exposed interior surfaces require screws capable of being recessed and covered with matching cover caps.
 - e. Each cabinet unit (wall and base unit) or undivided span shall have a minimum of four anchorage fasteners, two at the top and two at the bottom subject to:
 - 1) A maximum spacing of 16 inches on center, except wall cabinet units over 48 inches in height shall be 12 inches on center.
 - 2) Install fasteners vertically within 2 inches of the outside top and bottom of the cabinet and within 2 inches horizontally of the outside end.
 2. Adjoining cabinets: Adjacent cabinets shall be fastened together at the front with a minimum of two #8 x 1 1/4 inch flat, oval or pan-head screws a maximum of 30 inches on center and at exposed interior surfaces, fasteners shall be countersunk and covered to match the surface.
- E. Install casework without distortion so that doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
- F. Grommets shall be provided at all locations designated by the Owner. Do not install grommets until the Owner has approved the location.
- G. Provide cutouts for plumbing fixtures, and appliances as indicated. Smooth cut edges and coat with waterproof coating or adhesive.
- H. Apply a continuous bead of silicone sealant to the joint between the countertop and

splash.

- I. Provide all brackets as shown on Drawings.
- J. Adjustable Shelf Supports: Two vertical rows of 5 mm diameter holes spaced at 2 inches on center.
- K. Countertop overhangs shall be consistent with a minimum of 1/2 inch and a maximum of 1 1/4 inch of cabinet face and/or finish end.
- L. Unsupported countertop spans shall not exceed 48 inches and shall be reinforced to prevent deflection in excess of 1/4 inch under a 50 lb. per square foot load.
- M. Laminations to countertops shall be made securely with Type II adhesive.
- N. Built-up members for countertops shall be veneer core plywood material.
- O. Backsplashes require end splashes at walls.
- P. At Assembly 1, wall mount backsplash and end-splash:
 - 1. Top edge to be banded.
 - 2. Front edge of end-splash to be banded.
 - 3. All splash components shall be securely adhered to the wall, butt-joined to the countertop and shall be caulked with a clear waterproof caulking so as to leave a visual bead not exceeding 1/8 inch between the bottom of the splash and the countertop.

3.03 ADJUSTING

- A. Adjust work under provisions of Section 01 70 00 – Execution and Closeout Requirements: Testing, adjusting and balancing.
- B. Adjust moving or operating parts to function smoothly and correctly.

3.04 CLEANING

- A. Clean work under provisions of Section 01 70 00 – Execution and Closeout Requirements: Final cleaning.
- B. Clean casework, counters, shelves, hardware, fittings and fixtures.
- C. Protect surfaces from damage. Repair or replace damaged work that cannot be repaired to Architect's satisfaction.

END OF SECTION

SECTION 07 01 52 – ROOFING SYSTEM REPAIRS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. The existing roofing to be repaired is no longer under warranty. All work shall meet the standards of and be compatible with the existing roofing system currently in place.
- B. Remove existing roofing as required to install new HVAC units and equipment curbs and associated work. Provide roofing membrane repairs and flashings per this section and sheet metal work per Section 07 62 00.
- C. New flashings and roofing repairs for the subject work shall meet the minimum requirements set forth in these Specifications and comply with recognized standards of the industry, including those of the manufacturer(s) whose products are employed.

1.02 RELATED SECTIONS

- A. Section 07 62 00 – Sheet Metal Flashing and Trim.

1.03 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures.
- B. Product Data: For each type of roofing product specified. Include data substantiating that materials comply with requirements.
- C. Shop Drawings: Include plans, sections, details and attachments to other work for the following:
 - 1. Base flashings, cants and membrane terminations.
 - 2. Tapered insulation, including slopes.
 - 3. Crickets, saddles and tapered edge strips, including slopes.
- D. Samples for Verification of the Following Products:
 - 1. 12-by-12-inch square of modified bituminous, granule-surfaced cap sheets of color specified.
- E. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized or licensed by manufacturer to install specified roofing system.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Store roofing materials in a dry, well-ventilated, weather-tight location to ensure no significant moisture pickup and maintain at a temperature in accordance with roofing system manufacturer's written instructions. Store rolls of sheet materials on end on pallets or other raised surfaces. Do not double-stack rolls.
 - 1. Handle and store roofing materials and place equipment in a manner to avoid

significant or permanent damage to deck or structural supporting members.

- B. Do not leave sheet materials on the roof overnight or when roofing work is not in progress unless protected from weather and moisture and unless maintained at a temperature exceeding 50 degrees F (10 degrees C).
- C. Deliver and store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.
- D. Protect roofing insulation materials from physical damage and from deterioration by sunlight, moisture, soiling and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing and protecting during installation.

1.05 JOB CONDITIONS

- A. Do not apply any portion of the roofing system or its accessories, or start operations in the event precipitation is threatening.
- B. Do not remove any part of the roof and leave overnight without the application of a fully water-tight temporary or permanent repair.
- C. Prevent water migration into building by installation of roofing membrane and flashings. At no time leave the building in an open state that would allow water penetration.

1.06 FIRE SAFETY REQUIREMENTS FOR TORCH-APPLIED MEMBRANE

- A. General:
 - 1. Torch application of membranes may pose a threat of fire if strict application standards and procedures are not followed. All operators of torch equipment should be thoroughly trained in a program similar to the current CERTA program, offered by the Midwest Roofing Contractors Association (MRCA).
- B. Propane Equipment: All regulators, valves, tanks, hoses and torch assemblies should be free from leaks. Check for leaks using liquid soap. Do not use equipment until all gas leakage has been corrected. Propane tanks should be secured in an upright position or secured to a wheeled dolly to minimize the potential for upset. Do not use open flame within 10 feet (3 m) of propane tanks. Do not bypass valves or regulators on propane equipment. All torches should be equipped with a support rest to maintain the torch head upright during periods of non-use.
- C. Use of Heat Welding Equipment: A fire extinguisher of an appropriate type shall be easily accessible to all work areas where heat welding equipment is in use. Do not use open flame around open penetrations or "blind" areas where the conditions beneath are not visible. Keep all combustible materials a safe distance from open flames. Avoid prolonged application of heat to all surfaces. Consider "back-torching" flashing membranes for application to penetration curbs or at areas where the entire area to which the torch must be applied is not visible.
- D. Fire Watch: A fire watch shall be maintained on the project for a minimum of sixty (60) minutes following the last heat welding work on the job each day. Special attention is required at perimeters and penetrations where heat-welded flashings have been

installed. Any detected "hot spot" should be investigated prior to crew departure to ensure that necessary corrective action can be taken to replace smoldering materials if required. Comply with all local ordinances and code requirements for fire watch following heat-welded roofing system applications.

1.07 REFERENCES

- A. ASCE/SEI 7, American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures, current edition.
- B. NRCA Roofing and Waterproofing Manual: Fifth Edition.
- C. UL 790 – Tests for Fire Resistance of Roof Covering Materials.
- D. UL 1256 – Fire Tests for Roof Deck Construction.
- E. UL Fire Resistance Directory, Current Edition.
- F. ASTM B749 – Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products.
- G. ASTM C728 – Standard Specification for Perlite Thermal Insulation Board.
- H. ASTM C1289 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
- I. ASTM D41 – Standard Specification for Asphalt Primer Used in Roofing, Dampproofing and Waterproofing.
- J. ASTM D4586 – Standard Specification for Asphalt Roof Cement, Asbestos Free.
- K. ASTM D6163 – Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements.
- L. ASTM D6164 – Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcement.
- M. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
- N. ASTM E108 – Standard Test Methods for Fire Tests of Roof Coverings.
- O. ASTM E119 – Standard Test Method for Fire Tests of Building Construction and Materials.
- P. FM-Factory Mutual:
 - 1. .
 - 2. FM 4470 – Approval Standard for Class 1 Roof Covers.
 - 3. Loss Prevention Data 1-28, Design Wind Loads, September 2005.
 - 4. Loss Prevention Data 1-29, Roof Deck Securement and Above-Deck Roof

Components, January 2006.

5. Loss Prevention Data 1-49, Perimeter Flashing, September 2000.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: Qualified firm that is approved, authorized or licensed by roofing system manufacturer to install manufacturer's product and where applicable per Paragraph 1.01 is eligible to receive manufacturer's warranty.
- B. Installer Shall:
 1. Be experienced in cold- and/or torch-applied roofing applications for ten (10) years minimum.
 2. Be a roofing system manufacturer certified contractor.
- C. Manufacturer's Qualifications:
 1. Qualified roofing system manufacturer that has UL listing and FM approval for roofing system identical to that used for this project.
- D. Roof Assembly Fire Classification: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method indicated below by UL, FM or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
 1. Exterior Fire-Test Exposure: UL Class A; complying with ASTM E108, for application and slopes indicated.
 2. Fire-Resistance Ratings: ASTM E119, for fire-resistance-rated roof assemblies of which roofing system is a part.
 3. Roof Assembly with Foam Insulation: Passes FM 4450 or UL 1256.
- E. Surface Burning Characteristics
 1. Foam Insulation: Maximum 75/450 Flame Spread/Smoke Developed Index when tested in accordance with ASTM E84.
- F. Preliminary Roofing Conference: Before starting roof repairs, conduct conference at Project site. Meet with the same participants and review the same items listed for the pre-installation conference. In addition, review status of submittals and coordination of work related to roof construction. Notify participants at least 5 working days before conference.

1.09 PRE-INSTALLATION MEETINGS

- A. Pre-Installation Conference: Before installing roof repairs, conduct conference at Project site to comply with requirements of Section 01 30 00 – Administrative Requirements: Pre-installation meetings. Notify participants at least 5 working days before conference.
 1. Meet with Owner; Architect; Owner's insurer, if applicable; testing and inspecting agency representative; roofing Installer; roofing system manufacturer's

representative; deck and/or air barrier installer if applicable and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.

2. Review and finalize construction schedule and verify availability of materials, installers' personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and attachment to structural members.
5. Review roof slope.
 - a. Verify roofing system will provide the roof assembly fire classification as specified for the roof slope indicated.
6. Review loading limitations of deck during and after roofing.
7. Review flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing.
8. Review governing regulations and requirements for insurance, certifications, and inspection and testing, if applicable.
9. Review temporary protection requirements for roofing system during and after installation.
10. Review roof observation and repair procedures after roofing installation.
11. Document proceedings, including corrective measures or actions required, and furnish copy of record to each participant.
12. Review transition from wall air barrier to roof membrane and base flashing if applicable.

PART 2 PRODUCTS

2.01 SHEET PRODUCTS

A. Base Flashing Sheet Materials for SBS Modified Asphalt Fiberglass-Reinforced Membrane Systems:

1. Backer Sheet: ASTM D6163, Grade S, Type I or II glass fiber reinforced smooth surfaced, suitable for application method specified.
 - a. Application:
 - 1) Cold adhesive

- 2) Torch
 2. Flashing Sheet: ASTM D6164, Grade G, Type II, polyester reinforced, granular surface, suitable for application method specified. Color of granules to match existing. Provide fire-resistant sheet.
 - a. Application:
 - 1) Cold adhesive
 - 2) Torch
 - 3.
- B. Base Flashing Sheet Materials for SBS Modified Asphalt, Polyester-Reinforced Membrane Systems:
1. Backer Sheet: ASTM D6164, Grade S, Type I or II polyester-reinforced, smooth surface, suitable for application method specified.
 - a. Application:
 - 1) Cold adhesive
 - 2) Torch
 2. Flashing Sheet: ASTM D6164, Grade G, Type II, polyester-reinforced, granular surface, suitable for application method specified. Color of granules to match existing. Provide fire-resistant sheet.
 - a. Application:
 - 1) Cold adhesive
 - 2) Torch

2.02 BITUMINOUS MATERIALS

- A. Asphalt Primer: ASTM D41.
- B. Plastic Cement: ASTM D4586, Type I, asbestos free.
- C. Flashing Cement: Compatible with modified bitumen membrane.
- D. Cold Adhesive: Roofing system manufacturer's asphalt-based, two-component, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with membrane applications.

2.03 ACCESSORIES

- A. Mechanical Fasteners for Flexible Flashing:
 1. Wood Blocking: Hot-dipped galvanized steel, 1 1/2-inch shank length, 11 gauge, with 1-inch diameter cap. Head and shank shall be welded together.

- a. Manufacturer/product: Simplex cap nails.
- B. Termination Bars: 12 gauge by 1-inch hot-dipped galvanized with holes at 8 inches o.c.
- C. Tapered Polyisocyanurate Board Insulation: Rigid, cellular polyisocyanurate thermal insulation with core formed by using hydrocarbon blowing agents which are Montreal Protocol compliant, complying with ASTM C1289, Type II, Class 2, Grade 2:
 - 1. Thickness: As required to provide positive slope. Tapered insulation shall be installed at a minimum slope of 2 times the slope of the roof where the roof structure slopes, unless otherwise noted on the Drawings. Where the roof structure is set flat, provide tapered insulation at a minimum slope of 1/4 inch per foot, unless otherwise noted on the Drawings. Starting thickness ½ inches.
 - 2. Positioning: Above existing insulation.
 - 3. Codes and Compliances: Provide polyisocyanurate insulating materials that comply with the following testing standards:
 - a. FM Standard 4450/4470 approval for Class 1 insulated steel, wood, concrete and gypsum roof deck construction.
 - b. UL Standard 1256 Classification, insulated metal deck construction assemblies; Construction #120 & #123.
 - c. UL Standard 790 Classification, Class A with most roof membrane system.
- D. Wood Cants: Treated southern yellow pine wood cants, minimum 3 1/2 inch face, are specified in Section 06 10 53 – Miscellaneous Rough Carpentry.
- E. Fiber Cant: ASTM C728, Perlite with a factory-applied asphalt sealer, with a UL Fire Resistant Class 25 rating, minimum 3 1/2 inch face.
- F. Roofing Granules: Ceramic-coated roofing granules, No. 11 screen size with 100 percent passing No. 8 (2.36 mm) sieve and 98 percent of mass retained on No. 40 (0.425 mm) sieve, of color scheme matching the granule surfacing of the finish ply.
- G. Insulation and Coverboard Adhesive: Two-component low-rise polyurethane foam OlyBond500 insulation adhesive as manufactured by OMG Roofing Products. Roofing manufacturer shall verify the compatibility of the adhesive with the insulation.
- H. Coverboard: 1/4-inch-thick glass-faced gypsum roof board. Georgia Pacific DensDeck prime. Verify board with application of membrane (cold adhesive, torch) to board surface.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.
- B. Examine substrates, areas, and conditions under which roofing will be applied, with Installer present, for compliance with requirements.
- C. Verify that roof openings and penetrations are in place and set and braced.

- D. Verify that wood blocking, and nailers are securely anchored to roof deck at roof penetrations and terminations and match the thicknesses of insulation required.
- E. Do not proceed with installation until unsatisfactory conditions have been corrected.
- F. Start of installation shall constitute Contractor's acceptance of existing condition.

3.02 PREPARATION

- A. Clean substrate of dust, debris and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging existing roof drains and existing conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Protect all building surfaces against damage from roofing Work. The Contractor shall be responsible for clean-up of all bitumen bleed into the building interior.
- D. Demolished materials shall not be placed on existing or newly finished roofing membrane without required protection as specified in "Protection of Finished Work" in the Specification.
- E. Do not leave insulation exposed overnight without the required modified bitumen base sheet.

3.03 GENERAL ROOFING APPLICATION

- A. Install modified bituminous membrane roofing system according to roofing system manufacturer's written instructions and applicable recommendations of NRCA/ARMA's "Quality Control Recommendations for Polymer Modified Bitumen Roofing."
- B. Application of roofing shall follow application of spudding, demolition, installation of insulation and base sheet as a continuous operation on the same day wherever possible.
- C. Prime metal flanges, concrete and masonry surfaces with a uniform coating of asphalt in accordance with manufacturer's requirement.
- D. Application temperatures shall be in accord with the manufacturer's latest printed instructions.
- E. Roofing insulation, flashings and any other detailed or specified accessories shall be applied in strict accordance with approved industry methods and materials as well as manufacturer's latest printed specifications.
- F. Shingling Plies: Install modified bituminous membrane roofing system with ply sheets shingled uniformly to achieve required number of membrane plies throughout. Shingle in direction to shed water.
- G. Cant Strips: Install and secure preformed 45-degree cant strips at junctures of modified bituminous membrane roofing system with vertical surfaces or angle changes greater than 45 degrees.
- H. Cooperate with inspecting and testing agencies engaged or required to perform services for

installing modified bituminous membrane roofing system.

- I. Coordinate installing roofing system components so insulation and roofing plies are not exposed to precipitation or left exposed at the end of the workday or when rain is forecast. Phased construction is not permitted.
 1. Provide cutoffs at end of each day's work to cover exposed ply sheets and insulation with a course of coated felt with joints and edges sealed.
 2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
 3. Remove and discard temporary seals before beginning work on adjoining roofing.
 4. Provide permanent or temporary counter flashing daily.
 5. Remove and replace material that becomes wet or damaged.
- J. A fire watch shall be maintained on the project for a minimum of 60 minutes following the last heat welding work on the job each day.
 1. Special attention is required at perimeters and penetrations where heat welded flashings have been installed. Any detected "hot spot" shall be investigated prior to the crew leaving the site to ensure that the necessary corrective action can be taken to replace smoldering materials if required. Comply with all local ordinances and code requirements for fire watch following heat-welded roofing system applications.

3.04 INSULATION INSTALLATION

- A. Tapered Installation: Install tapered insulation under area of roofing to conform to slopes indicated and to Shop Drawings so as to provide uniform positive drainage. The tapered insulation shall be adhered to the existing roof insulation using materials approved by the manufacturer, compatible with the insulation specified and meeting the wind and fire rating requirements specified.
 1. Install cricket installation at edge of roof curbs.
 2. Establish straight, uniform cricket valley position over second layer roof insulation.
 3. Cricket valley slopes shall be a minimum of 1/4 inch per foot.
 4. Cricket surface slopes shall be a minimum of twice the slope of the roof.

3.05 CANT STRIP APPLICATION

- A. Cant strips are required at the intersection of all roofs and vertical surfaces to be flashed. They shall be placed either on top of the roof insulation or the wood insulation stops. Cant strips shall be nailed to the wood insulation stops and the wall, curb or vertical nailer where possible. When nailing is not possible, or when using Perlite cant strips, secure cant in a solid bed of roofing manufacturer's approved roofing cement.
- B. Securely fasten wood cant to substrate in accordance with the current edition of ANSI/SPRI ES-1. Nails used to secure cant strips to other wood members shall be long enough to penetrate 1 1/4 inches into the wood member. Provide two rows of nails, staggered, at 12

inches o.c. maximum. Spacing shall not exceed 6 inches o.c. in corner regions. Withdrawal resistance shall be 100 lb per nail minimum.

1. Provide corrosion resistant fasteners compatible with preservative-treated cant. Coordinate with Section 06 10 53.
 2. Ensure a smooth transition between with fiber cant and wood cant.
- C. Make straight, neat cuts and miter corners without perceptible gaps or open joints.
- D. Cut, shave, modify and combine various sized tapered materials to provide smooth, uniform transitions.

3.06 GENERAL WORK PROCEDURES

- A. Base Flashing Installation at New Curb Penetrations:
1. Remove existing sheet metal components, ventilation equipment, etc., as may be required by the Work.
 2. Remove existing plies, base flashing, insulation and/or other roofing components to the extent necessary for installation of new structural and mechanical Work. Remove all debris from the roof surface daily. Do not place debris directly on unprotected finished roof surface. Protect open edges of insulation from water entry at all times. Do not leave insulation edges open to the elements overnight.
 3. Install new structural repairs, decking, curbs, etc., and secure to structure/deck as required.
 4. Install new insulation and cant as required.
 5. Install 1/4-inch-thick coverboard over wood and insulated curbs, cants, roof insulation and any other flammable surface where roofing membrane and/or flashing membranes are torch-applied.
- B. Install modified bituminous membrane base flashing plies over cant strips and other sloping and vertical surfaces and equipment curbs, and secure to substrates according to roofing system manufacturer's written instructions and as follows: NOTE: The actual number of strip-in plies (base) and second (finish) plies must be consistent with the number of base and membrane plies used in the field.
1. Prime concrete and masonry surfaces and other substrates with asphalt primer if required by roofing system manufacturer.
 - a. Where membrane base flashing is installed onto the finished field membrane, prepare the granule surface in accordance with manufacturer's instructions. Install the base flashing membrane over the granule surface in accordance with the manufacturer's instructions.
 2. Base Flashing Application:
 - a. Torch or set backing sheet in cold adhesive.
 - b. Flashing sheet torch or set in cold adhesive to backing sheet.

- C. Extend base flashing plies up the wall a minimum of 8 inches above roof membrane and 4 inches onto field of roof membrane.
- D. Mechanically fasten tops of all modified bituminous membrane base flashing securely at terminations and perimeter of roofing.
 - 1. Fasten top edge 8 inches o.c. with nails driven or screws driven through minimum 1 inch diameter metal caps.
 - 2. Tops of all membrane flashings shall be sealed using flashing cement reinforced with woven glass fiber fabric, immediately following completion of membrane flashings and prior to installation of metal counterflashing.
 - 3. All vertical laps of the membrane flashing shall be sealed in accordance with membrane manufacturer's instructions.
- E. At all inside and outside corners of membrane base flashing reinforce the inside and outside corners in accordance with manufacturer's requirements.
- F. Install metal flashings per Section 07 62 00.

3.07 PROTECTION OF FINISHED WORK

- A. Protect finished Work from damage by other trades.
- B. Where traffic must continue over existing or new roofs the Contractor shall provide a protective covering consisting of plywood plies secured to a layer of 1/2-inch wood fiber insulation board or minimum 1-inch polyisocyanurate insulation board, and laid loose over the membrane with the insulation board side to the roof surface. If necessary the entirety of the roof shall be covered in this manner.
- C. No materials shall be stored on the roof without this protective covering. No materials weighing in excess of 20 lbs/sq ft shall be stored on the roof surface. Any damage to existing roofs shall be repaired at the Contractor's cost in a manner acceptable to the Architect.

END OF SECTION

SECTION 07 26 13 – MOISTURE CONTROL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the furnishing and application of moisture control systems and self-leveling underlayments for the reduction of moisture vapor transmission and alkalinity control for interior concrete slabs requiring the installation of following materials:
 - 1. Resilient Tile Flooring.
 - 2. Ceramic floor tile: Water proofing membrane.

1.02 RELATED SECTIONS

- A. Section 01 20 00 – Prices and Payment Procedures: Unit price for performing Work specified in this Section.
- B. Section 01 40 00 – Quality Requirements.
- C. Section 01 45 23 – Concrete In-Situ Relative Humidity and pH Testing: Testing requirements.
- D. Section 09 30 00-Tile: Installation of water proofing membranes and/or crack isolation membranes.
- E. Section 09 65 00 – Resilient Flooring: Resilient flooring installation requirements.

1.03 REFERENCES

- A. American Society of Testing Materials:
 - 1. ASTM D7234 – Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
 - 2. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials.
 - 3. ASTM F2170 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In Situ Probes.
 - 4. ASTM F3010 – Standard Practice for Two-Component Resin Based Membrane Flooring Moisture Mitigation Systems for Use Under Resilient Floor Coverings.
- B. ICRI, International Concrete Repair Institute.

1.04 TESTING

- A. Before installation of the finish floor materials over the concrete slabs, in-situ relative humidity testing per ASTM F2170 and pH testing shall be performed by the Owner's Testing Lab to determine the level of water vapor transmission in the slab and the type of moisture reduction system required. Refer to Section 01 45 23 for testing procedures.

- B. The Owner's Testing Lab shall coordinate the test with the General Contractor's project scheduling to allow sufficient time to test, submit their findings and install the moisture control system before the installation of the finish flooring materials.

1.05 SUBMITTALS

- A. General: Submit in accordance with Section 01 33 00 – Submittal Procedures.
- B. Product Data: Provide product data for each type of product and process specified which shall include the following:
 - 1. Manufacturer's specifications.
 - 2. Manufacturer's installation instructions.
 - 3. Independent test data.
 - 4. Certification requirements.
 - 5. Warranty information.
- C. The installer of the moisture control system shall submit the following tests obtained from the General Contractor:
 - 1. Test results from the in-situ relative humidity testing according to ASTM F2170.
 - 2. Test results from the pH test.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installation of the Moisture Control System shall be by a manufacturer-approved installer with experience in surface preparation and application of the materials specified.
 - 2. Approved installer shall have not less than five (5) years of experience installing the moisture control system specified.
- B. Manufacturer's Qualifications:
 - 1. The manufacturer shall have not less than three (3) years of experience in manufacturing the same moisture control system. The moisture control system shall be specifically formulated and marketed internationally for moisture control and alkalinity control without change of formulation or system design for a minimum period of three (3) years.
 - 2. Manufacturer shall provide the Owner with their standard 15-year warranty at no additional cost.
 - 3. Manufacturer shall provide Independent lab test reports documenting performance per the following:
 - a. ASTM E96 – Water Vapor Transmission (dry and wet methods).

Performance shall be documented at a minimum 90 percent water vapor transmission reduction compared to untreated durable concrete.

- C. The Moisture Control System shall be installed only over concrete surfaces that have been properly mechanically prepared to a minimum surface profile of ICRI CSP #3 and which have an RH value of 100 percent or less when measured in accordance with ASTM F2170.
- D. The moisture control system shall comply with ASTM F3010 – Standard Practice for Two-Component Resin Based Membrane Flooring Moisture Mitigation Systems for Use Under Resilient Floor Coverings.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to the job site in their original unopened containers, clearly labeled with the manufacturer's name and brand designation.
- B. Store products in an approved ventilated dry area, protect from moisture, freezing and direct sunlight.

1.08 WARRANTY

- A. Manufacturer's Warranty: Warrant vapor emission control treatment against manufacturing defects and improper installations for a period of 15 years.
 - 1. Cover costs of treatment materials, cementitious compounds and labor costs of application and preparation.
 - 2. Extend warranty to flooring material, adhesive and installation labor for same period against moisture vapor emission and alkalinity-related failure.
 - 3. Provide warranty underwritten by product liability insurance carrier having a minimum "A" rating from Best or equivalent rating system in the amount of \$5,000,000 per occurrence and naming Owner, Architect and Contractor as co-insured.
 - 4. Warranty may not exclude concrete slabs containing silica or silicate compounds.

1.09 SITE CONDITIONS

- A. Do not apply moisture control system to unprotected surfaces or surfaces with standing water.
- B. Do not apply moisture control system below 50 degrees F surface temperature or where the temperature is expected to fall below 50 degrees F within 24 hours from time of application.
- C. Allow for continuous ventilation and indirect air movement at all times during application and curing process.

PART 2 PRODUCTS

2.01 MANUFACTURERS/PRODUCTS

- A. Moisture control systems which may be incorporated in the Work shall be the product of a single manufacturer:
1. Manufacturer: Allied Construction Technologies, Inc.
 - a. Products
 - 1) Moisture control system: AC Tech 2170, two component, fluid applied 100 solids epoxy based moisture control system.
 - a) VOC content: 0 g/L < 100 g/L.
 - 2) Underlayment primer: AC Tech 2170 SLP self-leveling primer.
 - a) VOC content: 0 g/L < 100 g/L.
 - 3) Portland-cement-based underlayment system: Self-leveling underlayment concrete system recommended by AC Tech.
 - a) VOC content: 0 g/L < 100 g/L.
 2. Manufacturer: Ardex Engineered Cements
 - b. Products
 - 1) Moisture control system: Ardex MC Plus, two-coat moisture control system consisting of a primer and sealer.
 - a) VOC content: 0 g/L < 100 g/L.
 - 2) Underlayment primer: Ardex P82 Ultra primer.
 - a) VOC content: 0 g/L < 100 g/L.
 - 3) Portland-cement-based underlayment system: Ardex K15 Premium self-leveling underlayment concrete.
 - a) VOC content: 0 g/L < 100 g/L.
 3. Manufacturer: Koster American Corporation.
 - a. Products:
 - 1) Moisture control system: Koster VAP 1 2000 Zero (Zero VOC's) System.
 - a) VOC content: 0 g/L < 100 g/L.
 - 2) Underlayment primer: VAP 1 06 primer.
 - a) VOC content: 0 g/L < 100 g/L.
 - 3) Portland-cement-based underlayment system: Koster SL

Standard or SL Premium self-leveling underlayment..

a) VOC content: 0 g/L < 100 g/L.

- B. Materials: Provide all required materials necessary for a complete installation over the concrete surface where the vapor emissions, the relative humidity and pH levels of the concrete are in conformance with the flooring manufacturer's requirements and the concrete surface is suitable to receive the finish floor materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Pre-Installation Moisture Testing: Conduct pre-installation concrete relative humidity and alkalinity testing on all interior slab areas to receive finish flooring.
- B. Examine concrete substrates with Installer present for compliance with requirements for installation of concrete moisture-vapor and alkalinity control system. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Inspect all surfaces with regard to their suitability to receive the moisture control system with the manufacturer's representative.
- B. The concrete shall be clean, and free of all oil, grease, dirt, curing compounds and any substance that might act as a bond breaker.
1. Verify surfaces to be treated with the moisture control system have not been previously treated with other materials such as underlayments, screeds or penetrating sealers. Notify manufacturer's representative of these conditions prior to application of the moisture control system.
- C. Shotblast all floors to a concrete surface profile of #3 or #4 and clean surfaces to remove all residue off the concrete. Fibers used to reinforce the concrete shall be burned off, scraped and vacuumed. Remove all fibers, after shotblasting, leaving no fibers on the concrete surface. Acid etching and the use of sweeping compounds and solvents are not permitted as means of preparing the substrate.
1. Shotblast a small area and verify with the specific floor applicator that the surfaces are fit to receive the specified flooring system without application of an underlayment.
- D. Repair concrete prior to moisture vapor reduction system installation using materials recommended by moisture system control manufacturer.
- E. Joint and Crack Preparation:
1. Moving Joints: Do not bridge moving joints with the moisture control system.
2. Saw Cuts, Control Joints and Non-Moving Cracks: Fill all non-moving joints and cracks with material recommended by manufacturer of the moisture control system.

3.03 APPLICATION

- A. Mix and apply moisture control system following the printed instructions from the manufacturer.
- B. Apply self-leveling cementitious underlayment and primer to a smooth and level surface, after installation of the moisture control system. Install to a thickness of minimum 1/8 inch.

3.04 PROTECTION

- A. Protect each coat during the required cure time from any kind of traffic, water and contaminants.

END OF SECTION

SECTION 07 62 00 – SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flashing
 - 1. Receivers
 - 2. Counterflashing

1.02 RELATED WORK

- A. Section 06 10 53 – Miscellaneous Carpentry: Securing metal flashings to preservative treated lumber/plywood.
- B. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment: Roof Curbs for Mechanical Equipment.
- C. Section 26 05 29 – Hangers and Supports for Electrical Systems: Roof Curbs for Electrical Equipment.

1.03 REFERENCES

- A. SMACNA – Architectural Sheet Metal Manual, Current Edition.
- B. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot Dip Process.
- C. ASTM B32 – Solder Metal.
- D. ASTM AFS 0-F-506 – Flux, Soldering, Paste, and Liquid.
- E. National Roofing Contractors Association, Roofing and Waterproofing Manual Current Edition.
- F. FS TT-C-494 – Coating Compound, Bituminous, Solvent Type, Acid Resistant.
- G. ANSI/SPRI ES-1 Current Edition American National Standard Wind Design Standard for Edge Systems Used With Low Slope Roofing Systems.
- H. ASCE/SEI 7 Standard – Current Edition. American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures.

1.04 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
- C. Submit four samples, 4 inches x 4 inches, illustrating metal finish color prior to fabrication and installation.

- D. Product Data: Submit data on manufactured components metal types, finishes and characteristics.
- E. Submit sample workmanship and material warranties.
- F. Submit sealant literature.
- G. Sealants
 - 1. The General Contractor shall provide to sealant manufacturers, samples of all substrates which are in contact with sealant, regardless of whether adhesion must be achieved.
 - 2. For substrates which must support adhesion, submit to the Architect, for record only, sealant manufacturer's reports of adhesion tests conducted in accordance with ASTM C794.
- H. Submit fasteners.

1.05 QUALIFICATIONS

- A. Fabricator and Installer: Company specializing in sheet metal work with minimum five years of documented experience.

1.06 WARRANTY

- A. Provide a two-year workmanship warranty.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 – Product Requirements: Product storage and handling requirements.
- B. Deliver, store, and protect products according to manufacturer's recommendations.
- C. Stack pre-formed metal to prevent twisting, bending or abrasion and to provide ventilation.
- D. Slope metal sheets to ensure drainage.
- E. Prevent contact with materials during storage which may cause discoloration or staining.
- F. Do not install material which becomes damaged during storage and handling.

1.08 COORDINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and project.
- B. Coordinate with related Work and ensure timely installation of Work of this Section.

1.09 PRE-INSTALLATION MEETING

- A. Section 01 30 00 – Administrative Requirements: Pre-installation meeting.
- B. Convene 4 weeks prior to commencing work of this Section.
- C. Review installation procedures and coordination required with related Work.

PART 2 PRODUCTS

2.01 SHEET MATERIALS

- A. Galvanized Sheet Metal: ASTM A653, G90 zinc coating, structural sheet steel, various gauges.

2.02 ACCESSORIES

- A. Fasteners: **NOTE:** All fasteners shall be corrosion resistant. All fasteners used to connect materials to preservative treated lumber and plywood shall be as appropriate for use with the specified wood treatments and with the roof/sheet metal materials being fastened. Select appropriate fasteners as required to prevent galvanic corrosion with other materials.

- 1. Roofing Nails: Threaded, or ring-shank, minimum 3/8 inch head, in lengths to match application.

- a. Finish:

- 1) Stainless steel Type 304 or 316.
- 2) Fasteners with proprietary anti-corrosion coatings may be submitted for use with treated wood. When submitted, the fastener manufacturer shall furnish specific information regarding the performance of their products in the specified treated wood and any precautions or special instructions that may be applicable.

- 2. Wood Screws: #14 hex head or pan head, with integral, steel washer and minimum 5/8 inch neoprene or EPDM washer; prefinished heads and washers where exposed to view.

- a. Finish:

- 1) Stainless steel Type 304 or 316.
- 2) Fasteners with proprietary anti-corrosion coatings may be submitted for use with treated wood. When submitted, the fastener manufacturer shall furnish specific information regarding the performance of their products in the specified treated wood and any precautions or special instructions that may be applicable.

- 3. Sheet Metal Screws: #14; round or pan head, prefinished heads and washers where exposed to view. Provide stainless steel for use with stainless steel flashing.

- a. Finish:

- 1) Hot-dipped galvanized per ASTM A153.
- 2) Stainless steel Type 304 or 316.
- 3) Fasteners with proprietary anti-corrosion coatings may be submitted for use with treated wood. When submitted, the fastener manufacturer shall furnish specific information regarding the performance of their products in the specified treated wood and any precautions or special instructions that may be applicable.

applicable.

4. Fastener lengths as required to penetrate:
 - a. minimum 1 1/4 inch, or through wood receiving members.
 - b. 1/2 inch through sheet metal and steel receiving members.
- B. Solder: ASTM B32 – 50/50 type.
- C. Flux: FS 0-F-506.
- D. Asphalt Primer: ASTM D41 as approved by membrane manufacturer.
- E. Asphalt Mastic: ASTM D4586, asbestos free, of consistency required for roofing system manufacturer for application. Verify with roofing system manufacturer.
- F. Sealant/Tape:
 1. Acceptable Manufacturers and Products: Subject to compliance with requirements of Contract Documents, provide product by one of the manufacturers named below.
 - a. BASF Building Systems; Sonolastic 150 with VLM Technology.
 - b. STS Coatings; Greatseal PE-150 multipurpose sealant.
 - c. Tremco: Spectrum 2
 - d. Substitutions: Comply with the requirements of this section and Division 1 requirements and the following:
 - 1) Sealant shall comply with ASTM C920, Type S, Grade NS, Class 25 or higher. Use NT, T, M, G, A and O.
 2. Primers: Prime the following surfaces with primer recommended by joint sealant manufacturer:
 - a. Galvanized steel.
 3. Verify adhesion of sealant to each metal and coating specified in accordance with ASTM C794.
 4. Sealant Tape: 100 percent solids, high grade, butyl, size to fit application.

2.03 FABRICATION

- A. Sheet Metal Fabrication Standard: Fabricate sheet metal flashing and trim to comply with recommendations of SMACNA's "Architectural Sheet Metal Manual" or NRCA Construction Details that apply to the design, dimensions, metal and other characteristics of the item indicated.
- B. Comply with details shown to fabricate sheet metal flashing and trim that fit substrates and result in waterproof and weather-resistant performance once installed. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
- C. Form exposed sheet metal Work that is without oil canning, buckling, tool marks and defects, and that is true to line and levels indicated, true to shape, accurate in size, square with exposed edges folded back to form hems.

- D. Fabricate concealed cleats from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.
 - 1. Size: As recommended by NRCA for application.
 - 2. Cleat gauge shall be one gauge heavier than material being fastened.
 - 3. All cleats shall be continuous with lengths not to exceed 12 feet. Allow a 1/4 inch gap between pieces. Joints in cleats shall not coincide with joints in metal.
- E. Form pieces in 10 foot sections.
- F. Hem exposed edges on underside 1/2 inch; miter and seam corners.
- G. Fabricate corners, intersections and terminations of "running" flashing as fixed components, separate from other lengths of flashing. Fabricate such components with maximum 18 inch legs.
- H. Form joints in running flashings to accommodate thermal movement equally throughout all joints.
- I. Form material with standing seams, flat lock seams, except where otherwise indicated.
- J. Movement Joints:
 - 1. At moving joints, use sealed lapped, or bayonet-type joints. Where lapped or bayonet-type joint provision in work cannot be used or will not be weatherproof and waterproof, form moving joints of interlocking hooked seams, not less than 1 inch deep, filled with sealant (concealed within joint).
- K. Fabricate vertical faces with bottom edge formed outward 3/4 inch, maximum 30 degree brake, and hemmed to form a drip.
- L. Obtain approval to adjust dimensions and configurations of sheet metal flashings, within acceptable limits, to allow more effective yield of material or to facilitate fabrication in sheet metal brake. Ensure adjustments comply with design intent.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that related Work has progressed to the appropriate stage.
- B. Verify suitability of receiving surfaces.

3.02 PREPARATION

- A. Field-measure site conditions prior to fabricating work. Note variances; adjust dimensions to accommodate site conditions.
- B. Pre-prime top and bottom surfaces of metal flanges which are built into bituminous membrane roof, except where field soldered.
- C. Separate metal from noncompatible metal, corrosive substrates or preservative-treated

materials by coating concealed surfaces at locations of contact with asphalt mastic or other permanent separation material as recommended by roofing manufacturer.

D. Metal Flashings

1. Remove scale, rust, loose or inappropriate coatings, oils and protective films from metal a bright surface.
2. Prime the following surfaces with a primer recommended by joint manufacturer:
 - a. Fluorocarbon (Kynar) coatings.
 - b. Galvanized, galvalume steel.
 - c. Stainless steel.

E. Priming

1. Where priming metal flashings is required for proper adhesion, comply with the following:
 - a. Apply primer at full strength by wiping or brushing. Apply primer to a light, uniform coating. Do not apply or allow primer onto exposed face of substrate.
 - b. Allow primer to dry in accordance with manufacturer's instructions.

3.03 SOLDERING

- A. Solder only fixed components such as corners, intersections, termination, skirts, collars and one-piece flashings made of galvanized sheet steel.
- B. Pre-tin both sides of edges to be soldered using flux and solder to full-anticipated width of joint.
- C. Join sub-components together before soldering. For flat seams, and whenever possible, form flat-lock seams binding sheets tightly. Where flat-lock seams are impractical, provide tabs, partially interlocked if possible, and join with pop-rivets at 1 inch on center.
- D. Do not solder over nailheads.
- E. Apply flux to surface of joint, and solder slowly with well-heated irons. Heat sheets as necessary to sweat solder to full width of seam, or minimum 3/4 inch. Ensure an even flow of solder without excess build-up.
- F. Solder joints in a horizontal position whenever possible. When soldering on slopes steeper than 45 degrees, apply a second bead, neatly laced.
- G. Neutralize flux from surfaces immediately after soldering, use cloth saturated with 10% solution of soda and water, and wipe using separate cloth and clean water.

3.04 JOINTING

- A. Form joints in running flashings to accommodate thermal movement equally throughout all joints.
- B. Provide "slip"-type joints each side of soldered or joined components, except where total length of intersecting lengths is less than 5 feet.

- C. Provide joints aligned with expansion or control joints in walls. Overlap, notch and loosely interlock adjoining sections at lower hem. Fasten only one side of joint to wall.
- D. Form rigid, fixed joints only when constructing fixed components. Provide minimum 3/4 inch tabs, interlocked where possible. Join sections with tabs concealed.
- E. Solder fixed joints in galvanized metal. Seal laps and rivet 2 inches on center fixed joints in prefinished metal.
- F. Flashing Receivers:
 - 1. Form butt joint, leaving 1/2 inch space.
 - 2. Set 4 inch cover plate in double, side-by-side bead of sealant each side of joint (4 beads total). Hook lower edge of plate minimum 1/2 inch into pocket.
 - 3. Fasten plate only at center without engaging either flashing length. Provide slight kick-down all sides of plate.
 - 4. Tab inside and outside corners, seal between tabs with sealant, and rivet 1 inch on center.
- G. Counterflashing:
 - 1. Form minimum 4-inch lap joint. Apply single bead of sealant concealed inside lap. Notch and interlock lower hem allowing for 1/4 inch movement. Do not fasten through lap.
 - 2. Tab inside and outside corners, seal between tabs with sealant (or solder corner) and pop-rivet 1 inch on center.
 - 3. Install counterflashing so that a minimum of 4 inches of the roof membrane base flashing is covered. The lower edge of the counterflashing shall be 1 inch minimum above the cant.
- H. Concealed Cleats: Maximum length 12 feet. Leave 1/4 inch space between lengths. Joints in cleat shall not coincide with joints in fascia metal.

3.05 INSTALLATION

- A. General: Unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer's installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Anchor units of Work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install Work with laps, joints, and seams that will be permanently watertight and weatherproof.
- B. Provide uniform, symmetrical layout of flashing sections, seams, joints, and fasteners.
- C. Roughen surface of prefinished metal flanges which are stripped-in. Ensure strip-in plies bond to surface.
- D. Prime and embed membrane roof flanges in solid 1/8 inch bed of plastic cement. Fasten roof flange with threaded nails in uniform staggered pattern, without overdriving or causing excessive indentations. Apply strip-in plies same day.

- E. Ensure proper fit and positioning of flashings. Make adjustments necessary to accommodate variances and imperfections in receiving surfaces.
- F. Install flashings free of warp or distortion, and without stress on fixed components.
- G. Stagger joints between components.
- H. Counterflashings: Coordinate installation of counterflashings with installation of assemblies to be protected by counterflashing. Install counterflashings in reglets or receivers. Secure in a waterproof manner.

3.06 SCHEDULE

A. Pocket Receiver

- 1. Material: Galvanized steel.
- 2. Thickness: 24 gauge.
- 3. Fasteners
 - a. Corrosion resistant screw fasteners.
 - b. Spacing: 8 inches o.c.
- 4. Solder all outside and inside corners.

B. Counterflashing

- 1. Material: Galvanized steel.
- 2. Thickness: 24 gauge.
- 3. Fasteners:
 - a. Corrosion resistant screws with neoprene washers.
 - b. Spacing: 12 inches o.c.
- 4. Solder all outside and inside corners.

END OF SECTION

SECTION 08 12 14 – STANDARD STEEL FRAMES

PART 1 GENERAL

1.01 SUMMARY

A. This Section Includes:

1. Non-Rated Frames.
 - a. Door frames.
 - b. Transom frames.

B. Related Sections:

1. Section 08 13 14 – Standard Steel Doors.
2. Section 08 14 16 – Flush Wood Doors.
3. Section 08 71 00 – Door Hardware.
4. Section 08 80 00 – Glazing.
5. Section 09 22 16 – Non-Structural Metal Framing: Securing steel frames to metal studs.
6. Section 09 90 00 – Painting and Coating.

1.02 REFERENCES

A. American National Standards Institute:

1. ANSI/DHI A115 – Specifications for Hardware Preparations in Standard Steel Doors and Frames.
2. ANSI/DHI A115.1G – Installation Guide for Doors and Hardware.
3. ANSI A250.3 – Test Procedure and Acceptance Criteria for Factory Applied Finish Painted Steel Surfaces for Steel Doors and Frames.
4. ANSI A250.4 – Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frame Anchors and Hardware Reinforcings.
5. ANSI A250.6 – Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
6. ANSI A250.7 – Nomenclature for Steel Doors and Steel Frames.
7. ANSI A250.8-SDI-100 – Recommended Specifications for Standard Steel Doors and Frames; 2017 (R2014).
8. ANSI A250.10 – Test Procedure and Acceptance Criteria for Prime Painted Steel

Surfaces for Steel Doors and Frames.

9. ANSI A250.11 – Recommended Erection Instructions for Steel Frames (Formerly SDI-105).

B. ASTM International:

1. ASTM A568 – Standard Specification for Steel Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
2. ASTM A591 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
4. ASTM A924 – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
5. ASTM A1008 – Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

C. NAAMM/HMMA – Hollow Metal Manufacturers Association:

1. HMMA 820 TN03 – Guidelines for Glazing of Hollow Metal Transoms, Sidelights and Windows.

D. SDI – Steel Door Institute:

1. SDI 111 – Recommended Details and Guidelines for Standard Steel Doors and Frames and Accessories.
2. SDI 112 – Zinc-Coated (Galvanized/Galvannealed) Standard Steel Doors and Frames.
3. SDI 117 – Manufacturing Tolerances for Standard Steel Doors and Frames.
4. SDI 122 – Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
5. SDI 124 – Maintenance of Standard Steel Doors and Frames.

1.03 SUBMITTALS FOR REVIEW

- A. Section 01 33 00 – Submittal Procedures: Procedures for submittals.
- B. Product Data: Indicate frame configuration and finishes.
- C. Shop Drawings: Indicate frame elevations, reinforcement, anchor types and spacings, location of cut-outs for hardware, and finish.
- D. Certificates: Product certificates signed by manufacturer certifying material compliance

with specified requirements.

E. Installation Instructions: Manufacturer's printed installation instructions.

1.04 QUALITY ASSURANCE

A. Conform to requirements of ANSI A250.8-2017.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 5 years of documented experience.

1.06 DELIVERY, STORAGE AND PROTECTION

A. Section 01 60 00 – Product Requirements: Transport, handle, store and protect products.

B. Accept frames on site in manufacturer's packaging. Inspect for damage.

C. Frames shall be stored under cover on 4" wood sills on floors in a manner that will prevent rust and damage. Do not use non-vented plastic or canvas shelters, which create humidity and promote rusting. Frames shall be stored in a vertical position, five units maximum in a stack. Provide 1/4" space between frames to promote air circulation.

1.07 PROJECT CONDITIONS

A. Section 01 30 00 – Administrative Requirements: Coordination and Project Conditions.

B. Coordinate the work with frame opening construction, door and hardware installation.

C. Sequence installation to ensure wire connections are achieved in an orderly and expeditious manner.

PART 2 PRODUCTS

2.01 FRAME MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of the manufacturers listed below. If not named, submit as a substitution according to Conditions of the Contract and appropriate Division 1 sections.

1. Amweld Building Products, LLC.
2. Ceco Door/Assa Abloy.
3. Curries Company/Assa Abloy.
4. Deansteel Manufacturing Company.
5. Door Components.

6. Mesker.
7. MPI.
8. Pioneer.
9. Republic Builders Products.
10. Security Metal Products, Inc.
11. Steelcraft.

2.02 MATERIALS

- A. Frames and frame anchors for each of the levels and models specified shall be provided to meet the requirements of the performance levels specified. The material used in manufacturing these products and components shall comply with ANSI A250.8. Hardware reinforcing on frames shall comply with ANSI A250.6. The physical performance levels shall be in accordance with ANSI A250.4.
- B. Cold-rolled steel shall conform to ASTM designations A1008 – Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability and ASTM A568 – Standard Specification for Steel Sheet, Carbon and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
- C. Hot-dipped, zinc-coated steel shall be of the alloyed type and comply with ASTM designations A924 – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process and ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

2.03 FRAMES

- A. Provide metal frames for doors, transoms according to ANSI A250.8-2017 (R2014), and of types and styles as shown on Drawings and schedules. Conceal fastenings, unless otherwise indicated.
 1. Interior Frames:
 - a. Material: Cold-rolled steel conforming to ASTM A1008 and ASTM A568.
 - b. Minimum material thickness: 0.067 inches (14 gauge).
 2. Exterior Frames:
 - a. Material: Hot-dipped zinc-iron alloy-coated galvanized steel conforming to ASTM A653, coating designation A60.
 - b. Minimum material thickness prior to coating: 0.067 inches (14 gauge).
- B. Door Silencers: Except on weatherstripped frames drill stops to receive 3 silencers on strike jambs of single-door frames and 2 silencers on heads, of double-door frames.
- C. Plaster Guards: Provide minimum 0.0179 inch thick steel plaster guards or mortar boxes

at back of hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior of openings.

- D. Reinforce frames over 48 inches with rolled formed steel channels fitted tightly into frame head, flush with top,

2.04 FABRICATION

- A. Corner joints shall have all contact edges closed tight with faces mitered and stops either butted or mitered.
 - 1. Welded Frames: Full profile welded, also specified as fully welded or continuously welded.
 - a. Weld miter joints between head and jamb faces completely along their length either internally or externally.
 - b. Internally weld perimeter profile joints full length of soffit stops and rabbets with hairline seams on external meeting surfaces. Grind and finish face joints smooth.
 - c. Face joints at meeting mullions or between mullions and other frame members shall be completely externally welded on the faces only. All welds shall be ground and finished smooth.
 - 2. Welded frames shall be provided with two temporary steel spreader bars, welded to the jambs at each rabbet of door openings, for shipping and handling purposes only. These temporary spreader bars shall be removed and setting spreaders, supplied by the installer shall be used for installation of the frame. Refer to ANSI A250.11 – Recommended Erection Instructions for Steel Frames.
- B. Fabricate jambs, heads straight and uniform throughout their lengths; square and free of defects, warps or buckles.
- C. Fabricate frames with hardware reinforcement plates welded in place. Provide mortar guard boxes.
- D. Prepare frames for silencers. Provide three single silencers for single doors on strike side. Provide two single silencers on frame head at double doors without mullions.
- E. Glazing Beads: Provide frame glazing beads in exterior glazed openings where fixed glass is indicated in pressed steel frames. Prepare frames for the type of glazing beads required to receive the glass and gaskets indicated. Miter or butt join beads at corners. Glazing beads to be screw-on type. Install glazing beads on the secured side of the space, unless otherwise noted.
 - 1. At exterior frames, install glazing beads with tamper-proof fasteners on exterior side of rabbet.
- F. When shipping limitations or site access so dictate, or when advised by the contractor responsible for coordination or installation, frame product for large openings shall be fabricated in sections designated for assembly in the field by others. Alignment plates or angles shall be installed at each joint. Such components shall be the same material and thickness as the frame. Field joints shall be made in accordance with approved Submittal Drawings and shall be field welded by others.

G. Floor Anchors:

1. Floor anchors shall be provided with two holes for fasteners and shall be secured inside jambs with at least four (4) spot welds per anchor.
2. Where specified or scheduled, adjustable floor anchors, providing not less than 2 in. (50.8 mm) height adjustment, shall be fastened in place with at least four (4) spot welds per anchor.
3. For applications that do not permit the use of a floor anchor, an additional jamb anchor shall be substituted at a location not to exceed 8 in. (204 mm) from the base of the jamb.
4. Floor anchor shall be of same material and thickness as frame.

H. In cases where electrically or electronically operated hardware is required and indicated on the approved hardware schedule, conduit, hardware enclosures and/or junction boxes shall be provided. Access plates, where required, shall be the same material and thickness as the frame product and shall be fastened with not less than four (4) #8-32 machine screws or #6 sheet metal screws at a spacing not to exceed 12 inc. on center.

I. Tolerances:

1. Face Widths, Door Stop Heights and Jamb Depths: 0.031 inch.
2. Throat Openings: 0.063 inch.
3. Door Rabbets: 0.016 inch.

2.05 FINISHING

A. Steel:

1. Remove weld slag and splatter from exposed surfaces.
2. Fill and sand all tool marks, abrasions and surface blemishes to present smooth uniform surfaces.
3. On exposed surfaces where zinc-iron alloy coating has been removed during fabrication, factory apply rust inhibitive touch-up primer.
4. Fully cure primer prior to shipment.

2.06 SHOP PRIMER

- A. Prime Finish: Frames shall be thoroughly cleaned, and chemically treated to insure maximum paint adhesion. All surfaces of the frame exposed to view shall receive a factory applied coat of rust inhibiting primer, either air-dried or baked-on. The finish shall meet the requirements for acceptance stated in ANSI A250.10 "Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames."
- B. Apply primers to frames after fabrication. Coordinate primer with field-applied finish coatings as specified in Section 09 90 00 for compatibility, with finish coats.

2.07 HARDWARE PREPARATION

- A. Prepare frames for hardware specified elsewhere; comply with DHI A115 series standards; adjust locations to allow for specified clearances and size tolerances, with maximum variation from template dimensions of plus 0.015 inch and minus 0.
- B. Fully Templated Mortise Hardware: Factory blank, reinforce, drill and tap frames in accordance with approved shop drawings and templates provided by hardware supplier.
 - 1. Factory prepare templated holes 0.5 inch diameter and larger, except mounting and through bolt holes.
 - 2. Factory prepare templated holes less than 0.5 inch diameter when required for the function of the device (for knobs, levers, cylinders, thumb or turn pieces) or when these holes over-lap function holes.
- C. Mortised Hardware Not Fully Templated: Factory blank and reinforce frames; drill and tap on site.
- D. Reinforce frames in accordance with Table 4 of ANSI A250.8-2017 (R2014).

2.08 FRAME ANCHORAGE

- A. Frame Anchors: Provide anchors appropriate to floor, wall and frame construction.
 - 1. Provide fasteners, anchor bolts, and expansion shell anchors as required.
- B. Standard Frames:
 - 1. Dry Wall Type:
 - a. Frame product for installation in dry-wall partitions shall be provided with steel stud jamb anchors of suitable design, not less than 0.042 in. thickness, securely welded inside each jamb. Jamb anchors shall be placed a maximum of 18 in. from top and bottom of openings. The minimum number spaced at maximum 32 in. on center, near hinges and directly opposite on strike jambs, provided on each jamb, based on the overall frame height, shall be as follows:
 - 1) Up to 60 in.: 3 anchors.
 - 2) Greater than 60 in. up to 90 in.: 4 anchors.
 - 3) Greater than 90 in. up to 96 in.: 5 anchors.
 - 4) Greater than 96 in.: 5 anchors plus one for each 24 in. or fraction thereof, spaced at 24 in. maximum between anchors.
 - 2. Expansion Bolt Type:
 - a. Frame product for installation in existing masonry or concrete walls shall be prepared for expansion bolt type anchors. The preparation shall consist of a countersunk hole for a 0.375 in. diameter flat head bolt and a spacer within the frame profile. The spacer shall be welded to the frame and spaced a maximum of 6 in. from the top and bottom of the frame, with intermediate spacing at a maximum of 26 in. on center.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.

3.02 INSTALLATION

- A. General: Install steel frames and accessories according to Shop Drawings, manufacturer's data, and as specified.
- B. Placing Frames: Comply with provisions of ANSI A250.11 and DHI A115.IG, unless otherwise indicated.
 - 1. Install fire-rated frames per NFPA 80.
 - 2. Install smoke and draft control door frames per NFPA 105.
- C. Set frames plumb, square, aligned, without twist and at correct elevation, within the following tolerances:
 - 1. Plumbness: Not more than 0.063 inch out of plumb, measured using a line from the intersection of vertical members and the head to the floor.
 - 2. Squareness: Not more than 0.063 inch difference between diagonal measurements between corners.
 - 3. Alignment: Not more than 0.063 inch measured on jambs, through a horizontal line parallel to the plane of the wall.
 - 4. Twist: Not more than 0.063 inch measured at face corners of jambs, on parallel lines perpendicular to the plane of the wall.
- D. Brace frames rigidly in position while partitions are being constructed.
 - 1. Remove temporary steel shipping jamb spreaders.
 - 2. Install wood spreaders at mid-point of frame rabbet height to maintain frame widths.
 - 3. Provide vertical support at center of head for openings exceeding 48 inches in width.
 - 4. Remove wood spreaders after product has been built-in.
- E. Except for frames located in existing concrete, masonry or gypsum board assembly construction, place frames before constructing enclosing walls and ceilings.
- F. Secure anchorages and connections to adjacent construction.

- G. Install hardware in accordance with ANSI A115.IG, manufacturer's templates and instructions.
- H. Keep steel surfaces free of grout, tar, other bonding materials, and sealers; clean surfaces immediately following installation.
- I. Install glazing materials and door silencers; coordinate with field painting to avoid unnecessary masking or cleaning.
- J. Touch up damaged surfaces and exposed field welds with rust inhibitive primer:
 - 1. Prepare galvanized steel to be finished with latex paints by cleaning with soap and water to remove foreign matter.
 - 2. Prepare galvanized steel to be finished with alkyd paints by cleaning with turpentine or paint thinner.
 - 3. Finish exposed field welds to present a smooth uniform surface.
 - 4. Follow recommendations of final paint finish manufacturer.
- K. Damaged work will be rejected and shall be replaced at no additional cost to the owner.
- L. Coordinate installation of frames with hardware specified in Section 08 71 00 and doors in Section 08 13 14 and Section 08 14 16.

3.03 ADJUSTING

- A. Adjust operable parts for correct clearances and function.
- B. Adjust hinge sets, locksets and other hardware. Lubricate using a suitable lubricant compatible with door and frame coatings.

3.04 CLEANING AND PROTECTION

- A. Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions before Owner's acceptance.
- B. Remove from project site and legally dispose of construction debris associated with this work.
- C. Protect installed products and finished surfaces from damage during construction.

END OF SECTION

SECTION 08 13 14 – STANDARD STEEL DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Non-rated steel doors.

1.02 RELATED SECTIONS

- A. Section 08 12 14 – Standard Steel Frames.
- B. Section 08 71 00 – Door Hardware.
- C. Section 08 80 00 – Glazing: Glass for doors.
- D. Section 09 90 00 – Painting and Coating: Field painting of doors.

1.03 REFERENCES

- A. American National Standards Institute:

1. ANSI/DHI A115 – Specifications for Hardware Preparation in Standard Steel Doors and Frames.
2. ANSI/DHI A115.1G – Installation Guide for Doors and Hardware.
3. ANSI A250.3 – Test Procedure and Acceptance Criteria for Factory Applied Finish Painted Steel Surfaces for Steel Doors and Frames.
4. ANSI A250.4 – Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frame Anchors and Hardware Reinforcings.
5. ANSI A250.6 – Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
6. ANSI A250.8 – SDI-100 Recommended Specifications for Standard Steel Doors and Frames; 2017 (R2014).
7. ANSI A250.10 – Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
8. ANSI A250.11 – Recommended Erection Instructions for Steel Frames (Formerly SDI-105).

- B. ASTM International:

1. ASTM A568 – Standard Specification for Steel Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
2. ASTM A591 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

3. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 4. ASTM A924 – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 5. ASTM A1008 – Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 6. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
- C. SDI – Steel Door Institute:
1. SDI 111 – Recommended Details and Guidelines for Standard Steel Doors and Frames and Accessories.
 2. SDI 112 – Zinc-Coated (Galvanized/Galvannealed) Standard Steel Doors and Frames.
 3. SDI 117 – Manufacturing Tolerances for Standard Steel Doors and Frames.
 4. SDI 122 – Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
 5. SDI 124 – Maintenance of Standard Steel Doors and Frames.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 – Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate door elevations, internal reinforcement, closure method, and finish and cut-outs for glazing. Provide schedule of doors and frames using the same reference numbers for details and openings as those on the Drawings.
- C. Product Data: Indicate door configurations, location of cut-outs for hardware reinforcement.
- D. Manufacturer's Installation Instructions: Indicate special installation instructions.
- E. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Provide doors complying with ANSI A250.8-2017 (R2014). "Recommended Specifications for Standard Steel Doors and Frames" as specified, and other specifications herein named.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years of documented experience.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01 60 00 – Product Requirements: Requirements for transporting, handling, storing and protecting products.
- B. Inspect doors upon delivery for damage. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to architect; otherwise, remove and replace damaged items as directed.
- C. Store doors at building site under cover. Place units on minimum 4-inches-high wood blocking. Avoid use of non-vented plastic or canvas shelters which could create humidity chamber. If cardboard wrapper on door becomes wet, remove carton immediately. Provide 1/4 inch spaces between stacked doors to promote air circulation.

1.08 COORDINATION

- A. Coordinate with door opening construction and door frame and door hardware installation.
- B. Coordinate installation to accommodate door hardware electric wire connections.

PART 2 PRODUCTS

2.01 DOOR MANUFACTURERS (STANDARD STEEL DOORS)

- A. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of the manufacturers listed below. If not named, submit as a substitution according to Conditions of the Contract and appropriate Division 1 sections.
 - 1. Amweld Building Products, LLC.
 - 2. CECO Door/Assa Abloy.
 - 3. Curries Company/Assa Abloy.
 - 4. Deansteel Manufacturing Company.
 - 5. Door Components.
 - 6. Mesker.
 - 7. MPI.
 - 8. Pioneer.
 - 9. Republic Builders Products.
 - 10. Security Metal Products, Inc.
 - 11. Steelcraft.

2.02 MATERIALS

- A. Doors and hardware reinforcing for each of the levels and models specified shall be provided to meet the requirements of the performance levels specified. The material used in manufacturing these products and components shall comply with ANSI A250.8. Hardware reinforcing on doors and frames shall comply with ANSI A250.6. The physical performance levels shall be in accordance with ANSI A250.4.

2.03 DOORS

- A. Steel Doors: Provide 1-3/4 inch thick doors of materials and ANSI A250.8-2017 (R2014) for grades and models specified below.
- B. Cold-rolled steel shall conform to ASTM designations A1008 – Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability and A568 – Standard Specification for Steel Sheet, Carbon and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
 - 1. Exterior doors shall meet the following requirements:
 - a. Level: Level 4, maximum-duty.
 - b. Model: Model 2 – Seamless welded construction.
 - c. Physical performance level: Level A, 1,000,000 cycles.
 - d. Thickness: 0.067 inches (14 gauge).
 - e. Material: Hot-dipped zinc-iron alloy-coated galvanized steel conforming to ASTM A653.
 - 1) Coating designation: A60.
- C. Hot-dipped zinc-coated steel shall be of the alloyed type and comply with ASTM designations A924 – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process and A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process.

2.04 FABRICATION

- A. Fabricate steel doors to be rigid, neat in appearance and free from defects, warp, or buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site. Comply with ANSI A250.8 requirements.
 - 1. Internal Construction:
 - a. Vertical steel stiffeners with fiberglass insulation.
 - 2) Doors shall be stiffened by continuous vertically formed steel sections which, upon assembly, shall span the full thickness of the interior space between door faces. These stiffeners shall be 0.026 in. minimum thickness, spaced so that the vertical interior webs shall be no more than 6 in. apart and securely fastened to both face sheets by spot welds spaced a maximum of 5 in. o.c. vertically. Spaces between stiffeners shall be filled with fiberglass or mineral rock wool batt-type material.

2. Design clearances: Fabricate doors and frames to maintain the following clearances:
 - a. The clearance between the door and frame shall be 1/8 inch (3.2 mm) in the case of both single swing and pairs of doors.
 - b. The clearance between the meeting edges of pairs of doors shall be 3/16 inch (4.8 mm) plus or minus 1/16 inch (1.6 mm). The clearance measured from the bottom of the door to the bottom of the frame (undercut) shall be a maximum of 3/4 inch (19.1 mm) unless otherwise specified.
 - c. The clearance between the face of the door and the stop shall be 1/16 inch (1.6 mm) to 3/32 inch (2.4 mm).
 - d. All clearances shall be, unless otherwise specified in this document, subject to a tolerance of plus or minus 1/32 inch (0.8 mm).
 3. Top and Bottom End Closure: Channel 0.053 inch thick inverted unless noted otherwise.
 4. Door Edge Design: Provide in accordance with ANSI/SDI A250.8. Provide manufacturer's standard edge.
 5. Provide steel astragals where indicated on the Drawings, or where required by the manufacturer or NFPA 80.
- B. Tolerances: Comply with SDI 117 "Manufacturing Tolerances Standard Steel Doors and Frames."
- C. Fabricate concealed stiffeners, reinforcement, edge channels, from either cold-or hot-rolled steel sheet.
- D. Hot-Dipped Galvannealed Steel Doors and Panels: For the following locations, fabricate doors and panels from galvannealed steel sheet according to SDI 112, galvannealed to ASTM A924 and A653, A60. Close top and bottom edges of doors flush as an integral part of door construction or by addition of minimum 0.053 inch galvannealed steel channels, with channel webs placed even with top and bottom edges. Seal joints in top edges of doors against water penetration. Include galvannealed components and internal reinforcements.
1. At all exterior locations.
- E. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.
- F. Hardware Preparation: Prepare doors to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements of SDI 107 and ANSI A115 Series specifications for door and frame preparation for hardware.
- G. Reinforce doors to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.
1. Minimum hardware reinforcing gages shall comply with Table 4 of ANSI A250.8-2017 (R2014).
- H. Locate hardware as indicated on Shop Drawings or, if not indicated, according to the Door

and Hardware Institute's (DHI) "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

- I. At glazed openings provide removable stops, rolled steel, channel shaped, butted corners, prepared for countersink style, tamper proof screws.

2.05 PRIMER

- A. Prime Finish: Doors shall be thoroughly cleaned, and chemically treated to insure maximum paint adhesion. All surfaces of the door exposed to view shall receive a factory applied coat of rust inhibiting primer, either air-dried or baked-on. The finish shall meet the requirements for acceptance stated in ANSI A250.10 "Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames."
- B. Field-Applied Finish Paint
 1. Coordinate primer with field applied finish coatings as specified in Section 09 90 00 for compatibility with finish coats.
 - a. Furnish painting contractor with manufacturer's literature for description of primer used.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General: Install steel doors and accessories according to Shop Drawings, manufacturer's data and as specified.
 1. Doors shall be installed in accordance with ANSI/DHI A115.1G.
- B. Door Installation: Fit hollow-metal doors accurately in frames, within clearances specified in ANSI A250.8.
- C. Coordinate installation of doors with installation of frames specified in Section 08 12 14 and hardware specified in Section 08 71 00.
- D. Damaged work will be rejected and shall be replaced at no additional cost to the Owner.

3.02 ADJUSTING AND CLEANING

- A. Prime Coat Touch-Up: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.
- B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION

SECTION 08 14 16 – FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This Section includes the following flush wood doors, fire-rated and non-rated:
 - 1. Solid core doors with wood veneer faces.
 - 2. Factory finishing of flush wood doors.
 - 3. Factory fitting flush wood doors to frames and factory machining for hardware.

1.02 RELATED SECTIONS

- A. Section 08 12 14 – Standard Steel Frames.
- B. Section 08 71 00 – Door Hardware.

1.03 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI A115 – W Series, Wood Door Hardware Standards.
- B. Door and Hardware Institute:
 - 1. DHI-WDHA-3 – Recommended Hardware Locations for Wood Doors.
- C. Window and Door Manufacturers Association:
 - 1. ANSI/WDMA 1.S.1A-13 – Industry Standard for Architectural Wood Flush Doors.

1.04 SUBMITTALS FOR REVIEW

- A. Section 01 33 00 – Submittals: Procedures for submittals.
- B. Product Data: For each type of door indicate details of core and edge construction and factory-finishing specifications.
- C. Shop Drawings: Illustrate door opening criteria, elevations, sizes, types, swings, undercuts required, special beveling, special blocking for hardware, factory machining criteria, and factory finishing criteria.
- D. Construction Samples: Submit four samples of door construction, 5 by 5 inch in size, cut from top corner of door.
- E. Finishing Samples: Submit a set of 3 illustrating the range of color and grain of the specified door face material, minimum 6 x 6 inch in size illustrating:
 - 1. Faces of factory-finished doors with transparent finish: Wood grain, stain color and sheen.

- F. Manufacturer's full lifetime warranty.

1.05 SUBMITTALS FOR INFORMATION

- A. Section 01 33 00 - Submittals: Procedures for submittals.
- B. Manufacturer's Installation Instructions: Indicate special installation instructions.

1.06 QUALITY ASSURANCE

- A. Quality Standard: Comply with the following standard:
 - 1. Meet or exceed ANSI/WDMA 1.S.1 A-13 Industry Standard for Architectural Wood Flush Doors.
- B. Single-Source Responsibility: Obtain doors from one source and by a single manufacturer.

1.07 DELIVERY, STORAGE AND PROTECTION

- A. Section 01 60 00 – Product Requirements: Transport, handle, store and protect products.
- B. Deliver, store, protect and handle products under provisions of WDMA and manufacturer's care and handling instructions.
- C. Store doors flat on a level surface in a dry, well-ventilated building. Doors shall be kept at least 4 inches off the floor and shall have protective coverings under the bottom door and over the top. Covering shall protect doors from dirt, water and abuse, and shall allow for air circulation under and around the stack.
- D. Doors shall not be exposed to direct light (artificial or natural). Wrap individual doors with opaque wrapping.
- E. Do not subject doors to extremes of heat and or humidity. Do not allow doors to come in contact with water. HVAC systems shall be operational and balanced, providing a temperature range of 50 to 90 degrees F and 30% to 50% relative humidity.
- F. Do not install doors in buildings with wet plaster or cement.
- G. When handling doors, always lift and carry. Do not drag across other doors or surfaces.
- H. Each door shall be marked on top rail with door opening number.

1.08 PROJECT CONDITIONS

- A. Coordinate the work with door opening construction, door frame and door hardware installation.
- B. Conditioning: Do not deliver or install doors until conditions for temperature and relative humidity have been stabilized and will be maintained in storage and installation areas during the remainder of the construction period to comply with the following requirements applicable to Project's geographical location:

1. Deliver, store, protect and handle products under provisions of WDMA and manufacturer's care and handling instructions.

1.09 WARRANTY

- A. General Warranty: Door manufacturer's warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Door Manufacturer's Warranty: Submit written agreement on door manufacturer's standard form signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that have warped (bow, cup or twist) more than 1/4 inch in a 42-by-84-inch section or that show telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span, or do not conform to tolerance limitations of referenced quality standards.
 1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors where defect was not apparent prior to hanging.
 2. Warranty shall be in effect during the following period of time after date of Substantial Completion.
 - a. Solid Core Interior Doors: "Full Life of Original Installation."

PART 2 PRODUCTS

2.01 MANUFACTURERS/PRODUCTS

- A. Basis of Design: Contract Documents are based on manufacturer and product named below to establish a Standard of Quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and do not change concept as expressed in Contract Documents as judged by Architect.
 1. Basis of Design, Wood Veneer Doors:
 - a. Manufacturer/Product: Masonite Architectural, Aspiro Series | Marshfield-Algoma, Interior Solid Core Flush Wood Doors for Transparent Finish – Select Wood Veneer.
 - 1) Non-rated: Aspiro Series, Structural Composite Lumber, No added Urea-Formaldehyde, FSC Certified (extra heavy-duty performance level), Model A-SCLC-B-NR.
- B. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of the manufacturers below. If not named, submit as substitution according to Conditions of the Contract and appropriate Division 1 section.
 1. Eggers Industries, Architectural Door Division.
 2. VT Industries.

2.02 WORKMANSHIP

- A. Comply with ANSI/WDMA 1.S.1A-13.

2.03 PERFORMANCE STANDARD

- A. Comply with ANSI/WDMA I.S. 1A-13 Extra Heavy Duty, Performance Duty Level.
- B. Cross band required for fire approval and to meet ANSI/WDMA 1.S 1A-13 required performance duty level.

2.04 DOOR TYPES (WOOD VENEER)

- A. Door designation per ANSI/WDMA 1.S.1A-13.
- B. Flush Interior Doors (Non-Rated): SCLC-5, Environmental Structural Composite Lumber Core Door with wood veneer each side (5-ply), 1 3/4 inches thick.

2.05 MATERIALS

- A. Door Construction Aesthetic Grade:
 - 1. Except as may be otherwise shown on the drawings, fabricate the work of this Section to ANSI/WDMA 1.S.1A-13 "Custom A Grade."

2.06 FABRICATION

- A. Door Core Construction: Comply with the following requirements:
 - 1. Non-Rated: Extra Heavy Duty Performance Level Environmental Structural Composite Lumber Core.
 - 2. Bond stiles and rails to core, abrasive sand core assembly to achieve uniform thickness before veneering.
- B. Vertical Edges (Stiles)
 - 1. Non-Rated (Wood Veneer):
 - a. Manufacturer's standard laminated hardwood edge or SCL.
 - b. Edges, to match face veneer.
 - c. Joints: No joints allowed.
- C. Horizontal Edge (Rails)
 - 1. Mill option structural composite lumber or hardwood lumber.
- D. Adhesive:
 - 1. Type I or Type II.
- E. Machining for non-rated doors:

1. Factory fit and machine doors for frames and finish hardware in accordance with hardware requirements and dimensions.
- F. Wood Door Facing for Transparent Finish (5-ply): Supply wood doors with wood veneer as follows:
1. Grade: Custom with A Grade faces.
 2. Wood Veneer Species Cut and Thickness:
 - a. Species: Birch
 - b. Cut: Plain sliced (flat cut)
 3. Match between veneer leaves: Book match.
 4. Assembly of spliced veneers: Balanced match.

2.07 FABRICATION

- A. Fabricate flush wood doors to comply with following requirements:
1. Factory fit doors to suit frame-opening sizes indicated.
 2. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3 recommended hardware locations for wood flush doors. Comply with final hardware schedules, door frame Shop Drawings, ANSI A115.W Series Standards and hardware templates.
 - a. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before proceeding with factory machining.

2.08 FACTORY FINISHING

- A. General: Comply with ANSI/WDMA 1.S.1A-13 standard's requirements for factory finishing.
1. Factory finish to be water-based stain and ultraviolet (UV) cured polyurethane to comply with EPA Title 5 guidelines for Volatile Organic Compound (VOC) emissions limitations.
- B. Finish wood doors at factory.
- C. Transparent Finish at Wood Veneer Doors: Comply with requirements indicated for grade, finish system, staining effect and sheen.
1. Grade: Premium.
 2. Finish: ANSI/WDMA 1.S.1A-13 System TR-8 UV Cured Acrylated Polyester/Urethane.
 - a. Finish shall be cured using ultraviolet (UV) technology.
 3. Staining: Match existing doors.

4. Effect: Filled finish at open-grain veneers.
5. Sheen: Satin.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine installed door frames prior to hanging door:
 1. Verify that frames comply with indicated requirements for type, size, location and swing characteristics and have been installed with plumb jambs and level heads.
 2. Reject doors with defects.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Hardware: For installation see Section 08 71 00 – Door Hardware.
- B. Manufacturer's Instructions: Install wood doors to comply with manufacturer's instructions and referenced quality standard and as indicated.
- C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- D. Factory-Veneered Doors: Restore finish before installation, if fitting or machining is required at the job site.
- E. Do not install doors until the HVAC system is operating.

3.03 ADJUSTING AND PROTECTION

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Refinish or replace doors damaged during installation.
- C. Protect doors as recommended by door manufacturer to ensure that wood doors will be without damage or deterioration at the time of Substantial Completion.

END OF SECTION

FINISH HARDWARE

SECTION 087100

PART 1 - GENERAL

1.1 SCOPE

- A. Work under this section is comprised of furnishing and installing finish hardware specified herein and noted on the drawings, for a complete and operational system, including any electrified hardware components, systems and controls.
- B. Product and hardware schedule submittals.
- C. Installation and services for all permanent keyed cores and key cabinet setup specified shall be included per the pre-authorized locksmith allowance, as outlined herein.

1.2 RELATED DOCUMENTS

- A. Drawings and general conditions of contract, including general and supplementary conditions, and Division 1-specification sections, apply to this section.

1.3 RELATED WORK

- A. Specified elsewhere that should be examined for its effect upon this section:
 - 1. Section 062000 – Finish Carpentry
 - 2. Section 081100 – Standard Steel Doors & Frames
 - 3. Section 081400 – Wood Doors
 - 4. Division 28 – Electronic Access Control and Intrusion Detection

1.4 HARDWARE COMPLIANCE

- A. Provide only hardware that has been tested and listed by UL for types and sizes of doors required and complies with requirements of door and door frame. All hardware used on fire labeled openings will be listed for those types of openings and bear the identifying label indicating UL (Underwriter's Laboratories) approved for use on fire doors.

- B. All hardware specified herein will be in compliance with:
1. NFPA-80 - Standard for Fire Doors and Windows
 2. NFPA-101- Life Safety Code
 3. ADA, the Americans with Disabilities Act – title III – Public Accommodations
 4. ANSI-A 117.1 – American National Standards Institute – Accessible and Usable Buildings and Facilities
 5. UL – Underwriter’s Laboratories
 6. WHI – Warnock Hersey International, Division of INCHAPE Testing Services
 7. TAS -Texas Accessibility Standards
 8. State and local codes including authority having jurisdiction

1.5 GENERAL

- A. Installation of finish hardware is by SECTION 062000: Finish Carpentry. Hardware will be fitted prior to the painting and then removed. After painting is completed, final installation of the hardware will be made.
- B. Finish hardware must be neatly and properly installed in accordance with the best practices as approved by AISD or an AISD designated representative. All hardware must be thoroughly clean when it is turned over to AISD.
- C. No extra cost will be allowed because of changes or corrections necessary to facilitate the proper installation of any hardware. The General Contractor will be responsible for the proper fabrication of all work or materials to receive the hardware.
- D. Any specified hardware not specifically mentioned herein will be called to the attention of the Architect during the bidding period so that an addendum may be prepared to cover such items. It will be the responsibility of the successful bidder to furnish all required finish hardware, whether or not herein mentioned, unless excluded from this section of the specifications.

- E. "AISD facilities operate in multiple security modes and change modes independently. The AISD Police Department has no interest in electronic "programming" of its approximately 2,500 card access doors. Changing of security modes is handled at the facility using mechanical means. This allows facility managers to lock the facility all-the-time, unlock doors during peak-traffic-periods, or lock doors only evenings/weekends. Security modes can, in this way be modified immediately at the discretion of Principals/facility managers."

1.6 QUALIFICATIONS

- A. The finish hardware supplier will be a person or firm technically proficient and experienced in this trade, who has been furnishing "Institutional Grade" hardware in the Austin area or within a fifty (50) mile-radius for not less than five (5), years and will be responsible for properly detailing and fitting material to the conditions required by the Drawings.
- B. Hardware supplier to be a qualified "direct distributor" of the products to be furnished. In addition, the supplier is to have, in their employment, an A.H.C. representative, certified by the "Door and Hardware Institute", who will be made available at reasonable times to consult with the Architect, Contractor and AISD Project Manager, regarding any matters affecting the finish hardware.
- C. Installer for mechanical hardware shall have a minimum of 2 years of experience of installing architectural finish hardware and attend a pre-installation meeting with the manufacturer's representative of locks, exit devices and closers.
- D. Installer for electrified hardware shall have a minimum of 3 years of experience of installing electrified architectural hardware and attend a pre-installation meeting with the manufacturer's representative of the electrified locking devices.
- E. Installer of permanent keyed cores and services to setup key cabinet shall be only from one of the following AISD pre-authorized locksmith dealers.
 - 1. Advanced Lock Solutions, Inc. 512-933-0300
 - 2. Hidell Builders Supply 512-459-7692
 - 3. Fairway Supply 512-452-6300

1.7 SUBMITTALS^{air}

- A. Hardware Schedule: in a prudent and timely manner, submit copies of schedule in accordance with Division 1, General Requirements.

Schedule will be in “vertical format”, listing each door opening, including handing of opening, all hardware scheduled for opening or otherwise required to allow for proper function of door opening as intended, and finish of hardware.

- B. Submit manufacturer’s cut sheets on all hardware items.
- C. Submit a sample of each lockset, with lever handles and any specially identified hardware, if requested by AISD. Samples will be returned after review, for use on this project.
- D. The General Contractor will deliver finish hardware templates to and coordinate with related door and frame suppliers.
- E. System diagrams: provide complete systems diagrams, including elevation drawings, for each opening requiring electrified hardware, except openings where only magnetic hold-open devices are specified. Supply one copy with delivery of hardware to jobsite.
- F. Operational descriptions: provide complete operational descriptions of electronic components listed by opening in the hardware submittals. Operational descriptions (electronic hardware and systems) to detail how each electrical component functions within the opening, incorporating all conditions of ingress and egress. Provide a copy with delivery of hardware to the jobsite.
- G. The General Contractor will furnish to Owner’s Representative one complete copy of installation instructions and maintenance guides on all hardware, both electrical and mechanical.

1.8 DELIVERY, HANDLING, AND PACKAGING

- A. Furnish all hardware to the jobsite securely boxed, bagged, wrapped or packaged with each unit clearly marked and numbered in accordance with the hardware schedule. Include door and item number for each.
 - 1. Each delivery will be accompanied by a Dray Ticket listing the items by schedule item number, door opening number from the architectural plans, or description correlated to the hardware schedule.
- B. Pack each item complete with all necessary parts and fasteners. Include whatever information may be necessary to show compliance with

requirements, and include instructions for installation and for maintenance of operating parts and finish. Transmit copy of applicable data to Installer.

- C. Hardware supplier is responsible for setting-up the hardware on the site, in a suitable, dry and secure room, provided by the General Contractor.

1.9 WARRANTY

- A. Provide warranty that all items furnished under this section of the specification will be free of defects in material and workmanship and will perform the services for which it was intended for a period of one (1) year (door closers, thirty (30) years, exit devices five (5) years) after substantial completion. Replace, repair or adjust any items not fulfilling this warranty at no further expense to AISD.

1.10 TEMPLATES

- A. The General Contractor will furnish, in a timely manner, finish hardware templates to each supplier or fabricator of doors, frames, and other work to be factory-prepared for the installation of hardware. Contractor will check the shop drawings of such other work, to confirm that adequate provisions are made for the proper installation of hardware, with all specified operating characteristics and clearances.

1.11 KEY CONTROL

- A. On all new schools, additions and remodels requiring more than thirty locksets, furnish and install one complete wall key cabinet with lock and with sufficient hooks for all the cylinder locks, padlocks and cabinet locks for the entire school building, plus 50% for extra and miscellaneous keys. The system will be what is known as the double tag system. The file key has a tag of a different color from the duplicate key. All keys have a fiber tab. Also provide system with triple cross index, collection envelopes, receipt forms, etc.

1.12 KEYING

- A. The General Contractor must be coordinated through the AISD Service Center Locksmith Coordinator (512) 414-3298, and the AISD Project Manager assigned to the project.

- B. All locks requiring mortise cylinders, locks requiring rim cylinders, tubular locks, panic devices, cylindrical locks, and padlocks to be grandmaster keyed in the set to be acted upon by existing AISD grandmaster keys, control keys and a master key that are already established for this facility or shall be grandmaster keyed in the set to be acted upon by new AISD BEST grandmaster system and a new master key that will be established for this facility.
1. On additions or remodeling to existing schools, Hardware Supplier will verify with the AISD Service Center Locksmith Coordinator (512) 414-3298 for the matching of key system with existing campus master key system or the use of new interchangeable core master key system in the new BEST Cormax interchangeable core grandmaster key system.
- C. Two or more doors entering the same room will be keyed alike in one set for the room.
- D. Locks will be further master keyed, sub-mastered, sub-sub-mastered, keyed alike or otherwise keyed as directed by AISD. Hardware supplier will not place the order with the manufacturer until the keying schedule has been approved in writing by AISD
- E. All grandmaster, master and control keys will be delivered direct to The Service Center Lockshop by the lock manufacturer to the attention of the AISD Locksmith Coordinator.
- F. All locks will be supplied with construction cores.
- G. Permanent cores shall be installed only by an AISD pre-authorized locksmith dealer as outlined in Section 087100 1.6 paragraph E; upon completion of the facility and at request from AISD Project Manager.
1. At the time of installation of permanent cores, keys will be cataloged and placed in key cabinet. Provide complete instruction to the school administration on how key system and key cabinet is set up.
 2. The charges for the following services are included in the base bid, as part of Section 087100- Finish Hardware.:
 - a. Project site visit billed at \$90.00 per round trip.
 - b. Core installations billed at \$8.00 per core on any quantity.
 - c. Complete key cabinet setup and key system instruction to campus administration billed \$250.00 per project of 1 to 100.

- d. Complete key cabinet setup and key system instruction to campus administration billed \$325.00 per project of 101 or more.
3. The charges for the following services are not included in the base bid, as part of Section 087100-Finish Hardware. Utilize unit prices as follows:
 - a. \$15.00 drill charge for construction cores that can't be extracted with the construction control key.
 - b. \$85.00 per hour labor fee for any agreed upon additional services not specified herein.
- I. Contact the Hardware Supplier somewhere around (60) to (90) days before the anticipated installation date of the permanent key system to ensure the following:
 1. Cores have been purchased for the job.
 2. A BEST Lock Company Key System Specialist is contacted in writing to set up the key system directly with the AISD Service Center Locksmith.
 3. BEST Lock Co. is given an approximate date for core installation.
- J. The prime contractor shall contact the AISD Project Manager and the AISD Service Center Locksmith Coordinator somewhere around (60) to (90) days before the anticipated installation date of the permanent key system to provide the following:
 1. A labeled floor plan with all the openings involving keying identified with the same architectural information that was supplied to BEST Lock Co.
 2. A hardware schedule of all the openings involving keying.
- K. AISD Pre-authorized Locksmith dealer must be contacted (60) to (90) days before the anticipated installation date of the permanent key system to ensure the following.
 1. Contract issued for permanent core installation and key cabinet setup agreed upon.
 2. Tentative scheduled dates for core installation and key cabinet setup are agreed upon.
- L. Contact permanent core Supplier 30 days prior to installation to confirm that the permanent keying package will be deliverable at the approximate installation date.

- M. As soon as a definite installation date can be determined, at least 5 working days prior to installation, contact the AISD pre-authorized locksmith dealer to schedule the core installation.

1.13 OPERATION AND MAINTENANCE DATA

- A. Provide Owner with manufacturer's parts list and maintenance instructions under provisions of the General Conditions, for each type of hardware supplied and necessary wrenches and tools required for proper maintenance of hardware

PART 2 - PRODUCTS

2.1 HARDWARE

- A. Provide items as listed in schedule at end of this section, complete to function as intended.
 - B. Items include but are not limited to the following:
 1. Levers and Trim
 2. Locks and Latches
 3. BEST Cormax– Cylinders, Cores and Keying
 4. Door Closers
 5. Hinges, Continuous Hinges and Pivots
 6. Exit devices
 7. Mullions
 8. Flush bolts
 9. Door silencers
 10. Stops, overhead controls
 11. Kick plates
 12. Push/pull plates
 13. Thresholds, gasketing, and door bottoms
 14. Miscellaneous trim and accessories
 15. Electrified hardware, power supplies, system diagrams

2.2 ACCEPTABLE MANUFACTURERS

- A. The numbers and symbols used herein, establish the quality, merit, and function required and have been selected from the following manufacturers:

LCN
Glynn-Johnson Corporation
Hager Hinge Co.
Stanley
PHI
BEST Lock Co.
Falcon Lock Co.
Trimco
Von Duprin
H. B. Ives
National Guard Products
Select Products

- B. Goods of equal quality and merit will be accepted from the following manufacturers:

McKinney Manufacturing Co.
Stanley Commercial - Closers
Precision (PHI)
Pemko
Zero International

2.3 FINISHES

- A. US 26 D DULL CHROME or US-32D Stainless Steel unless otherwise noted
- B. All exposed hardware will be dull chrome (US 26 D) finish unless otherwise noted. Closers will be powder coated epoxy enamel to match adjacent hardware finish

2.4 FASTENINGS

- A. As required for finished installation
- B. Hardware furnished under this section of the specifications will be complete with all necessary screws, bolts, anchors, adapter brackets or other fastenings for proper application. Such fastenings will be of suitable size and type, and will harmonize with hardware as to material and finish and as the manufacturer supplies with their products. Stops, thresholds and holders will be fastened to concrete with steel drop-in anchors and to doors with sex bolts. All closers and exit devices will be thru-bolted.
- C. Utilize screws and installation tools provided with the hardware. No other screws or attachments are acceptable. Self-taping screws will not be accepted unless provided by the manufacturer.

2.5 LEVERS AND TRIM

- A. Levers will be cast or forged solid brass (dull chrome US 26 D or 626), or stainless steel (US 32 D or 630). Zinc alloys or pot metal material will not be acceptable.
- B. Roses for use with levers will be wrought brass or stainless steel, and will have built-in dead stops. Roses shall have concealed springs, or trim cassettes, to keep lever from sagging.

2.6 LOCKS AND LATCHES

- A. BEST 45H; FALCON – MA Series (no substitutions)
- B. (See Item 2.19 concerning substitutions)
- C. Will be of the mortise type only. All locksets, latchsets, electrified locksets, cylinders, and trim to be of one manufacturer as hereafter listed for continuity of design and consideration of warranty.
- D. Case will be of .090 gage Cold formed steel, zinc dichromate plated: 6" high by 4-1/4" wide by 1" wide with post indexed trim.
- E. Front will be armored, wrought brass, bronze or stainless steel, adjustable for door bevel, reinforced by heavy gauge steel with stabilizing ribs, fastened by machine screws. Fronts will be 8" x 1-1/4" in size.
- F. Strikes will be ASA size of stainless steel, brass or bronze with lips of length to protect all jamb trim but will be no longer than so required. Provide and install stamped box strikes at all locations.
- G. Deadbolts will be no less than 1" projection. Construction shall be either solid brass or bronze, chrome plated, with two hardened free-floating steel pins, or solid stainless steel to prevent sawing
- H. Backset will be 2-3/4".
- I. Hubs will be stainless powdered metal or forged brass or hardened steel. Lever action will be balanced mechanically to provide equal pressure on knob in either direction to actuate the latch bolt.
- J. Springs will be a coiled spring for latch bolt return and a coiled torsion spring for hub return.

2.7 CYLINDERS, CORES AND KEYING

- A. Cylinders will be Falcon or BEST Lock Co. as required, keyed to an existing AISD grandmaster and control system; or New AISD BEST Lock Cormax patented key system grandmaster and control system. (No exceptions).
- B. Furnish all locks & cylinders as follows: All mortise locks, panic devices, cylindrical locks, and padlocks to be keyed to an existing AISD grandmaster key and control keys or New BEST Lock Co. Cormax grandmaster key and control keys. Establish a new master key for new facilities. Match existing master keys of existing facilities for additions and renovations as directed by AISD Service Center Locksmith Coordinator. Keying of new BEST Cormax shall be coordinated with BEST Access Systems' Key System Specialist and as directed by AISD Service Center Locksmith Coordinator.
- C. Furnish construction master keys & control keys as listed or per the attached hardware schedule.
 - 1. Furnish (10) each construction master keys.
 - 2. Furnish (6) each construction control keys.
- D. All permanent keyed cores for existing Falcon systems will be Falcon Lock Co. with Best* style capping cores part number CB 807 626 as required.
- E. All existing Falcon systems to receive permanent cut keys and master keys, Falcon Lock Co. standard part number KB718 as required. Furnish 2 each cut keys or 2 each blank keys per core as directed by AISD Service Center Locksmith Coordinator. Furnish 15 each master keys per system. Furnish no control keys.
- F. All permanent cores and cut keys shall have "VKC' visual key control using standard Door and hardware Institute keying system nomenclature or as required by AISD Service Center Locksmith Coordinator.
- G. All permanent cores, cut keys, grandmaster and master keys and control keys shall be shipped directly from the manufacturer to Austin ISD Service Center, 5101 E. 51st Street, Austin, Texas 78723, Attn. Lockshop.
- H. Each new keying system, and expansion of existing key systems shall be importable to BEST KeystoneWeb by project, code and door schedule.

2.8 DOOR CLOSERS

- A. LCN 4041 or Stanley Commercial QDC100
- B. All door closers, unless otherwise specified or shown on the Drawings, will be heavy duty, surface mounted, full rack and pinion liquid (hydraulic) type, with cast iron cylinders, capable of controlling door through 180 degrees of swing. Provide full covers of non-ferrous, non-corrosive material painted to match the adjacent hardware finish.
- C. Surface closers will be adjusted by key valves. Furnish six (6) adjusting keys. Spring power of each closer will be adjustable, and will be capable of meeting handicapped accessibility code requirements.
- D. No closer will be installed on the outside of any exterior door or on the corridor side of any room door. Wherever it is necessary to install a closer on the side of a door away from the butts, a parallel arm will be used. Corner or soffit brackets will not be permitted. Corridor installation is acceptable where abutting walls prevent normal installation. All fastenings to the door will be by sex bolts.
- E. Closers to have adjustable spring power, which allows for closer sizing. Closers to have separate tamper resistant, non-critical regulating hydraulic screw valves for closing speed, latching speed, and back check control as a standard feature.
- F. All parallel arms will be extra heavy-duty solid forged steel (EDA Extra Duty Arm). All closers, without exception, will be installed to 180° door swing specifications. Closers shall not have soffit stops.
- G. All door closers must be covered by a thirty-year factory warranty [limited lifetime warranty] against defective material or workmanship.
- H. The successful bidder is required to keep in touch with the progress of the job and have a factory trained representative visit the job prior to installation to train the General Contractor's installer on proper techniques and once again insure that all closers are properly adjusted at completion of the installation. Closers will be re-inspected and adjusted by the General

Contractor, at no cost to AISD, one month prior to the expiration of the one-year warranty period.

2.9 CONTINUOUS HINGES

- A. Continuous hinges – Select Products SL-24HD as indicated in hardware schedule or Stanley equivalent.
- B. Continuous hinges shall be manufactured of 6063-T6 aluminum alloy with anodized finish. All hinge profiles shall be manufactured to template screw locations, with heavy duty patterns identical as to number and placement of holes.
- C. Hinge profiles to be heavy duty with bearing configurations at 2 9/16” spacing with a minimum of 32 bearing.
- D. Hinge fasteners shall be 410 stainless steel, brite hardened and plated.
- E. Continuous hinges shall be warranted for the life of the opening.

2.10 HINGES

- A. (BUTTS) BB1279 or BB1168 Series Hager (or Stanley equivalent)
- B. Hinges will be five-knuckle, standard or heavy-duty, ball bearing, button-tip, full mortise template type hinges, and equal to Hager BB1279 or BB1168 Series. Electric hinges equal to Hager ETW 6 wire hinge are acceptable in grouted jamb hollow metal frame conditions.
- C. At labeled doors, or doors with closers, provide steel (painted) bearing-type hinges.
- D. Exterior door hinges will be of steel (painted) with non-removable pins, or will have pins held in place by a set screw which can only be removed while the door is open.
- E. Provide heavyweight hinges on all openings with high frequency usage as indicated in the hardware schedule.
- F. Hinges (butts) will be of the class as indicated by manufacturer's number in the hardware sets. All hinges will have sufficient throw to clear the door trim, plinth, or cove base, but will have no more throw than is necessary.
- G. Hinges will be sized as follows:

1. Doors 3'-0" wide or less: 4-1/2" x 4-1/2" (1-1/2 pair hinges)
2. Doors over 3'-0" wide: 4-1/2" x 4-1/2" (2 pair hinges)

H. Quantity of hinges per door will be as follows:

1. Door up to 60" in height 1 pair (2)
2. Door up to 90" in height 1-1/2 pair (3)
3. Door over 90" in height 1 additional hinge for every 30" or fraction thereof.

2.11 EXIT DEVICES

A. Von Duprin #99 Series finish as follows:

1. Housing US 28 (628) brushed aluminum
2. Push Pad US 32 D (630) stainless steel
3. Exterior Pull US 26 D (626) dull chrome

B. PHI 2000 Series finish as follows:

1. Housing US 32 D (630) stainless steel
2. Push Pad US 32 D (630) stainless steel
3. Exterior Pull US 26 D (626) dull chrome

C. All devices will be manufactured by Von Duprin or PHI – no substitutions. Devices will be Von Duprin Touch Bar 99 series or PHI 2000 series. Electrified devices and trim to be the same series and design as mechanical devices and trim. All devices must have dead locking latches for better security.

D. Vertical rod exit devices will not be accepted.

E. All exit devices for fire rated labeled doors **and labeled frame assemblies** will bear the UL label for "fire exit hardware". All devices will comply with NFPA 80 and NFPA 101 requirements.

2.12 MULLIONS

A. Von Duprin # 9954 at all openings, rated or non-rated – or PHI KR822 at non-fire rated openings, or PHI FLKR822 at fire rated.

- 2 Removable mullions will be 2" x 3" steel, with sprayed aluminum (SP 28) finish, Provide a set of stabilizers per pair of doors. Removable mullions will be installed at specially designated doors, as indicated on the floor plan or hardware schedule.
- 3 Only certain mullions as determined by AISD shall be key removable. Provide non-keyed, dummy cylinders at other locations.

2.13 FLUSH BOLTS

- A. Trimco # 3917
- A. Edge mount all flush bolts unless specifically noted to be face mounted. The rod for the top bolt will be at least 12". Flush Bolts will be UL listed equal to Trimco # 3917 (Cast).
- B. Provide Flush bolts with dust proof strikes as indicated in the individual hardware sets.
- C. Provide frame-stop type coordinators with filler bars and brackets for proper installation / coordination with adjacent hardware.

2.14 DOOR SILENCERS

- A. IVES #SR64 or Glynn-Johnson #GJ64.
- B. Furnish door silencers for all interior doors (except gasketed doors); SR64 for doors with metal jambs. Furnish three (3) silencers for each single door – four (4) silencers for each pair of doors.

2.15 DOOR STOPS

- A. Interior: Trimco #1214 (1-3/4")
- B. Exterior: Trimco #1214H (2-1/4")
- C. Wall Mounted: Trimco #1209W
- D. Door stops are to be furnished for every door leaf, unless otherwise indicated in the hardware schedule. No substitutions accepted.
- E. When possible, door stops should be wall mounted.

- F. Place door stops in such a position that they permit maximum door swing, but do not present a hazard or obstruction. All floor mounted door stops will be installed using flush bolts and steel drop-in anchors manufactured by Ramset or Red Head: Anchors will be set at least one inch into the concrete. Lead anchors will not be allowed. Floor stops shall be placed as far from the hinge edge of the door so as to not allow a trip hazard.
- G. Exterior door stops, when possible, should be wall mounted on a wing wall or recess that acts to stop the door from swinging more than 90 degrees from the closed position. If wing walls are not possible to construct, the alternative floor mounted stop is to be provided, with appropriate railing to prevent a tripping hazard.
- H. Overhead holders (as scheduled) shall be Glynn-Johnson #GJ70-series at exterior and #GJ450 series at interior. Install with thru-bolts and grommet nuts.

2.16 KICK PLATES

- A. Kick plates will be of 1/8" thick Textolite, Formica, Micarta or Bakelite and will be 10" high by width of door less 2". Where louvers or other construction prevents use of 10" kick plate, 8" may be used. Color: Gray.
- B. For doors with louvers or narrow bottom rails, kick plate height to be 1" less than the dimension shown from the bottom of door to the bottom of the louver or glass.

2.17 PUSH/PULL PLATES

- A. Push Plates: Trimco #1001-3
- B. Pull Plates: Trimco #1013-3
- C. Push plates and pull plates finish to match door hardware. (Provide thru-bolt mounting for all pull plates)

2.18 THRESHOLDS AND GASKETING

- A. Provide materials and finishes as listed in the hardware schedule or as shown on the Drawings. All thresholds must be in accordance with the requirements of ANSI A117.1 and the ADA. If no thresholds or gasketing is specified, provide thresholds and complete gasketing at all exterior doors, and smoke seals at all interior fire rated doors as follows:
 - 1. Weatherstrip NGP #120NA – 628

2. Smoke Seal NGP #5050 – Brn
 3. Threshold NGP #425 “SIA” – 628 or NGP #896V “SIA” – 628
 4. Bottom NGP #200NA – 628
 5. Auto Bottom NGP #420NA – 628
 6. Astragal NGP #137NA (2pc) –628
- B. Provide overhead rain drips at all exterior doors without canopy protection. Width shall be door-frame width plus 6”.
1. Overhead Rain Drip NGP #16AD
- C. Provide thresholds with machine screws and steel anchors, and all necessary anchoring devices for weather-stripping and seals.

2.19 PRODUCT STANDARDS / SUBSTITUTIONS

- A. Unless otherwise approved in writing, provide only the specified products.
- B. All requests for substitutions must be made prior to bid in accordance with Division 1, General Conditions, and are to be in writing, and delivered to the Architect. Requests will be evaluated by AISD Lock Shop Coordinator. Decisions will be issued through the Project Manager to the Architect. All requests must be accompanied by (2) copies of the manufacturer’s brochures and a physical sample of each item in the appropriate design and finish. No substitutions shall be made after bid date, unless manufacturer specified cannot supply specified product.

2.20 ELECTRONIC HARDWARE AND SYSTEMS

- A. Selected exterior and interior doors are required to have “card-reader” access per AISD requirements in locations as noted.
- B. Von Duprin Electric Latch Retraction 99 series devices with the Special Center Case Dogging option shall be installed with Von Duprin power transfer EPT10 wired to Von Duprin power supply PS873-2 at selected exterior entrance doors. The use of electric hinges is acceptable at specific locations where existing jamb frames are fully grouted. Substitute PHI Electric Latch Retraction, power transfer and power supplies.
- C. Falcon LM881 Series fail-secure storeroom function electrified mortise locks shall be installed with Von Duprin power transfer EPT10 or electric

hinge at exterior kitchen doors and interior card reader controlled doors. The lock shall provide for free egress from the secured space at all times. Provide power supplies for electrified mortise locks. Substitute BEST lock, PHI power transfer.

- D. Von Duprin Electric Strike 6111 or 6211 shall be installed at interior or exterior doors where other electronic hardware may not be practical. The Owner shall review and approve all electric strike applications. Provide power supplies for electrified strikes. Substitute HES or RCI.
- E. Section 281300 will provide card readers, door position switches, and other access control system equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Hardware installers shall be professional hardware installers with ten years of documented hardware installation experience. Contractor shall submit hardware installer's names and experience qualifications to Architect and Owner for review and approval prior to start of hardware installation.
- B. Check hardware against the reviewed hardware schedule upon delivery. Do not install hardware when it is apparent that the scheduled hardware will not function properly for the application for which it was intended. Contact the Architect immediately for clarification, and correction of the application – prior to installation of the incorrect hardware.
- C. Finish hardware installed prior to the building being “dried in” and “climate conditioned”, which shows any signs of rusting, wear or abuse, will be subject to rejection by the Architect or AISD Project Manager. Any such rejected hardware will be replaced, at no cost to AISD, by the General Contractor.
- D. Mount hardware units at heights recommended in “Recommended Location for Builders’ Hardware” by BHMA, except as otherwise specifically indicated or required to comply with governing regulations, including ADA and the Accessibility Standards of the Architectural Barriers Act Article 9102, of the Texas Civil Statutes, except as may be otherwise directed by the Architect. Use only the fasteners supplied by the manufacturer. All fastening points will be used.
- E. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, install each item completely and then remove and

store in a secure place during the finish application. After completion of the finishes, re-install each item. Do not install surface-mounted items until finishes have been completed on the substrate. The use of cardboard shim stock is prohibited.

- F. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation. Mortise and cutting to be done neatly, and evidence of cutting to be concealed in the finished work.
- G. Drill and countersink units that is not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- H. Mount door stops using plated, flathead screws and steel drop-in anchors.
- I. Take care when using cleaning chemicals around finish hardware so as not to damage the finish.
- J. Architect, AISD and Finish Hardware Supplier shall inspect completed hardware installation and operation upon completion of hardware installation. Hardware installer shall correct any installation deficiencies noted during this inspection.
- K. Permanent keyed core
 - 1. Installation and key cabinet system installation will be completed only by AISD pre-authorized locksmith dealers.

3.2 FINAL ADJUSTMENT

- A. Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make a final check and adjustment of all hardware items in such space or area. Clean and re-lubricate operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.
- B. Instruct Owner's personnel in proper adjustment and maintenance of hardware during the final adjustment of hardware.
- C. Door closers will be adjusted by a carpenter trained by the hardware supplier trained personnel at completion of installation and again one month

prior to expiration of the Contractor’s one-year anniversary of substantial completion.

3.3 FIELD QUALITY CONTROL

After installation has been completed, obtain the services of a qualified hardware consultant to check for proper application of finish hardware, according to the finish hardware schedule, keying schedule and specifications. In addition, check all hardware for adjustments and proper operation. A complete report of any omissions, errors and general condition of installation shall be submitted to AISD Office of Construction Management.

3.4 HARDWARE SCHEDULE

HARDWARE GROUP NO. 205

FOR USE ON MARK/DOOR #(S):

208 326 328

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HW HINGE	5BB1HW 4.5 X 4.5 NRP	600	IVE
1	EA	STOREROOM LOCK	MA581-L/C SG	626	FAL
1	EA	CYLINDER	AS REQUIRED	626	BES
1	EA	SURFACE CLOSER	4040XP EDA SNB	689	LCN
1	EA	KICK PLATE	6000 10" X 2" LDW		TRI
1	EA	FLOOR STOP	1214H	626	TRI
1	EA	DRIP CAP	16A	CL	NGP
1	SET	SEALS	120NA H&J	CL	NGP
1	EA	DOOR SWEEP	200NA	CL	NGP
1	EA	THRESHOLD	425 SIA	CL	NGP

GENERAL CONTRACTOR/HW SUPPLIER FIELD-VERIFY PRIOR TO BID DATE. NEW HARDWARE TO BE INSTALLED ON EXISTING FRAME. ADVISE ARCHITECT OF ANY INCOMPATIBILITY. IN SUBMITTAL PROVIDE NAME, COMPANY AND DATE OF FIELD VERIFICATION.

HARDWARE GROUP NO. 303

FOR USE ON MARK/DOOR #(S):

313R

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK	MA311 OCCUPIED/VACANT SGM	626	FAL
1	EA	OH STOP	90S	630	GLY
3	EA	SILENCER	SR64	GRY	IVE

GENERAL CONTRACTOR/HW SUPPLIER FIELD-VERIFY PRIOR TO BID DATE. NEW HARDWARE TO BE INSTALLED ON EXISTING FRAME. ADVISE ARCHITECT OF ANY INCOMPATIBILITY. IN SUBMITTAL PROVIDE NAME, COMPANY AND DATE OF FIELD VERIFICATION.

HARDWARE GROUP NO. 553

FOR USE ON MARK/DOOR #(S):

101	102	103	104	105	106
201	202	203	204	205	206

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CLASSRM SEC LOCK	MA441-L/C SG	626	FAL
2	EA	CYLINDER	AS REQUIRED	626	BES
1	EA	WALL STOP	1209W	626	TRI
3	EA	SILENCER	SR64	GRY	IVE

GENERAL CONTRACTOR/HW SUPPLIER FIELD-VERIFY PRIOR TO BID DATE. NEW HARDWARE TO BE INSTALLED ON EXISTING FRAME. ADVISE ARCHITECT OF ANY INCOMPATIBILITY. IN SUBMITTAL PROVIDE NAME, COMPANY AND DATE OF FIELD VERIFICATION.

HARDWARE GROUP NO. 714CM

FOR USE ON MARK/DOOR #(S):

128

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY	628	IVE
2	EA	MULLION STABILIZER	154	689	VON
1	EA	REMOVABLE MULLION	KR4954 HEIGHT AS REQ	689	VON
1	EA	PANIC HARDWARE	99-DT-990	628	VON
1	EA	PANIC HARDWARE	99-NL-990	628	VON
1	EA	R. CYLINDER	AS REQUIRED	626	BES
1	EA	M. CYLINDER	AS REQUIRED	626	BES
2	EA	SURFACE CLOSER	4040XP EDA SNB	689	LCN
2	EA	KICK PLATE	6000 10" X 2" LDW		TRI
2	EA	FLOOR STOP	1214H	626	TRI
1	EA	DRIP CAP	16A	CL	NGP
1	SET	SEALS	120NA H&J	CL	NGP
1	EA	MULLION SEAL	5100	BLK	NGP
1	EA	DOOR SWEEP	200NA	CL	NGP
1	EA	THRESHOLD	425 SIA	CL	NGP

COORDINATE KICKPLATE HEIGHT AT BOTTOM OF FULL GLASS DOORS

GENERAL CONTRACTOR/HW SUPPLIER FIELD-VERIFY PRIOR TO BID DATE. NEW HARDWARE TO BE INSTALLED ON EXISTING FRAME. ADVISE ARCHITECT OF ANY INCOMPATIBILITY. IN SUBMITTAL PROVIDE NAME, COMPANY AND DATE OF FIELD VERIFICATION.

HARDWARE GROUP NO. 714EM

FOR USE ON MARK/DOOR #(S):

327

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HW HINGE	5BB1HW 4.5 X 4.5 NRP	600	IVE
2	EA	MULLION STABILIZER	154	689	VON
1	EA	KEYED FIRE RATED REMOVABLE MULLION	KR9954	689	VON
1	EA	PANIC HARDWARE	99-DT LENGTH AS REQ	628	VON
1	EA	PANIC HARDWARE	99-NL LENGTH AS REQ	628	VON
1	EA	R. CYLINDER	AS REQUIRED	626	BES
1	EA	M. CYLINDER	AS REQUIRED	626	BES
2	EA	SURFACE CLOSER	4040XP EDA SNB	689	LCN
2	EA	KICK PLATE	6000 10" X 2" LDW		TRI
2	EA	FLOOR STOP	1214H	626	TRI
1	EA	DRIP CAP	16A	CL	NGP
1	SET	SEALS	120NA H&J	CL	NGP
1	EA	MULLION SEAL	5100	BLK	NGP
2	EA	DOOR SWEEP	200NA	CL	NGP
1	EA	THRESHOLD	425 SIA	CL	NGP

GENERAL CONTRACTOR/HW SUPPLIER FIELD-VERIFY PRIOR TO BID DATE. NEW HARDWARE TO BE INSTALLED ON EXISTING FRAME. ADVISE ARCHITECT OF ANY INCOMPATIBILITY. IN SUBMITTAL PROVIDE NAME, COMPANY AND DATE OF FIELD VERIFICATION.

HARDWARE GROUP NO. 715

FOR USE ON MARK/DOOR #(S):

200

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112XY	628	IVE
1	EA	PANIC HARDWARE	99-NL LENGTH AS REQ	628	VON
1	EA	R. CYLINDER	AS REQUIRED	626	BES
1	EA	SURFACE CLOSER	4040XP EDA SNB	689	LCN
1	EA	KICK PLATE	6000 10" X 2" LDW		TRI
1	EA	FLOOR STOP	1214H	626	TRI
1	EA	DRIP CAP	16A	CL	NGP
1	SET	SEALS	120NA H&J	CL	NGP
1	EA	DOOR SWEEP	200NA	CL	NGP
1	EA	THRESHOLD	425 SIA	CL	NGP

GENERAL CONTRACTOR/HW SUPPLIER FIELD-VERIFY PRIOR TO BID DATE. NEW HARDWARE TO BE INSTALLED ON EXISTING FRAME. ADVISE ARCHITECT OF ANY INCOMPATIBILITY. IN SUBMITTAL PROVIDE NAME, COMPANY AND DATE OF FIELD VERIFICATION.

END OF SECTION 087100

SECTION 08 80 00 – GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Glass and glazing for doors, transom lites.

1.02 RELATED SECTIONS

- A. Section 08 12 14 – Standard Steel Frames.
- B. Section 08 13 14 – Standard Steel Doors.

1.03 REFERENCES

- A. ASTM International:

1. ASTM C162 – Standard Terminology of Glass and Glass Products.
2. ASTM C864 – Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks and Spaces.
3. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
4. ASTM C1036 – Standard Specification for Flat Glass.
5. ASTM C1048 – Standard Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass.
6. ASTM C1193 – Standard Guide for Use of Joint Sealants.
7. ASTM E546 – Standard Test Method for Frost Point of Sealed Insulating Glass Units.
8. ASTM E576 – Standard Test Method for Frost Point of Sealed Insulating Glass Units in the Vertical Position.
9. ASTM E773 – Standard Test Method for Seal Durability of Sealed Insulating Glass Units.
10. ASTM E774 – Standard Specification for Sealed Insulating Glass Units.
11. ASTM E1300 – Standard Practice for Determining the Minimum Thickness and Type of Glass Required to Resist a Specific Load.

- B. Glass Association of North America:

1. GANA (GM) – FGMA Glazing Manual; Glass Association of North America.
2. GANA (SM) – FGMA Sealant Manual; Glass Association of North America.

- C. Consumer Products Safety Commission, CPSC 16 CFR 1201 – Safety Standard for Architectural Glazing.

1.04 DEFINITIONS

- A. Sealed Insulating Glass Unit Surfaces:
 - 1. Surface 1 – Exterior surface of outer pane.
 - 2. Surface 2 – Interior surface of outer pane.
 - 3. Surface 3 – Interior surface of inner pane.
 - 4. Surface 4 – Exterior surface of inner pane.

1.05 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures.
- B. Product Data on Glass Types Specified: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.
- C. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors.
- D. Manufacturer's Installation Instructions: Indicate special precautions required.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Provide material safety and data sheets on all products.
- G. Verification Samples:
 - 1. Flat Glass Materials: Two 12-inch by 12-inch samples of each glass type specified.
 - 2. Sealed Insulating Glass Units: Two 12-inch by 12-inch samples representative of unit construction.
- H. Quality Assurance/Control Submittals:
 - 1. Design Data: Glass size calculations, prepared in accordance with specified method.
 - 2. Certificates: Contractor's certification that:
 - a. Products of this section, as provided, meet or exceed specified requirements.
 - b. Fabricator of flat glass and sealed insulating glass meets specified qualifications.
 - c. Installer of products of this section meets specified qualifications.

1.06 QUALITY ASSURANCE

- A. Glazing Standards: Comply with recommendations of GANA Glazing Manual and GANA Sealant Manual, except where more stringent requirements are indicated. Refer to those publications for definitions of glass and glazing terms not otherwise defined in this section

or other referenced standards.

- B. Safety Glazing Standard: Where safety glass is indicated or required by authorities having jurisdiction, provide type of products indicated which comply with testing requirements of CPSC 16 CFR Part 1201 for category II materials.
 - 1. Identification of Safety Glazing: Each pane of safety glazing installed in hazardous locations shall be identified in accordance with the building code.
- C. Single-Source Responsibility for Glass: To ensure consistent quality of appearance and performance, provide materials produced by a single manufacturer or fabricator for each kind and condition of glass indicated and composed of primary glass obtained from a single source for each type and class required.
- D. Qualifications:
 - 1. Manufacturer, Flat Glass Materials: Minimum five (5) years of documented experience producing glass products specified in this section.
 - 2. Fabricator of Flat and Sealed Insulating Glass: Minimum five (5) years of documented experience.
 - 3. Installer: Minimum five (5) years of documented experience installing products specified in this section, and approved by fabricator.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Do not install glazing when ambient temperature is less than 50 degrees F.
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.08 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on Shop Drawings.

1.09 COORDINATION

- A. Coordinate the Work with glazing frames, wall openings and perimeter air and vapor seal to adjacent Work.

1.10 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.
- B. Provide ten (10) year warranty to include replacement of sealed glass units exhibiting seal failure, interpane dusting or misting.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Glass Manufacturers: Subject to compliance with requirements, provide products of one

of the following manufacturers:

1. Manufacturers of Flat Glass Materials:
 - a. Vitro Architectural Glass
2. Manufacturers offering equivalent products include but are not limited to:
 - a. AGC Flat Glass
 - b. Pilkington
3. Substitutions: Section 01 60 00 – Product Requirements.

2.02 GLASS FABRICATORS

- A. Subject to compliance with requirements, provide products on one of the following fabricators:
 1. Fabricators of Flat Glass Materials:
 - a. Cristacurva
 - b. Oldcastle Glass
 - c. Tristar Glass, Inc.
 - d. Trulite

2.03 GLASS PRODUCTS – GENERAL

- A. Primary Glass Standard: Provide primary glass which complies with ASTM C1036 requirements, including those indicated by reference to type, class, quality and if applicable, form, finish, mesh and pattern.
- B. Tempered Glass Standard: Provide tempered glass which complies with ASTM C1048 requirements, including those indicated by reference to kind, condition, type, quality, class, and, if applicable, form, finish, and pattern.
 1. Safety Glass: Furnish tempered glass conforming to CPSC 16 CFR 1201, Category II at locations where safety glass is required by the Code. Refer to the contract documents for the applicable code and year.
- C. Sizes: Fabricate glass to sizes required for glazing openings indicated, with edge clearances and tolerances complying with recommendations of glass manufacturer. Provide thicknesses indicated or, if not otherwise indicated, as recommended by glass manufacturer for application indicated.
- D. Provide the same exterior tinted glass from the same manufacturer.

2.04 SEALED INSULATING GLASS UNITS

- A. Fabricate units in accordance with ASTM E774, Class CBA, with components and performance characteristics specified. Insulated Glass Units, Type SIG-A:
 1. Outer Pane
 - a. Glass Type: Vitro Architectural Glass Optigray with Solarban 70XL low-e coating on #2 surface

- b. Glass Color: Gray
 - c. Glass Thickness: 1/4 inch
 - d. Heat Treating
 - 1) Fully tempered
2. Air Space: 1/2 inch wide, hermetically sealed, argon-filled
3. Inner Pane
- a. Glass Type: Vitro Architectural Glass
 - b. Glass Color: Clear
 - c. Glass Thickness: 1/4 inch
 - d. Heat Treating
 - 1) Fully Tempered
4. Performance Characteristics
- a. Transmittance:
 - 1) Ultraviolet: 4 percent
 - 2) Visible: 47 percent
 - 3) Total Solar Energy: 18 percent
 - b. Exterior Reflectance:
 - 1) Visible light: 8 percent
 - c. U-Value:
 - 1) Winter nighttime: 0.28
 - 2) Summer daytime: 0.26
 - d. Shading Coefficient: 0.28
 - e. Solar Heat Gain Coefficient: 0.24
 - f. Light to solar gain: 1.96
5. Provide unit edge seals meeting requirements of ASTM E773, with aluminum spacers having mitered and corners, and silicone sealant for glass-to-spacer seals.

2.05 MISCELLANEOUS GLAZING MATERIAL

- A. Compatibility: Provide materials with proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers and Sealers: Type recommended by sealant or gasket manufacturer.
- C. Setting Blocks: ASTM C864, neoprene, 80 to 90 Shore A durometer hardness; length 4 inches, width of glazing rabbet space less 1/16 inch, height required for glazing method, pane weight and pane area.
- D. Spacer shims: ASTM C864, neoprene, 50 to 60 Shore A durometer hardness; length 3 inches, one half height of glazing stop, thickness required for application, one face self-adhesive.

- E. Glazing Tape: Butyl compound tape with integral resilient tube spacer, 10 to 15 Shore A durometer hardness, black color, coiled on release paper; widths required for specified installation.
- F. Glazing Tape: Closed-cell polyvinyl chloride foam, maximum water absorption by volume 2 percent, designed for 25 percent compression percent for air barrier and vapor retarder seal, black color, coiled on release paper over adhesive on two sides; widths required for specified installation. [Not for storefront/curtain wall]
- G. Glazing Clips: Manufacturer's standard type.
- H. Sealants: Specified in Section 07 90 00.
- I. Silicone Polyester Enamel: Type recommended by flat glass materials manufacturer; color selected by Architect.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that openings for glazing are correctly sized and within tolerance.
- B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions and ready to receive glazing.

3.02 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

3.03 GLAZING – GENERAL

- A. Comply with combined recommendations of manufacturers of glass, sealants, gaskets and other glazing materials, except where more stringent requirements are indicated, including those in referenced glazing publications.
- B. Glazing channel dimensions as indicated on Drawings provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
- C. Protect glass from edge damage during handling and installation as follows:
 - 1. Use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar. Rotate glass lites with flares or bevels on bottom horizontal edges so edges are located at top of opening, unless otherwise indicated by manufacturer's label.
 - 2. Remove damaged glass from Project site and legally dispose of offsite. Damaged glass is glass with edge damage or other imperfections that, when installed, weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by

preconstruction sealant-substrate testing.

- E. Install elastomeric setting blocks in sill rabbets, sized and located to comply with referenced glazing standard, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spaces for glass sizes larger than 50 united inches (length plus height) as follows:
 - 1. Locate spacers inside, outside and directly opposite each other. Install correct size and spacing to preserve required face clearances, except where gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and comply with system performance requirements.
 - 2. Provide 1/8 inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- H. Provide edge blocking to comply with requirements of referenced glazing publications, unless otherwise required by glass manufacturer.
- I. Set glass lites in each series with uniform pattern, draw, bow and similar characteristics.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

3.04 INSTALLATION

- A. Install sealants in accordance with sealant manufacturer's written instructions and recommendations.
- B. Exterior Wet Method (Sealant and Sealant):
 - 1. Place setting blocks at 1/4 points; install glazing unit.
 - 2. Install removable stops; center glass unit in space by inserting spacer shims both sides at intervals of 24 inches; set spacer shims 1/4 inch below sight line.
 - 3. Fill gaps between glazing and stops with sealant to depth equal to bite of frame on glazing and to 3/8 inch below sight line; ensure full contact with glazing for continuity of air and vapor seal.
 - 4. Apply sealant to uniform line flush with sight line. Tool sealant surface smooth.
- C. Installation of glazing in steel frames is specified in Section 08 12 14.
- D. Installation of glazing in steel doors is specified in Section 08 13 14.

3.05 CLEANING

- A. Clean work under provisions of Section 01 70 00.
- B. Remove glazing materials from finish surfaces.

- C. Remove labels after work is complete.
- D. Clean glass.

3.06 PROTECTION OF FINISHED WORK

- A. After installation, mark pane with an "X" by using removable plastic tape or paste.

END OF SECTION

SECTION 09 21 16 – GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tile Backer Board.
- B. Moisture and Mold Resistant Paper Faced Gypsum Board.
- C. Drywall Suspension System.
- D. Mold and Moisture Resistant Joint Treatment.

1.02 RELATED SECTIONS

- A. Section 06 10 53 – Miscellaneous Carpentry: Wood blocking for support of fixtures, equipment and trim.
- B. Section 09 22 16 – Non-Structural Metal Framing: Metal stud framing for walls, partitions, furring, soffits and ceilings.
- C. Section 09 30 00-Tile: Securing tile to tile backer board.
- D. Section 09 90 00 – Painting and Coating: Painting gypsum wall board.

1.03 ASSEMBLY PERFORMANCE REQUIREMENTS

- A. Sound Transmission Characteristics: For gypsum board assemblies with STC ratings, provide materials and construction identical to those of assemblies whose STC ratings were determined according to ASTM E90 and classified according to ASTM E413 by a qualified independent testing agency.

1.04 REFERENCES

- A. ASTM International:
 - 1. ASTM C475 – Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - 2. ASTM C665 – Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - 3. ASTM C834 – Standard Specification for Latex Sealants.
 - 4. ASTM C840 – Standard Specification for Application and Finishing of Gypsum Board.
 - 5. ASTM C919 – Standard Practice for Use of Sealants in Acoustical Applications.
 - 6. ASTM C954 – Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. to 0.112 in. in Thickness.

7. ASTM C1002 – Standard Specification for Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases.
8. ASTM C1177 – Standard Specification for Glass Mat Water-Resistant Gypsum Backing Panel.
9. ASTM C1178 – Standard Specification for Coated Glass Mat Gypsum Backing Panel.
10. ASTM C1396 – Standard Specification for Gypsum Board.
11. ASTM C1658 – Standard Specification for Glass Mat Gypsum Panels.
12. ASTM D3273 – Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environment Chamber.
13. ASTM D3274 – Standard Test Method for Evaluating Degree of Disfigurement of Paint Films by Microbial (Fungal or Algal) Growth or Soil and Dirt Accumulation.
14. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
15. ASTM E90 – Standard Test Method for Laboratory Measurement of Airborne-Sound Transmission Loss of Building Partitions.
16. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.

B. Gypsum Association (GA):

1. GA-214 – Recommended Specification: Levels of Gypsum Board Finish.
2. GA-216 – Recommended Specifications for the Application and Finishing of Gypsum Board.

1.05 PERFORMANCE CHARACTERISTICS

- A. Acoustic Attenuation for Identified Interior Partitions: Refer to Drawings for STC values in accordance with ASTM E90.

1.06 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures.

B. Manufacturer's Literature and Data:

3. Cornerbead and edge trim..
4. Ceiling Suspension System.
5. Finishing materials.
 - a. Provide product data for mold and moisture resistant joint compound and test reports performance under ASTM D3273 and D3274.

6. Gypsum board, each type.

1.07 QUALITY ASSURANCE

- A. Finishing Materials: Obtain finishing materials from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable to gypsum board manufacturer.
- B. Perform work in accordance with GA-214, GA-216 and ASTM C840.

1.08 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the project site with manufacturer's labels intact and legible. Handle materials with care to prevent damage to edges or surfaces.
- B. Store materials indoors under cover, stacked flat to prevent sagging and off the floor, protected from weather, direct sunlight, surface contamination and damage from construction traffic or other causes.
- C. Store adhesives in dry area and protect against freezing.

1.09 PROJECT CONDITIONS

- A. Environmental Conditions, General: Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C840 requirements or gypsum board manufacturer's recommendations, whichever are more stringent.
- B. Maintain a room temperature of not less than 40 degrees F for mechanical attachment of gypsum board. For finishing of gypsum board, maintain not less than 50 degrees F (10 degrees C) for 48 hours before application and continuously after until dry. Do not exceed 95 degrees F (35 degrees C) when using temporary heat sources.
- C. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

PART 2 PRODUCTS

2.01 GYPSUM BOARD PRODUCTS

- A. General: Provide gypsum board of types indicated in maximum lengths available that will minimize end-to-end butt joints in each area indicated to receive gypsum board application.

Note: The use of gypsum wallboard imported, marketed or distributed by a foreign manufacturer will not be allowed.

1. Widths: Provide gypsum board in widths of 48 inches and minimum lengths of 120 inches.
- B. Tile Backer Board: Water-resistant treated core with glass mat moisture-protectant coating and glass mats, both sides. The face is surfaced with heat-cured copolymer water-resistant coating.

1. Acceptable Manufacturers and Products: Subject to compliance with requirements of contract documents, provide products by one of the manufacturers listed below for non-rated assemblies:
 - a. CertainTeed Diamondback GlasRoc Tile Backer.
 - b. Georgia-Pacific Gypsum, LLC: DensShield Fireguard Tile Backer.
 - c. National Gypsum Company: Gold Bond Brand eXP Fireshield Tile Backer, Type X.
 - d. USG: Durock Brand Glass-Mat Tile Backer Board, Type X.
 2. Standards:
 - a. ASTM C1178 – Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel.
 3. Resists the growth of mold when tested, as manufactured, according to ASTM D 3273.
 - a. Panel shall have a score of 10.
 4. Type: Type X.
 5. Size:
 - a. Thickness: 5/8 inch.
 - b. Width: 4'-0".
 - c. Length: 8'-0".
 6. Use mold and moisture resistant joint treatments with this board. Where tile is installed use mortar used to set tile to treat fasteners and panel joints.
 7. Use: Base layer at single layer application.
- C. Moisture and Mold Resistant Paper Faced Gypsum Wall Board: Fire-resistive Type X, ASTM C1396 and as follows:
1. Acceptable Manufacturers and Products: Subject to compliance with requirements of Contract Documents, provide products by one of the manufacturers listed below,for non-rated assemblies unless otherwise noted.
 - a. American Gypsum Company, LLC: M-Bloc 5/8 inch Type X with mold and moisture resistance.
 - b. National Gypsum Co.: Gold Bond XP Fire-Shield gypsum board.
 - c. United States Gypsum Co.: Sheetrock Brand Mold Tough panels, Firecode X.
 2. Edges: Tapered and featured (rounded or beveled) for prefilling.
 3. Thickness 5/8 inch, unless otherwise indicated.
 4. Moisture-resistant treated core with moisture and mold-resistant treated paper facings on front, back and long edges.
 - a. Board shall achieve a score of 10 per ASTM D3273.

5. Use: Base layer at single layer application and ceilings..

2.02 DRYWALL SUSPENSION SYSTEM

- A. General: Provide components complying with ASTM C754 for conditions indicated.
- B. Wire Hangers: ASTM A641, Class 1 zinc coating, soft temper, 12 gauge diameter.
- C. Grid Suspension System for Interior Ceilings: ASTM C635, manufacturer's standard hot-dipped galvanized direct-hung grid suspension system composed of main beams and cross-furring members than interlock to form a modular supporting network.
 1. USG Drywall Suspension System
 - a. Class: Heavy Duty
 - b. Main Tee: DGLW-26 – 12-foot length, 1-1/2 inch face
 - c. Cross Tee: DGLW424 – 4-foot length, 1-1/2 inch face.
 - 1) DGLW224, 2 foot long accessory cross tee, 1-1/2 inch face
 - d. Molding: DGWM-24, 1 inch by 1-1/2 inch by 12 feet long
 - e. DGSC-180 splice clip, for joining two in-line main tees field cut to length, or for joining two grid tees intersecting off module.
 2. Substitutions: Products from the following manufacturers may be submitted:
 - a. Armstrong Drywall Grid System.

2.03 TRIM ACCESSORIES

- A. Accessories for Interior Installation: Cornerbead, edge trim and control joints complying with ASTM C1047 and requirements indicated below:
 1. Material: Formed metal or plastic, with metal complying with the following requirement:
 - a. Steel sheet zinc coated by hot-dip process or rolled zinc.
 2. Shapes indicated below by referenced to Fig. 1 designations in ASTM C1047:
 - a. Cornerbead on outside corners, unless otherwise indicated.
 - b. L-bead with face flange only; face flange formed to receive joint compound. Use L-bead at window openings, door openings, casements and where indicated.
 - c. One-piece control joint formed with V-shaped slot and removable strip covering slot opening equal to USG 093.

2.04 JOINT TREATMENT MATERIALS

- A. General: Provide joint treatment materials complying with ASTM C475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.
- B. Joint Tape for Gypsum Board:

1. At moisture and mold resistant paper faced gypsum wallboard, and tile backer board provide 2 inch wide 10 by 10 glass fiber mesh tape.
- C. Setting-Type Joint Compounds manufactured to ASTM C475 for moisture and mold resistant paper faced gypsum wallboard,: Factory-packaged, mold and moisture resistant, job-mixed, chemical-hardening powder products formulated for uses indicated.
1. Where setting-type joint compounds are indicated as a taping compound only or for taping and filling only, use formulation that is compatible with other joint compounds applied over it.
 2. Prefilling: At open joints, rounded or beveled panel edges, damaged surfaces, and laminating gypsum boards together.
 3. Moisture and mold resistant paper faced gypsum wallboard installed in non-tile, non-wet areas, scheduled for painting:
 - a. Embedding and first coat: For embedding glass fiber tape and first coat on joint fasteners and trim flanges, use setting-type taping compound.
 - b. Fill coat: For second coat use setting-type, sandable topping compound.
 - c. Finish coat: For third coat, use setting-type, sandable topping compound.
 4. At tile backer board installed in areas scheduled to be tiled, imbed glass fiber tape in mortar used to install tile. Refer to Section 09 30 00 – Tiling.
- D. Skim Coat: For level 5 finish provide the following material or approved equivalent:
1. USG Sheetrock Brand Tuff-Hide primer surfacer.

2.05 MISCELLANEOUS MATERIALS

- A. General: Provide auxiliary materials for gypsum board construction that comply with referenced standards and recommendations of gypsum board manufacturer.
- B. Gypsum Board Screws: Self-drilling, self-tapping steel screws.
1. For steel framing less than 0.03 inch thick, comply with ASTM C1002.
 2. For steel framing from 0.033 inch thick to 0.112 inch thick, comply with ASTM C954.
 3. Provide Type S or Type S-12 screws, rust resistant, lengths as required to suit application as noted below:
 - a. Where securing one layer of 5/8 inch Type "X" gypsum wallboard to framing: Provide 1 inch long steel screws unless noted otherwise.
 - b. Where securing tile backer board to framing: Provide type of screw and minimum length as recommended by board manufacturer.
- C. Sealant:
1. ASTM C920, Type S, Grade NS, Class 25, Use NT, Use 1, Use M, Use G. Flexible mildew-resistant 100% silicone sealant, complying with SCAQMD Rule

1168, Adhesive and Sealant Applications, amended January 7, 2005.

2. Manufacturers/products:
 - a. Laticrete/Latasil VOC content 37.16 g/L < 250 g/L.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates to which gypsum board assemblies attach or abut, installed hollow metal frames, and structural framing, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 EXISTING WORK

- A. Extend existing gypsum board installations using materials and methods specified.

3.03 INSTALLATION OF STEEL FRAMING FOR SUSPENDED AND FURRED CEILINGS

- A. Install in accordance with ASTM C636.
- B. Suspend ceiling hangers from building structural members and as follows:
 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying or other equally effective means.
 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
 3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews or other devices and fasteners that are secure and appropriate for substrate and in a manner that will not cause them to deteriorate or otherwise fail.
 4. Do not support ceilings directly from permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 5. Do not attach hangers to steel deck tabs.
 6. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 7. Do not connect or suspend steel framing from ducts, pipes or conduit.
- C. Sway-brace suspended steel framing with hangers used for support.

- D. Install suspended steel framing components in sizes and at spacings indicated, but not less than that required by the referenced steel framing installation standard.
 - 1. Grid Suspension System:
 - a. Wire Hangers: Maximum 48 inches o.c. At ceilings where tile backer board is installed, install wire hangers at maximum 36 inch o.c.
 - b. Main Beams: Maximum 48 inches o.c.
 - c. Cross Furring Members (Furring Members): Maximum 16 inches o.c.
- E. Installation Tolerances: Install steel framing components for suspended ceilings so that cross-furring or grid suspension members are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) as measured both lengthwise on each member and transversely between parallel members.
- F. Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

3.04 APPLYING AND FINISHING GYPSUM BOARD – GENERAL

- A. Gypsum Board Application and Finishing Standards: Install and finish gypsum panels to comply with ASTM C840, GA-214, and GA-216.
- B. Confirm sound-attenuation blankets have been installed where indicated prior to installing gypsum panels unless blankets are readily installed after panels have been installed on one side.
- C. Install ceiling board panels perpendicular to framing members spaced at 16 inches o.c. and across framing to minimize the number of abutting-end joints and to avoid abutting-end joints in the central area of each ceiling. Stagger abutting-end joints of adjacent panels not less than one framing member. Install gypsum and/or tile backer board panels on ceiling before wall/partition board application.
- D. Install gypsum panels with face side out. Do not install imperfect, damaged or damp panels. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- E. Locate both edge or end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Avoid joints other than control joints at corners of framed openings where possible.
- F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- G. Attach gypsum panels to framing provided at openings and cutouts.
- H. Form and install control and expansion joints at locations indicated and as follows with space between edges of adjoining gypsum panels, as well as supporting framing behind gypsum panels:
 - 1. At all door frames, provide control joints at each corner of the door frame and extend joints from top of frame up to bottom of structure/ deck. At all door frames

located in interior partitions, locate control joints on both sides of partitions. At door frames on exterior walls provide control joints on interior side.

- I. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chassis that are braced internally.
 - 1. Fit gypsum panels around ducts, pipes and conduits.
 - 2. Where partitions intersect steel beams, steel joists, and other structural members projecting below underside of roof deck, cut gypsum panels to fit profile formed by beams, joists, and other structural members; allow 1/2 inch wide joints to install sealant. Where partitions intersect the bottom of roof decks, cut gypsum wallboard to the profile of the deck; allow 1/2 inch wide joints to install sealant.
- J. At non-rated, non-load-bearing partitions that extend to the underside of the roof deck, isolate perimeter of the gypsum board partitions at structural abutments and roof deck, as detailed. Provide 1/2 inch wide spaces at these locations. Seal joints between abutting structural surfaces, roof deck etc. with acoustical sealant, unless otherwise noted.
- K. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's recommendations.
 - 1. Space screws a maximum of 12 inches o.c. for vertical applications.
- L. Space fasteners in panels that are tile substrates a maximum of 6 inches o.c.

3.05 GYPSUM BOARD APPLICATION METHODS

- A. Single-Layer Application: Install gypsum wallboard panels as follows:
 - 1. On ceilings, apply gypsum panels prior to wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
 - 2. On partitions/walls, apply gypsum panels vertically (parallel to framing), and provide panel lengths that will minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of board.
- B. Tile Backer Board:
 - 1. Install tile backer board panels at all areas scheduled to be tiled. Install with gray coated surface away from studs. Locate edge joints parallel to and on framing. Stagger intermediate end joints of adjacent lengths. Secure boards to studs with Type S-12 bugle head, self-tapping, rust resistant, fine thread minimum 1 5/8 inch screws at 6 inches o.c or type of fastener recommended by board manufacturer. At light gauge framing provide Type S, bugle self-tapping rust-resistant 1 1/4 inch screws at 6 inches o.c.or type of fastener recommended by board manufacturer. Butt ends and edges. Install with 1/4 inch open space where panels abut other construction or penetrations. Seal ends, cut edges and penetrations of each piece with water-resistant adhesive or where recommended by board manufacturer with water-resistant joint compound. Panels shall be installed horizontally.

- a. Where ceilings are installed, extend tile backer board to ceiling leaving a 1/8 inch gap at corner.
- C. Single-Layer Fastening Methods: Apply gypsum panels to supports as follows:
1. Fasten with screws.

3.06 INSTALLING TRIM ACCESSORIES

- A. General: For trim accessories with back flanges, fasten to framing with the same fasteners used to fasten gypsum board. Otherwise, fasten trim accessories according to accessory manufacturer's directions for type, length and spacing of fasteners.
- B. Install cornerbead at all external corners.
- C. Install edge trim where edge of gypsum panels would otherwise be exposed. Provide edge trim type with face flange formed to receive joint compound, except where other types are indicated.
 1. Install LC-bead where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.
- D. Install control joints according to ASTM C840 and manufacturer's recommendations and in specific locations approved by Architect for visual effect.

3.07 FINISHING GYPSUM BOARD ASSEMBLIES

- A. General: Treat gypsum board joints, interior angles, flanges of cornerbead, edge trim, control joints, penetrations, fastener heads, surface defects and elsewhere as required to prepare gypsum board surfaces for decoration.
- B. Prefill open joints, rounded or beveled edges and damaged areas using setting-type compound.
- C. Apply joint tape over gypsum board joints, except those with trim accessories having flanges not requiring tape.
- D. Apply joint tape over gypsum board joints and to flanges of trim accessories as recommended by trim accessory manufacturer.
- E. Levels of Gypsum Board Finish: Provide the following levels of gypsum board finish per GA-214.
 1. Level 1 for ceiling plenum areas, concealed areas and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
 2. Level 4 for walls and ceilings exposed to view.
 3. Level 5 for walls exposed to view where epoxy, gloss and semi-gloss paints are applied to gypsum board surfaces.
- F. Use the following joint compound combinations as applicable to the finish levels specified.

1. Sandable Setting Type: Embedding and First Coat: Sandable setting-type joint compound. Fill (Second) coat: Sandable setting-type joint compound. Finish (Third) Coat: Sandable setting-type joint compound.
- G. Level 1:
1. All joints and interior angles shall have tape set in joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable.
- H. Level 4 finish for all surfaces to be painted.
1. All joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over all flat joints and one separate coat of joint compound applied over interior angles.
 2. All fastener heads and accessories shall be covered with three separate coats of joint compound.
 3. All joint compounds shall be smooth and free of tool marks and ridges.
- I. Level 5 finish for all surfaces to be painted with epoxy, gloss and semi-gloss paint systems. All ceilings where glass mat gypsum wall board is installed.
1. All joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over all flat joints and one separate coat of joint compound applied over interior angles.
 2. All fastener heads and accessories shall be covered with three separate coats of joint compound.
 3. All joint compounds shall be smooth and free of tool marks and ridges.
 4. Skim coat all surfaces using material specified .
 - a. Apply primer-surfacer in accordance with manufacturers written instructions using spray equipment approved by manufacturer.
 - b. Thoroughly mix primer surfacer. Do not thin.
 - c. Apply primer-surfacer to a minimum wet film thickness of 15 mils. Do not apply in excess of 20 mils wet film thickness.

3.08 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Architect will conduct an above-ceiling observation prior to installation of gypsum board ceilings and report any deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
1. Notify Architect one week in advance of the date and the time when the Project, or part of the Project, will be ready for an above-ceiling observation.
 2. Prior to notifying Architect, complete the following in areas to receive gypsum board ceilings:
 - a. Installation of eighty percent (80%) of lighting fixtures, powered for operation.

- b. Installation, insulation and leak and pressure testing of water piping systems.
- c. Installation of air duct systems.
- d. Installation of air devices.
- e. Installation of mechanical system control air tubing.
- f. Installation of ceiling support framing.

3.09 CLEANING AND PROTECTION

- A. Promptly remove any residual joint compound from adjacent surfaces.
- B. Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure gypsum board assemblies are without damage or deterioration at the time of Substantial Completion.
- 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.

END OF SECTION

SECTION 09 22 16 – NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Interior (drywall) non-load-bearing non-structural framing.
- B. Accessories.

1.02 RELATED SECTIONS

- A. Section 01 33 00 – Submittal Procedures.
- B. Section 01 60 00 – Product Requirements: Product substitution procedures.
- C. Section 06 10 53 – Miscellaneous Carpentry: Securing wood blocking to steel studs.
- D. Section 09 21 16 – Gypsum Board Assemblies: Securing gypsum wall board to framing
- E. Section 10 28 00 – Toilet, Bath and Laundry Accessories: Supporting toilet accessories off steel stud framing.

1.03 REFERENCES

- A. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot Dip Process.
- C. ASTM A780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- D. ASTM A1003 – Standard Specification for Steel Sheet, Carbon Metallic and Non-Metallic-Coated for Cold-Formed Framing Members.
- E. ASTM C645 – Standard Specification for Non-Structural Steel Framing Members.
- F. ASTM C754 – Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
- G. ASTM C1002 – Standard Specification for Steel Drill Screws for Application of Gypsum Panel Products on Metal Plaster Bases.
- H. American Welding Society:
 - 1. AWS D1.1 – Structural Welding Code – Steel.
 - 2. AWS D1.3 – Structural Welding Code – Sheet Steel.
- I. National Association of Architectural Metal Manufacturers:
 - 1. NAAMM ML/SFA 540 – Lightweight Steel Framing Systems Manual.

- J. SSPC: The Society for Protective Coatings:
 - 1. SSPC Paint 20 – Zinc-Rich Primers (Type I – Inorganic and Type II – Organic).
 - K. Steel Stud Manufacturers Association:
 - 1. SSMA – Product Technical Information.
 - L. AISI – (American Iron and Steel Institute) “North American Specification for the Design of Cold-Formed Steel Structural Members,” Current Edition.
 - M. FS TT-P-645 – Primer, Paint, Zinc-2 Chromate, Alkyd Type.
- 1.04 PERFORMANCE REQUIREMENTS – INTERIOR (DRYWALL) NON-LOAD-BEARING STEEL STUD FRAMING
- A. Maximum Allowable Deflection: L/240 span, with a minimum load of 5 pounds per square foot applied perpendicular to walls.
 - 1. Where tile is installed, the deflection shall not exceed L/360, with a minimum load of 5 pounds per square foot applied perpendicular to walls.
 - B. Design framing system to accommodate deflection of building. Structure and construction tolerances:
 - 1. Vertical Deflection: 1/2 inch.
- 1.05 SUBMITTALS – INTERIOR (DRYWALL) NON-LOAD-BEARING NON-STRUCTURAL FRAMING
- A. Section 01 33 00 – Submittal Procedures: Submittal Procedures.
 - B. Product Data: Provide data describing standard framing member materials and finish, product criteria, load charts, limitations and type of fasteners.
- 1.06 QUALITY ASSURANCE – INTERIOR (DRYWALL) NON-LOAD-BEARING NON-STRUCTURAL FRAMING
- A. Single-Source Responsibility for Steel Framing: Obtain steel framing members from a single manufacturer, unless otherwise noted.
 - 1. Furnish framing materials in accordance with SSMA – Product Technical Information.
 - B. Perform work in accordance with ASTM C754.
 - C. Installer qualifications: Company specializing in performing the work of this Section with minimum 5 years of experience.
- 1.07 DELIVERY, STORAGE AND HANDLING

- A. Protect metal framing from corrosion, deformation and other damage during delivery, storage and handling.
- B. Store metal framing, protect with a waterproof covering and ventilate to avoid condensation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers for Interior (Drywall) Studs: Subject to compliance with requirements, provide metal framing by one of the following:
 - 1. Allied Studco
 - 2. Allsteel & Gypsum Products Inc.
 - 3. California Expanded Metal Products Co.
 - 4. ClarkDietrich Building Systems
 - 5. Cemco Steel Framing and Metal Lath
 - 6. Consolidated Fabricators, Corp.
 - 7. Craco Metal Manufacturing, LLC
 - 8. Custom Stud, Inc.
 - 9. Design Shapes in Steel
 - 10. LFB Engineered Systems, Inc/Lennar Homes of California, Inc.
 - 11. Marino/Ware – A Division of Ware Industries
 - 12. MBA Building Supplies, Inc.
 - 13. Olmar Supply dba Denmar Steel
 - 14. Quail Run Building Materials, Inc.
 - 15. SCAFCO Corporation
 - 16. Southeastern Stud & Components, Inc.
 - 17. Steel Construction Systems
 - 18. Steeler, Inc.
 - 19. Telling Industries.
 - 20. The Steel Network, Inc.
 - 21. United Metal Products, Inc.

- B. Basis-of-Design Product: The design for connecting devices for interior (drywall) framing is based on The Steel Network, Inc.

Subject to compliance with requirements, provide named product or a comparable product by:

1. ClarkDietrich Building Systems.

2.02 INTERIOR (DRYWALL) FRAMING

- A. General: Provide steel framing members complying with the following requirements:

1. Provide G60 hot-dip galvanized coating where framing members are in direct contact with masonry or concrete surfaces.
2. Protective Coating: ASTM A653, G40 hot-dip galvanized coating.

- B. Steel Studs and Runners: ASTM C645, with flange edges of studs bent back 90 degrees and doubled over to form 3/16-inch wide minimum lip (return), and complying with the following requirements for minimum thickness of base (uncoated) metal and for depth:

1. Thickness: 30 mil (20 gauge Drywall), design thickness 0.0312 inch, minimum yield, 33 ksi.
2. Depth: As indicated.
3. Track: 1-1/4 inches. Gauge of track to match stud gauge unless otherwise noted.

- C. Deflection Clips: 1-1/2 inches by 3 inches slotted leg by 33 mils VertiClip SLD angle or VertiTrack VTD as manufactured by The Steel Network. Width of clip to match depth of stud. Clip shall be manufactured from steel conforming to ASTM A653A, Grade 50, Class 1, 50 KS1 minimum yield strength, 65 KS1 minimum tensile strength, G-60 hot-dipped galvanized coating. Clips shall be designed for positive attachment to structure and stud web using step bushing to provide frictionless vertical movement. Provide clips with attached bushing and screws. At sloping beams and roof deck, bend horizontal leg as required so that vertical leg remains plumb. Use only deflection connection products that comply with ICC Acceptance Criteria AC261 such as Report No. ESR-1903 (or equivalent). Site fabricated clips are not permitted.

1. Alternate Deflection Track: VertiTrack VT Slotted Track as manufactured by The Steel Network. Substitutions permitted according to the Conditions of the Contract and appropriate Division 01 Sections. At fire rated partitions provide a top runner that allows the partition head to expand and contract with movement of the structure while maintaining continuity of the fire-resistance-rated assembly indicated, in thickness not less than indicated for studs and in a width to accommodate depth of the studs. Comply with UL 2079. Refer to Section 07 84 00 Firestopping for approved fire stop materials

- a. Material: ASTM A1003/A1003M Structural Grade 50 Type H, ST50H: 50ksi minimum yield strength, 65ksi minimum tensile strength, 33mil minimum thickness (20 gauge, 0.0346" design thickness) with ASTM A653/A653M G90 hot dipped galvanized coating.

- D. Flat Steel Plate: Steel sheet complying with ASTM A653 or ASTM A568 with minimum base metal thickness as follows:

1. Thickness:
 - a. 54 mils, (16 gauge) 33 ksi steel.
 2. Width: 6 inches, unless noted otherwise.
 3. Length: 10 feet.
- E. Fasteners for Metal Framing: Provide fasteners of type, material, size, corrosion resistance, holding power and other properties required to fasten steel framing and furring members securely to substrates involved; complying with the recommendations of gypsum board manufacturers for applications indicated.
- F. Bridging:
1. Bridging: BridgeBar 75 as manufactured by The Steel Network or approved equal.
- G. Utility Angles: Used to connect, reinforce and secure metal stud framing.
1. Size: As shown on Drawings.
 2. Thickness: 30 mils, (20 gauge) unless otherwise noted on Drawings.

2.03 ANCHORS, CLIPS AND FASTENERS

- A. Steel Shapes and Clips: ASTM A36, zinc coated by the hot-dip process according to ASTM A123.
- B. Powder-Actuated Anchors: Federal Specification FF-P-395b. Manufactured from AISI 1062 or 1065 steel, austempered to a minimum core hardness of 50 to 54 HRC and zinc plated in accordance with ASTM B 633. Provide fasteners listed or approved by one or more of the following and of type, diameter and length as required by structural design calculations:
1. Underwriters Laboratory.
 2. Factory Mutual.
 3. International Code Council (ICC).
- C. Mechanical Fasteners: Corrosion-resistant coated, self-drilling, self-threading steel drill screws. Provide screw type and size as required by structural design calculations for the specific condition and thickness of materials being joined.
1. Head Type: Low profile head beneath sheathing, manufacturer's standard elsewhere.

2.04 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

2.05 FABRICATION

- A. Fabricate metal framing and accessories plumb, square, true to line, and with connections securely fastened, according to manufacturer's recommendations and the requirements of this Section.
 - 1. Fabricate framing assemblies in jig templates.
 - 2. Cut framing members by sawing or shearing; do not torch cut.
 - 3. Fasten metal framing members by screw fastening as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Locate mechanical fasteners and install according to metal framing manufacturer's instructions with screw penetrating jointed members by not less than 3 exposed screw threads.
 - 4. Fasten other materials to metal framing by bolting, or screw fastening according to manufacturer's recommendations.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or distortion.
- C. Fabrication Tolerances: Fabricate assemblies to a maximum allowable tolerance variation from plumb, level, and true to line of 1/8 inch in 10 feet and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that building framing components are ready to receive work.
- B. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION – GENERAL

- A. Install metal framing and accessories plumb, square, true to line and with connections securely fastened, according to manufacturer's recommendations and the requirements of this Section.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten metal framing members by screw fastening, as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Locate mechanical fasteners and install according to metal framing manufacturer's instructions with screw penetrating jointed members by not less than 3 exposed screw threads.

- B. Install framing members in one-piece lengths, unless splice connections are indicated for track or tension members.
- C. Provide temporary bracing and leave in place until framing is permanently stabilized.
- D. Fasten reinforcement plate over web penetrations that exceed size of manufacturer's standard punched openings.
- E. At all locations where multiple studs and tracks occur, fasten studs and tracks together at maximum 24 inch o.c.

3.03 INSTALLATION – INTERIOR (DRYWALL) STEEL FRAMING

- A. Examine substrates to which gypsum board assemblies attach or abut, installed hollow metal frames, cast-in-anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of drywall construction. Do not proceed with installation until satisfactory.
- B. Steel Framing Installation Standard: Install steel framing to comply with ASTM C754 and with ASTM C840 requirements that apply to framing installation.
- C. Install supplementary framing, blocking and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings or similar construction. Comply with details indicated and with recommendations of gypsum board manufacturer or, if none available, with United States Gypsum Co.'s "Gypsum Construction Handbook."
 - 1. Coordinate with Section 06 10 53 – Miscellaneous Carpentry for rigid wall backing plates as locations specified.
- D. Isolate steel framing from building structure and underside of floor/roof deck at locations indicated to prevent transfer of loading imposed by structural movement. Comply with details shown on Drawings.
- E. Do not bridge building control and expansion joints with steel framing or furring members. Independently frame both sides of joints with framing or furring members as indicated.
- F. Install runners (tracks) at floors, top of partitions, ceilings and structural walls and columns where gypsum board stud assemblies abut other construction.
 - 1. Where studs are installed directly against concrete walls, install asphalt felt strips or foam gaskets between studs and wall.
- G. Installation Tolerances: Install each steel framing and furring member so that fastening surface do not vary more than 1/8 inch (3 mm) from the plane formed by the faces of adjacent framing.
- H. Extend partition framing full height to structural supports, underside of floor or roof deck, except where partitions are indicated to terminate above suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
 - 1. At deflection clips, cut studs 1/2 inch short of full height to provide perimeter relief.
 - 2. STC-rated partitions that extend to the underside of roof decks or other

continuous solid structural surfaces to obtain ratings, install framing around structural and other members extending below roof decks, as needed, to support gypsum board closures needed to make partitions continuous from floor to underside of solid structure.

- I. Install steel studs and furring in sizes and at spacings indicated.
 - 1. Single-Layer Construction: Space studs 16 inches o.c., unless otherwise indicated.
- J. Install steel studs so flanges point in the same direction and leading edge or end of each gypsum board panel can be attached to open (unsupported) edges of stud flanges first.
- K. Frame door openings with minimum two studs and one nested track. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames.
 - 1. At jambs install two channel shaped metal studs and one metal track. The metal track shall be nested within the metal stud as shown. Boxed stud and track shall be screw attached together using #10-16 screws at maximum 24 inches o.c. Attach second stud to boxed stud/track using #10-16 screws at maximum 24 inches o.c.
 - 2. At the frame head, provide a steel track for openings up to 3'-0" wide. For openings wider than 3'-0" provide box header.
 - 3. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint.
- L. Coordinate installation of wood bucks, anchors and wood blocking with electrical and mechanical work to be placed within or behind stud framing.
- M. Blocking: Coordinate with Section 06 10 53 – Miscellaneous Carpentry.
- N. Coordinate placement of insulation in stud spaces made inaccessible after stud framing erection.
- O. Horizontal Bridging: At the following partitions install bridge bar or approved equal to each stud spaced as follows:
 - 1. Non-Composite-Fully Braced where the gypsum wall board on both sides stops at the ceiling and the stud continues to deck. Spacing of horizontal bridging shall be based on the Lu (critical unbraced length for lateral-torsional buckling) shown in the schedule titled "Interior Wall Heights-Non-Composite-Fully Braced"
 - 2. Non-Composite-Braced where the stud framing and gypsum wallboard on one side of the wall stops at the deck. Spacing of horizontal bridging shall be at maximum 48 inches on center

3.04 TOLERANCES

- A. Maximum Variation from Plumb, Level and True Position: 1/8 inch in 10 feet.

SCHEDULE (NOTE: Table was taken from the SSMA Product Technical Guide).

- B. Interior Wall Heights-Composite, based on maximum allowable deflection of L/240 span,

with a minimum load of 5 pounds per square foot applied perpendicular to walls.

Composite limiting heights are based on a single layer of 5/8 inch Type X gypsum board installed in the vertical orientation to both sides of the wall over the full height using minimum No. 6 Type S drywall screws spaced a maximum of 16 inches on center but not less than the spacing noted in Section 09 21 16 Gypsum Board Assemblies for rated and non-rated partitions.

At interior partitions that include an STC rating install studs at 16 inches on center.

1.	Stud	Spacing	Height Limitation
	162S125-30	12"	11'-10"
	162S125-30	16"	10'-9"
	250S125-30	12"	15'-10"
	250S125-30	16"	14'-5"
	362S125-30	12"	18'-3"
	362S125-30	16"	16'-7"
	600S125-30	12"	27'-1"
	600S125-30	16"	24'-7"

- C. Interior Wall Heights-Non-Composite-Fully Braced, based on maximum allowable deflection of L/240 span, with a minimum load of 5 pounds per square foot applied perpendicular to walls.

Non-Composite-Fully Braced limiting heights are based on the gypsum board on both sides of the partition stopping at the ceiling and the stud framing continues to deck and the distance between the deck and the top of the gypsum board is limited to Lu (Critical unbraced length for lateral-torsional buckling). Members are considered fully braced, using horizontal bridging as specified in this section when unbraced length is less than Lu)

1.	Stud	Spacing	Height Limitation	Lu (inches)
	162S125-30	12"	9'-3"	29.2
	162S125-30	16"	8'-5"	29.2
	250S125-30	12"	12'-9"	28.9
	250S125-30	16"	11'-7"	28.9
	362S125-30	12"	17'-0"	28.6
	362S125-30	16"	15'-6"	28.6
	600S125-30	12"	25'-2"	27.6
	600S125-30	16"	22'-11"	27.6

- D. Interior Wall Heights-Non-Composite-Braced at 48 inches o.c., based on maximum allowable deflection of L/240 span, with a minimum load of 5 pounds per square foot applied perpendicular to walls.

Non-Composite-Braced at 48 inches o.c. limiting heights are based on the stud framing along with the gypsum board on one side of the wall stopping at the roof deck and the distance between the horizontal bracing is 48 inches o.c. maximum.

1.	Stud	Spacing	Height Limitation
	162S125-30	12"	9'-3"
	162S125-30	16"	8'-5"
	250S125-30	12"	12'-10"
	250S125-30	16"	11'-8"
	362S125-30	12"	17'-1"
	362S125-30	16"	15'-6"
	600S125-30	12"	25'-4"
	600S125-30	16"	23'-0"

E. Ceramic Tile: Minimum 3 5/8 inch metal studs.

Interior Wall Heights-Non-Composite based on maximum allowable deflection of L360 span, with a minimum load of 5 pounds per square foot applied perpendicular to walls.

Non-composite limiting heights are based on the properties of stud framing alone.

1.	Stud	Spacing	Height Limitation
	362S125-30	12"	14'-10"
	362S125-30	16"	13'-6"
	600S125-30	12"	22'-0"
	600S125-30	16"	20'-0"

END OF SECTION

SECTION 09 30 00 – TILING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall Tiles.
- B. Floor Tile.
- C. Setting Materials.
- D. Tile Accessories.
- E. Waterproofing Membranes.
- F. Sealants.

1.02 RELATED SECTIONS

- A. Section 01 40 00 – Quality Requirements.
- B. Section 01 45 23 – Concrete In-Situ Relative Humidity and pH Testing:
- C. Section 07 90 00 – Joint Protection: Sealants installed at movement joints.
- D. Section 09 21 16 – Gypsum Board Assemblies: Tile backer board.

1.03 REFERENCE STANDARDS

- A. Installation Specifications:
 - 1. ANSI A108 Series/A118 Series/A136.1 – American National Standard Specifications for the Installation of Ceramic Tile (Compendium of the following).
 - a. ANSI A108.5-2016 – Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Mortar (not published separately).
 - b. ANSI A108.6-2016 – Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile Setting and Grouting Epoxy.
 - c. ANSI A108.13-2016 – Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone.
- B. Material Specifications:
 - 1. ANSI A118.3-2016 – Chemical Resistant, Water Cleanable Tile Setting and Grouting Epoxy and Water Cleanable Tile Setting Epoxy Adhesive.
 - 2. ANSI A118.4-2016 – Latex Modified Portland Cement Mortar (not published separately).
 - 3. ANSI A118.10-2016 – Standard Specifications for Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installations.
 - 4. ANSI A118.15-2016 – Improved Latex Modified Cement Mortars.

5. ANSI A137.1-2016 – American National Standard Specifications for Ceramic Tile.
6. TCNA – (Tile Council of North America) Handbook for Ceramic, Glass and Stone Tile Installation, Current Edition.

C. ASTM:

1. ASTM C373 – Standard Test Method for Water Absorption, Bulk Density, Apparent Porosity and Apparent Specific Gravity of Fired Whiteware Products.
2. ASTM C648 – Standard Test Method for Breaking Strength of Ceramic Tile.
3. ASTM C650 – Standard Test Method for Resistance of Ceramic Tile to Chemical Substances.
4. ASTM D5957 – Standard Guide for Flood Testing Horizontal Waterproofing Installation.

D. ISO – International Organization of Standardization

1. 13007 Standards for Adhesives and Grouts.

1.04 SUBMITTALS

A. Section 01 33 00 – Submittal Procedures.

B. Product Data: Provide product data and installation instructions for the following materials:

1. Floor tiles.
2. Wall tiles.
3. Waterproof membranes.
4. Mortar bond coat materials.
5. Grout materials.
6. Tile accessories.
7. Cleaners and sealers.
8. Sealants.

C. Samples: Two samples of each tile and grout in color and size specified.

D. Manufacturer's Certificate: Each product manufacturer furnishing products under this section shall certify in writing that the products are recommended for the intended use.

1.05 CLOSEOUT SUBMITTALS

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Maintenance Data: Include recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.

1.06 QUALITY ASSURANCE

- A. Comply with applicable parts of ANSI A108 series of tile installation standards included under "American National Standard Specifications for the Installation of Ceramic Tile."
- B. Comply with applicable parts of Tile Council of America (TCA) "Handbook for Ceramic Tile Installations," Latest Edition.
- C. Single-Source Responsibility for Tile: Obtain each color, grade, type, composition and variety of tile from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the work.
- D. Single-Source Responsibility for Setting and Grouting Materials: Obtain ingredients of a uniform quality from one manufacturer for each, epoxy and admixture component and from one source or producer for each aggregate.
- E. Installer Qualifications: Engage an experienced Installer who has successfully completed tile installations similar in material, design and extent to than indicated for Project.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Section 01 30 00 – Administrative Requirements.
- B. Deliver and store packaged materials in original containers with seals unbroken and label intact until time of use. Comply with requirements of ANSI A137.1 for labeling sealed tile packages.
- C. Prevent damage or contamination to materials by water, freezing, foreign matter and other causes.
- D. Handle tile with temporary protective coating on exposed surfaces to prevent coated services from contacting backs or edges of other items. If despite these precautions coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.08 PROJECT CONDITIONS

- A. Section 01 60 00 – Product Requirements.
- B. Maintain environmental conditions and protect work during and after installations to comply with referenced standards and manufacturer's printed recommendations.
- C. Vent temporary heaters to exterior to prevent damage to tile work from carbon dioxide buildup.
- D. Maintain temperatures at 50 degrees F (10 degrees C) or more in tiled areas during installation and for 7 days after completion, unless higher temperatures are required by referenced installation standard or manufacturer's instructions.

1.09 PRE-INSTALLATION MEETINGS

- A. Convene four weeks prior to commencing work of this section, under provisions of Section 01 30 00 – Administrative Requirements: Pre-installation meeting.

DO NOT PROCEED WITH THE INSTALLATION OF THE TILE AND WATERPROOFING MEMBRANE, IF APPLICABLE, PRIOR TO THE PRE-INSTALLATION MEETING.

DO NOT PROCEED WITH THE PRE-INSTALLATION MEETING IF ANY ONE OF THE FOLLOWING PARTIES IS NOT IN ATTENDANCE:

**INSTALLER
OWNER'S REPRESENTATIVE (IF APPLICABLE)
ARCHITECT
GENERAL CONTRACTOR
PLUMBING CONTRACTOR, IF APPLICABLE**

1.10 EXTRA MATERIALS

- A. Section 01 70 00 – Execution and Closeout Requirements.
- B. Deliver extra materials to Owner. Furnish extra materials that match products installed as described below, packaged with protective covering for storage and identified with labels clearly describing contents.
 - 1. Tile Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern and size.

PART 2 PRODUCTS

2.01 MANUFACTURERS/PRODUCTS/COLORS

- A. Manufacturers: Refer to the "List of Finishes" located on the Drawings for a list of manufacturer's, products and colors for wall tiles and floor tiles on the floors and walls.

2.02 PRODUCTS – GENERAL

- A. ANSI Standard for Ceramic Tile: Comply with ANSI A137.1 "American Standard Specifications for Ceramic Tile" for types, compositions and grades of tile indicated.
 - 1. Furnish tile complying with "Standard Grade" requirements unless otherwise indicated.
- B. Water Absorption, ASTM C373
 - 1. Impervious – Tiles exhibiting 0.5% or less.
 - 2. Vitreous – Tiles exhibiting more than 0.5% but not more than 3.0%.
 - 3. Semi-Vitreous – Tiles exhibiting more than 3.0% but not more than 7.0%.
 - 4. Non-Vitreous – Tile exhibiting more than 7.0%.
- C. ANSI Standard for Tile Installation Materials: Comply with ANSI standard referenced with products and materials indicated for setting and grouting.
- D. Coefficient of Friction:
 - 1. Per ANSI A137.1-2012, ceramic tile selected for level interior spaces expected to

be walked upon when wet shall have a minimum wet DCOF AcuTest value of 0.42.

- E. Colors, Textures and Patterns: 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 the following requirements:
 - 1. Match color, texture and pattern indicated by reference to manufacturer's standard designations for these characteristics.
 - 2. Provide tile trim and accessories that match color and finish of adjoining tile.
- F. Factory Blending: For tile exhibiting color variations within the ranges selected during sample submittals, blend tile in factory and package accordingly so that tile units taken from one package show the same range in colors as those taken from other packages and match approved samples.
- G. Where factory-mounted tile is specified, provide back- or edge-mounted tile assemblies methods as standard with manufacturer unless another mounting method is indicated.
 - 1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies that this type of mounting is suitable for these kinds of uses and has been successfully used on other projects.

2.03 TILE PRODUCTS

- A. Refer to "List of Finishes" as shown on the Drawings for each wall tile and floor tile product specified including manufacturer, composition, size, thickness and color.
- B. Trim Units: Provide tile trim units to match characteristics of adjoining flat tile and to comply with the following requirements:
 - 1. Size and shapes: As indicated on the Drawings and in the "List of Finishes."
 - 2. Shapes: As follows, selected from manufacturer's standard shapes:
 - a. Wainscot cap: Surface bullnose

2.04 TILE ACCESSORIES

- A. Floor Edge Protection: Schluter-Schiene, Satin Anodized Aluminum Finish (AE)
 - 1. Sizes
 - a. AEU 100, H = 3/8 inch
 - b. AEU 125, H = 1/2 inch
 - 2. Provide appropriate size (height) for transitioning from specified tile floor material to resilient flooring.
- B. Edge Protection for Tiled Edges and Outside Corners: Schluter-Quadec Trendline, Textured Color coated Aluminum.
 - 1. Sizes

- a. Q 100, H =3/8 inch, Color(s) as selected by Architect
2. Provide inside and outside corners and connectors.
- C. Cove Shaped Profile: Schluter-Dilex-AHK, Satin Anodized Aluminum Finish (AE)
 1. Sizes
 - a. AHK 1S 100, H = 3/8 inch
 - b. AHK 1S 125, H = 1/2 inch
 2. Provide 90 degree inside and outside corners, connectors and end caps.

2.05 WATERPROOFING FOR THIN-SET TILE INSTALLATIONS

- A. Liquid Rubber Waterproofing/Crack Isolation Membrane: Manufacturer's standard factory-prepackaged, job-mixed, proprietary self-curing liquid rubber polymer and reinforcing fabric which meets ANSI A118.10 and is IAPMO listed for use as a waterproofing shower pan liner.
 1. Liquid Rubber Waterproofing
 - a. Laticrete Hydroban waterproof membrane; Laticrete International, Inc.
 - 1) VOC content: 2.39 g/L..
 - b. Mapelastic AquaDefense; Mapei
 - 1) VOC content: 0 g/L.

2.06 SETTING MATERIALS

- A. Latex-Portland Cement Mortar: Provide products from the following manufacturers and complying with the ANSI and ISO 13007 standards indicated. Note: The use of organic adhesives complying with ANSI A136.1 will not be allowed.
 1. Provide products for setting the following types of tiles:
 - a. Ceramic.
 - b. Porcelain.
 2. Product/Manufacturer:
 - a. Ultraflex 2/Mapei Corporation
 - 1) Standards: ANSI A118.4 and ISO 13007 Classification C2EP1.
 - 2) VOC content: 0 g/L.
 - b. 253 Gold/Laticrete International, Inc.
 - 1) Standards: ANSI A118.4 and ISO 13007 Classification C2
 - 2) VOC content: 0 g/L.
- B. Latex-Portland Cement Mortar: Provide products from the following manufacturers and complying with the ANSI and ISO 13007 standards indicated. Note: The use of organic adhesives complying with ANSI A136.1 will not be allowed.

1. Provide products for setting the following types of tiles:
 - a. Tiles weighing more than 5 pounds per square foot.
 - b. Setting larger tiles, tiles with at least one edge greater than 15 inches long.
2. Product/Manufacturer:
 - a. Ultraflex LFT/Mapei Corporation
 - 1) Standards: ANSI A118.4 and ISO 13007 Classification C2TES1P1.
 - 2) VOC content: 0 g/L.
 - b. 4-XLT/Laticrete International, Inc.
 - 1) Standards: ANSI A118.4, A118.15 and ISO 13007 C2TES2
 - 2) VOC content: 2.56 g/L.

2.07 GROUTING MATERIALS

- A. Commercial grade water-cleanable epoxy grout: ANSI A118.3 and ISO 13007 Classification R2/RG, R2: Reaction Resin Adhesive, improved, RG: Reaction Resin Grout; color(s) as selected from manufacturer's standard colors.
 1. Use: All locations floors and walls unless noted otherwise, for grout joints 1/16 inch to 3/8 inch
 2. Product/Manufacturer:
 - a. Kerapoxy CQ/Mapei Corporation
 - 1) Standards: ANSI A118.3 and ISO 13007 Classification R2/RG.
 - 2) VOC content: 8 g/L.
 - b. SpectraLOCK Pro Premium/Laticrete International, Inc.
 - 1) Standards: ANSI A118.3 and ISO 13007 Classification RG and EN.
 - 2) VOC content: 0.031 g/L.

2.08 CLEANERS/SEALERS

- A. Sealer: Grout and tile sealer as recommended by grout and tile manufacturer.
 1. Product/Manufacturer:
 - a. UltraCare Penetrating Plus Stone, Tile & Grout Sealer/Mapei Corporation.
 - 1) VOC Content: 45 g/L.
 - b. StoneTech BulletProof Sealer/Laticrete International, Inc.
 - 1) VOC Content: 20 g/L.

2.09 PRIMERS

- A. For gypsumbased walls, provide primer recommended by manufacturer of setting materials.

2.10 SEALANTS

- A. Sealant shall comply with ASTM C920, Single, Multi-Component or Pourable, Use T, Uses M and G as recommended by tile manufacturer for sealing joints in floor tile. Color of sealant to match grout color.

- 1. Product/Manufacturer:
 - a. Mapesil T/Mapei Corporation
 - 1) VOC content: 44 g/L.

2.11 MIXING MORTAR AND GROUT

- A. Mix mortars and grouts to comply with requirements of referenced standards and manufacturers including those for accurate proportioning of materials, water, or additive content, type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortars and grouts of uniform quality with optimum performance characteristics for application indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and areas where tile will be installed, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
 - 1. Verify that substrates for setting tile are firm, dry, clean and free from oil or waxy films and curing compounds.
 - 2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile have been completed before installing tile.
 - 3. New and existing concrete surfaces shall be mechanically prepared to a minimum ICRI (International Concrete Repair Institute) CSP #3 to CSP #5. **Note:** Installing tile over troweled surfaces is not permitted.
- B. Verify concrete floors are dry to a maximum moisture content allowed by flooring manufacturer and exhibit negative alkalinity, carbonization or dusting.
 - 1. Relative Humidity Test Method: Perform humidity testing using in situ probes in accordance with ASTM F2170.
 - a. Waterproofing Membranes: Maximum moisture in concrete/mortar bed shall not exceed 75 percent relative humidity unless otherwise noted by the manufacturer.
- C. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Blending: For tile exhibiting color variations within the ranges selected during sample submittals, verify that tile has been blended in factory and packaged accordingly so that tile units taken from one package show the same range in colors as those taken from other packages and match approved samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.03 INSTALLATION – GENERAL

- A. ANSI Tile Installation Standard: Comply with parts of ANSI 108 Series of Tile Installation Standards included under “American National Standard Specifications for the Installation of Ceramic Tile” that apply to type of setting and grouting materials and methods indicated.
- B. TCNA Installation Guidelines: TCNA “Handbook for Ceramic, Glass and Stone Tile Installation”; comply with TCNA Installation Methods indicated.
- C. Extend tile work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions except as otherwise shown. Terminate work neatly at obstructions, edges and corners without disrupting patterns or joint alignments.
- D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, or built in items for straight aligned joints. Fit tile close to electrical outlets, piping fixtures, and other penetrations so that plates and covers overlap tile.
- E. Jointing Pattern: Unless otherwise shown, lay tile in grid pattern. Align joints when adjoining tiles on the floor, base and walls are the same size. Lay out tile work and center tile fields in both directions in each space or on each wall. Adjust to minimize tile cutting. Provide uniform widths unless otherwise shown.
- F. Lay out tile wainscots to next full tile beyond dimension indicated.
- G. Grout tile to comply with the requirements of the following installation standards:
 - 1. For chemical-resistant epoxy grouts, comply with ANSI A108.6.
- H. Allow tiles to set firmly for 48 hours before grouting.
- I. Prime surfaces as required using materials recommended by manufacturer of setting materials.
- J. Tile accessories:
 - 1. Floor edge protection: Provide floor edge between:
 - a. Resilient flooring and tile.
 - 2. Edge protection for Tiled Edges and Outside Corners: Refer to drawings for location of edge protection.
 - 3. Cove Shaped Profile: Provide cove shaped profile at all floor tile to wall tile transitions.

3.04 WATERPROOFING INSTALLATION

- A. Install waterproofing membrane in compliance with waterproofing manufacturer's instructions to produce a waterproof membrane of uniform thickness bonded securely to substrate. Install all required flashings at corners and wall to floor edges.
- B. Do not install mortar bed and or tile over waterproofing until waterproofing has been tested in accordance with ASTM D5957 to determine that it is watertight.

3.05 FLOOR, INTERIOR – INSTALLATION METHODS, THIN-SET LOAD-BEARING WATERPROOF MEMBRANE, OVER CONCRETE FLOORS (FOR SLAB-ON-GROUND CONSTRUCTION WHERE BENDING STRESS DOES NOT OCCUR)

- A. Concrete: Install tile to comply with requirements indicated below for setting bed methods, TCNA installation methods related to types of subfloor construction and group types:
 - 1. Concrete subfloors, interior, bonded waterproof membrane: Installed over concrete:
 - a. TCNA F122
 - b. Waterproof Membrane: ANSI A108.13
 - c. Bond Coat: Latex-Portland Cement Mortar, ANSI A108.5.
 - d. Grout: Epoxy Grout ,ANSI A108.6.

3.06 WALL TILE, INTERIOR – INSTALLATION METHOD OVER COATED GLASS MAT WATER-RESISTANT GYPSUM BACKER BOARD (DRY AREA)

- A. Install types of tile designated for wall applications to comply with requirements indicated below for TCNA installation methods related to subsurface wall conditions and group types.
 - 1. Thin-Set Mortar:
 - a. Walls, Interior
 - 1) Coated Glass Mat Water Resistant Gypsum Tile Backer Board over Metal Studs: TCNA W245
 - 2) Bond Coat: Latex-Portland Cement Mortar, ANSI A108.5.
 - 3) Grout: Epoxy Grout, ANSI A108.6.

3.07 CLEANING

- A. Cleaning: Upon completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter, in conformance with tile and grout manufacturer's instructions.
 - 1. Clean tile using epoxy grout film remover, in accordance with manufacturer's instructions.
- B. Finished Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded and otherwise defective tile work.
- C. Provide final protection and maintain conditions in a manner acceptable to manufacturer and installer that ensures that tile is without damage or deterioration at time of Substantial

Completion.

- D. Seal tile and grout with sealer in accordance with manufacturer's instructions.

END OF SECTION

SECTION 09 51 13 – ACOUSTICAL PANEL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical ceiling panels.
- C. Wire hangers, fasteners, main runners, cross tees, wall angle moldings and perimeter trim.

1.02 RELATED SECTIONS

- A. Section 23 37 00 – Air Outlets and Inlets: Air diffusion devices in ceiling system.
- B. Section 26 51 00 – Interior Lighting: Light fixtures in ceiling systems.

1.03 REFERENCE STANDARDS

- A. ASTM A1008 – Standard Specification for Steel, Sheet, Cold Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
- B. ASTM A641 – Standard Specification for Zinc-Coated (Galvanized) Carbon steel Wire.
- C. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
- D. ASTM C423 – Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
- E. ASTM C635 – Standard Specification for the Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
- F. ASTM C636 – Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
- G. ASTM E84-94 – Standard Test Method for Burning Characteristics of Building Materials.
- H. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
- I. ASTM E1414 – Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum.
- J. ASTM E1264 – Classification of Acoustical Ceiling Products.
- K. ANSI Standard S12.60 -2010/Part 1. Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools Part 1: Permanent Schools.
- L. CISCA – Acoustical Ceilings: Use and Practice.

1.04 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures.
- B. Product Data: Provide data on metal grid system components and acoustical units.
- C. Samples: Submit two samples full size 6 x 6 inch in size illustrating material and finish of each acoustical unit specified.
- D. Provide 12-inch-long samples of each metal grid system specified.

1.05 QUALITY ASSURANCE

- A. Conform to CISCA Requirements.
- B. Single-Source Responsibility: Provide acoustical panel units and grid components by a single manufacturer.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years of recommended experience.
- B. Installer: Company specializing in performing work of this section with minimum five years of documented experience.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Maintain uniform temperature and humidity levels as recommended by the manufacturer prior to, during and after acoustical unit installation.

1.08 EXTRA MATERIALS

- A. Section 01 70 00 – Execution and Closeout Requirements.
- B. Provide 1 percent of total acoustical unit area of extra tile panels to Owner of each panel type specified.
- C. Provide 1 percent of exposed suspension system to Owner of each grid type specified.

1.09 SEQUENCING

- A. Sequence work to ensure acoustic ceilings are not installed until building is enclosed, sufficient heat is provided, dust-generating activities have terminated, and overhead work is completed, tested and approved.
- B. Install acoustic units after interior work is dry.

1.10 WARRANTY

- A. Refer to each product specified for warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS – SUSPENSION SYSTEM

- A. Armstrong.
- B. USG.
- C. CertainTeed.

2.02 SUSPENSION SYSTEM MATERIALS

- A. Non-Fire-Rated Grid: ASTM C635, intermediate duty; hot-dipped galvanized. Exposed grid surface width shall be 15/16, "Prelude XL" as manufactured by Armstrong.
 - 1. Color: White Aluminum.
- B. Wall Angle Molding: 7/8 inch hemmed angle molding.
- C. Support Channels and Hangers: Galvanized steel; size and type to suit application.
- D. Select wire diameter so that the stress at 3 times the hanger load (ASTM C635, Table 1, direct hung) will be less than the yield stress of wire with a minimum requirement of 12-gauge wire.

2.03 MANUFACTURERS – ACOUSTICAL UNITS

- A. Armstrong.
- B. USG.
- C. CertainTeed.

2.04 ACOUSTICAL CEILING PANELS

- A. Acoustical Ceiling Panels conforming to ASTM E1264 and as follows:
 - 1. ACT : 24 inches by 48 inches by 3/4 inch anti-microbial panels, Armstrong Ultima Square Lay-In, Item No. 1913.
 - a. Composition: Mineral Fiber
 - b. NRC: 0.75
 - c. CAC: 35
 - d. LR: 0.90
 - e. Sag Resistant: Humiguard+
 - f. Anti-Microbial: BioBlock+
 - g. Color: White
 - h. Recycled Materials:
 - 1) 76 percent pre-consumer
 - 2) 38 percent post-consumer
 - i. VOC formaldehyde: Free of formaldehyde-based resins.
 - j. Grid: Install ceiling panels with Armstrong "Prelude XL" Grid System.
 - k. Products from the following manufacturers may be submitted:
 - 1) USG: Mars ClimaPlus, Item No. 88185. Grid system to be DONN DX Suspension System.
 - 2) CertainTeed: Symphony M, Item No. 1220-OVT-1. Grid System to be 15/16 inch Classic Stab.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements.
- B. Verify that layout of hangers will not interfere with other work.

3.02 INSTALLATION – LAY-IN GRID SUSPENSION SYSTEM

- A. Install suspension systems to comply with ASTM C635 and ASTM C636, with hangers supported only from building structural members. Do not secure to metal roof deck. Locate hangers not more than 4'-0" on center along main runner direct-hung suspension system with additional hangers at ends of suspension members, at light fixtures, and 6 inches from vertical surfaces, leveling to tolerance of 1/8 inch in 12'-0".
- B. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eye-screws, or other devices that are secure and appropriate for substrate, and which will not deteriorate or fail with age or elevated temperatures.
- C. Do not tie framing to:
 - 1. HVAC ductwork or sprinkler piping.
 - 2. Metal roof deck.
- D. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum which are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal force by bracing, counterplying or other equally effective means.
- E. Install edge moldings of type indicated at perimeter of acoustical ceiling area and at locations where necessary to conceal edges of acoustical units.
- F. Screw-attach moldings to substrate at intervals not over 16 inches on center, and not more than 3" from ends, leveling with ceiling suspension system to tolerance of 1/8 inch in 12'-0". Miter corners accurately and connect securely.
- G. Form expansion joints where shown.

3.03 LAY-IN CEILING PANELS:

- A. Install acoustical panels in coordination with suspension system, with edges concealed by support of suspension members.
- B. Arrange and orient directionally-patterned units (if any) in a manner shown by reflected ceiling plans.
- C. Install in level plane and straight line courses, in accordance with Drawings and manufacturer's printed instructions.
- D. Seal joints in acoustical units around ducts, pipes, electrical outlets, etc., with acoustical sealant.
- E. Cutting Acoustic Units:

1. Cut to fit irregular grid and perimeter edge trim.

F. Where bullnose concrete block corners or round obstructions occur, install preformed closures to match perimeter molding.

3.04 ADJUST AND CLEAN

A. Clean soiled or discolored unit surfaces after installation. Comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Touch up scratches, abrasions, voids and other defects in painted surfaces. Remove and replace work which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage. Remove and replace damaged or improperly installed units.

END OF SECTION

RESILIENT FLOORING

SECTION 096500

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification sections, apply to work of this Section.

1.2 DESCRIPTION OF WORK

- A. Extent of resilient flooring and accessories is shown on Drawings and in schedules and includes the following:
 - 1. Vinyl composition floor tile
 - 2. Rubber tile flooring
 - 3. Sheet vinyl flooring
 - 4. Rubber base
 - 5. Rubber stair treads, stringers, risers and nosing

1.3 QUALITY ASSURANCE

- A. Manufacturer: Provide resilient flooring and accessories as produced by a single manufacturer, including recommended primers, adhesives, sealants, and leveling compounds.
- B. All flooring sealants, adhesives, coatings and primers shall comply with SCAQMD rules 113 and 1168 as consistent with performance and warranty requirements.**
- C. All resilient flooring shall be FloorScore certified.**

1.4 SUBMITTALS

- A. Product Data: Submit two (2) copies of manufacturer's technical data and installation instructions for each type of resilient flooring and accessory.

- B. Samples: Submit samples of each type, color, and pattern of resilient flooring, including accessories, required, indicating full range of color and pattern variation. Provide full-size tile units and 2-1/2" long sections of resilient flooring accessories.
- C. Maintenance Instructions: Submit two (2) copies of manufacturer's recommended maintenance practices for each type of resilient flooring and accessory required.
- D. **Submit verification of FloorScore certification or GreenGuard certification.**
- E. **Submit product data and MSDS for all flooring sealants, adhesives, coatings and primers, indicating the VOC content in g/l of each product.**

1.5 JOB CONDITIONS

- A. Maintain minimum temperature of 65 degrees F (18 degrees) in spaces to receive resilient flooring for at least 48 hours prior to installation, during installation, and for not less than 48 hours after installation. Store resilient flooring materials in spaces where they will be installed for at least 48 hours before beginning installation. Subsequently, maintain minimum temperature of 55 degrees F (13 degrees C) in areas where work is completed.
- B. Install resilient flooring and accessories after other finishing operations, including painting, have been completed. Do not install resilient flooring over concrete slabs until the latter have been cured and are sufficiently dry to achieve bond with adhesive as determined by manufacturer's recommended bond and moisture test.

1.6 GUARANTEE

- A. **Provide Owner with installer's written guarantee that shall guarantee completed installation to be free of defects in materials and workmanship for a period of one year after final acceptance. Guarantee shall provide for replacement of defective work at no cost to Owner.**

2 PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following or an acceptable substitute approved prior to bidding. For substitution request, refer to Section 01631.

1. Vinyl Composition Tile

- a) Armstrong : Standard Excelon; Imperial Texture or pre-approved equal.
Specifications:
Gauge 1/8 inch
Form 12 inch x 12 inch size
Reference ASTM F-1066, Class 2-through pattern
Fire Test Data ASTM E 648 Critical Radiant Flux 0.45 watts /cm sq or more.
Class 1
Static Load Limit ASTM E 662 Smoke – 450 or less
Adhesive ASTM F 970; 75 psi
As recommended by manufacturer
and complaint with current VOC limits of SCAQMD rule 1168 as consistent with performance and warranty requirements.
- b) Azrock: V-423-3 Autumn Haze;
Gauge 1/8 inch
Form 12 inch x 12 inch
Adhesive As recommended by manufacturer
and complaint with current VOC limits of SCAQMD rule 1168 as consistent with performance and warranty requirements.

2. Rubber Tile Flooring: Provide low profile disc design rubber floor tile with sanded back, continuous field pattern of 3/4" diameter discs raised .025", made of homogenous rubber compound, color extending throughout thickness.

a. Thickness: 1/8"

b. Size: 24" x 24"

3. Wall Base: Provide vulcanized rubber base (SBR) complying with FS SS-W-40, Type I, with matching end stops and preformed, molded, or job fabricated corner units, and as follows:

- a. Height: 4"
 - b. Thickness: 1/8" gage
 - c. Style: Standard cove style
 - d. Finish: High gloss
4. Rubber Stringers: At all stairs provide stringers to match adjacent wall base.
- a. Height: 12"
 - b. Thickness: .10"
5. Rubber Stair Treads: Molded rubber treads with diamond design, square nose, in lengths as required, FS RR-T-650, Composition A.
- a. Depth: 12-1/2"
 - b. Thickness: 1/4" tapering to 3/16"
6. Rubber Stair Risers: Molded rubber risers to match stair treads or nosings, in lengths as required.
- a. Thickness: 0.10"
 - b. Height: 7"
7. Flooring Type 12: Vinyl Sheet Flooring
- a. Armstrong: Medintec or pre approved equal
Specifications:

Gauge:	0.080 inch overall
Reference:	ASTM F-1913
Fire test data	ASTM E 648 Critical Radiant Flux .45 watts/cm sq or more Class 1
Static Load Limit	ASTM E 662 Smoke – 450 or less
Adhesives:	ASTM F 970 750 psi (modified)

**As recommended by manufacturer
and complaint with current VOC
limits of SCAQMD rule 1168 as
consistent with performance and
warranty requirements.**

b. Flooring Type 13: Vinyl Sheet Flooring

Armstrong: Classic Corlon or pre approved equal.
Specifications

Gauge: .085 inch

Reference: ASTM F 1303 Type II Grade 1 Class A
Backing

Fire Test Data ASTM 648 Critical Radiant Flux .45
watts/cm sq or more
Class 1

Static Load Limit ASTM F 970 9 (modified) 500 psi
Installation Securabond method

8. Resilient Edge Strips: 1/8" thick, homogeneous vinyl or rubber composition, tapered or bullnose edge, color to match flooring, or as selected by Architect from standard colors available; not less than 1" wide.
9. Adhesives (Cements): Waterproof, stabilized type as recommended by flooring manufacturer to suit material and substrate conditions. **Adhesive shall comply with current VOC limit of SCAQMD rule 1168 as consistent with performance and warranty requirements.**
10. Concrete Slab Primer: Non-staining type as recommended by flooring manufacturer. **Primer shall comply with current VOC limit of SCAQMD rule 1113 as consistent with performance and warranty requirements.**
11. Leveling Compound: Latex type as recommended by flooring manufacturer.

3. PART 3 - EXECUTION

3.1 PREPARATION

- A. Broom clean or vacuum surfaces to be covered, and inspect subfloor. Start of flooring installation indicates acceptance of subfloor conditions and full responsibility for completed work.
- B. Use leveling compound as recommended by flooring manufacturer for filling small cracks and depressions in subfloors.

- C. Perform bond and moisture tests on concrete slabs to determine that concrete surfaces are sufficiently cured, dried and ready to receive flooring.
- D. Apply concrete slab primer, if recommended by flooring manufacturer, prior to application of adhesive. Apply in compliance with manufacturer's directions.

3.2 INSTALLATION

A. General

- 1. Install flooring using method indicated in strict compliance with manufacturer's recommendations. Extend flooring into toe spaces, door reveals, and into closets and similar openings.
- 2. Maintain reference markers, holes, or openings that are in place or plainly marked for future cutting by repeating on finish flooring as marked on subfloor. Use chalk or other non-permanent marking device.
- 3. Tightly cement flooring to subbase without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, or other surface imperfections.

B. Tile Floors

- 1. Lay tile from center marks established with principal walls, discounting minor offsets, so that tile at opposite edges of room area of equal width. Adjust as necessary to avoid use of cut widths less than 1/2 tile at room perimeters. Lay tile square to room axis, unless otherwise shown.
- 2. Match tiles for color and pattern by using tile from cartons in same sequence as manufactured and packaged if so numbered. Cut tile neatly around all fixtures. Broken, cracked, chipped, or deformed tiles are not acceptable.
- 3. Lay tile in a pattern to be provided by the Architect consisting of not more than 3 different colors of tile.
- 4. Adhere tile flooring to substrates using full spread of adhesive applied in compliance with flooring manufacturer's directions.

C. Accessories

- 1. Apply wall base to walls, columns, pilasters, casework and other permanent fixtures in rooms or areas where base is required. Install base in lengths as long as practicable, with preformed corner units, or

fabricated from base materials with mitered or coped inside corners. Tightly bond base to substrate throughout length of each piece, with continuous contact at horizontal and vertical surfaces.

2. On masonry surfaces, or other similar irregular substrates, fill voids along top edge of resilient wall base with manufacturer's recommended adhesive filler material.
3. Place resilient edge strips tightly butted to flooring and secure with adhesive. Install edging strips at edges of flooring which would otherwise be exposed.

3.3 CLEANING AND PROTECTION

- A. Remove any excess adhesive or other surface blemishes, using neutral type cleaners as recommended by flooring manufacturer. Protect installed flooring with heavy Kraft paper or other covering.
- B. Finishing: After completion of project and just prior to final inspection of work, thoroughly clean floors and accessories.

END OF SECTION 096500

SECTION 09 90 00 – PAINTING AND COATING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This Section includes surface preparation, painting and finishing of exposed interior and exterior items and surfaces.
1. Surface preparation, priming and finish coats specified in this section are in addition to shop priming and surface treatment specified under other sections.
- B. Paint exposed surfaces whether or not colors are designated in “schedules,” except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Architect will select from standard colors or finishes available. Sherwin Williams Coatings listed at the end of this specification where used to establish the level of quality of the coating systems. The coating manufacturer shall match the colors identified in the finish schedule.
1. Painting includes field painting exposed bare pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.
- C. Painting is not required on pre-finished items, finished metal surfaces, concealed surfaces, operating parts, and labels.
1. Pre-finished items not to be painted include the following factory-finished components:
 - a. Acoustic materials.
 - b. Finished mechanical and electrical equipment.
 - c. Light fixtures.
 - d. Switchgear.
 - e. Distribution cabinets.
 - f. Wood veneer doors
 - g. .
 - h. Wood veneer woodwork and casework.
 - i. Metal flashings.
 2. Concealed surfaces not to be painted include wall or ceiling surfaces in the following generally inaccessible areas:
 - a. Furred areas.
 - b. Pipe spaces.
 - c. Ceiling plenums.
 3. Finished metal surfaces not to be painted include:
 - a. Anodized aluminum.
 - b. Stainless steel.
 - c. Chromium plate.
 - d. Copper.
 - e. Bronze or brass.

4. Operating parts not to be painted include moving parts of operating equipment such as the following:
 - a. Valve and damper operators.
 - b. Linkages.
 - c. Sensing devices.
 - d. Motor and fan shafts.
5. Labels: Do not paint over Underwriters Laboratories, Factory Mutual or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

1.02 RELATED SECTIONS

- A. Section 08 12 14 – Standard Steel Frames: Shop Primed, Field Painted.
- B. Section 08 13 14 – Standard Steel Doors: Shop Primed, Field Painted.
- C. Section 09 21 16 – Gypsum Board Assemblies: Finishing gypsum board prior to application of paint.
- D. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
- E. Section 23 05 53 – Identification for HVAC Piping and Equipment.
- F. Section 26 05 53 – Identification for Electrical Systems.
- G. Section 27 05 53 – Identification for Communication Systems.

1.03 REFERENCES

- A. Steel Structures Painting Council
 1. SP-1 Solvent Cleaning
 2. SP-2 Hand Tool Cleaning
 3. SP-3 Power Tool Cleaning
 4. SP-13 Nace No. 6 Surface Preparation for Concrete

1.04 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – Submittal Procedures.
- B. Product Data: Manufacturer's data sheets on each paint and coating product shall include:
 1. Product characteristics.
 2. Surface preparation instructions and recommendations.
 3. Primer requirements and finish specification.

4. Storage and handling requirements and recommendations.
 5. Application methods.
 6. MSDS sheets listing VOC content in g/L.
- C. Samples: Upon selection of colors by the Architect, submit samples for Architect's review of color and texture only. Provide a listing of material and application for each coat of each finish sample.
1. On 12 inch by 12 inch hardboard, provide one sample of each paint color listed in the color schedule, with texture to simulate actual conditions. Resubmit samples as requested by Architect until acceptable sheen, color and texture are achieved. Samples shall be stepped to show primer, first coat and second coat.
 2. On actual wall surfaces and other exterior and interior building components, duplicate painted finishes of prepared samples as directed by Architect. On at least 100 square feet of surface as directed, provide full-coat finish samples until required sheen, color and texture is obtained; simulate finished lighting conditions for review of in-place work.
 3. Do not proceed with painting until materials and finishes are approved by Architect.

1.05 QUALITY ASSURANCE

- A. Single-Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.
- B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
1. Notify the Architect of problems anticipated using the materials specified.
- C. Material Quality: Provide the manufacturer's best quality trade sale paint material of the various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.
1. Proprietary names used to designate colors or materials are not intended to imply that products named are required or to exclude equal products of other manufacturers.
 2. Federal Specifications establish a minimum quality level for paint materials, except where other product identification is used. Provide written certification from the manufacturer that materials provided meet or exceed these criteria.
 3. Products that comply with qualitative requirements of applicable Federal Specifications, yet differ in quantitative requirements, may be considered for use when acceptable to the Architect. Furnish material data and manufacturer's certificate of performance to Architect for proposed substitutions.
- D. Chemical Component Restrictions: The manufacturer shall demonstrate that the following chemical compounds are not used as ingredients in the manufacture of the product:

1. Halomethanes:
 - a. Methylene chloride
2. Chlorinated ethanes:
 - a. 1,1,1-trichloroethane
3. Aromatic solvents:
 - a. Benzene
 - b. Toluene (methylbenzene)
 - c. Ethylbenzene
4. Chlorinated ethylenes:
 - a. Vinyl chloride
5. Polynuclear aromatics:
 - a. Naphthalene
6. Chlorobenzenes:
 - a. 1,2-dichlorobenzene
7. Phthalate esters:
 - a. Di (2-ethylhexyl) phthalate
 - b. Butyl benzyl phthalate
 - c. Di-n-butyl phthalate
 - d. Di-n-octyl phthalate
 - e. Diethyl phthalate
 - f. Dimethyl phthalate
8. Miscellaneous semi-volatile organics:
 - a. Isophorone
9. Metals and their compounds:
 - a. Antimony
 - b. Cadmium
 - c. Hexavalent chromium
 - d. Lead
 - e. Mercury
10. Preservatives (anti-fouling agents)
 - a. Formaldehyde
11. Ketones:
 - a. Methyl ethyl ketone
 - b. Methyl isobutyl ketone
12. Miscellaneous volatile organics:
 - a. Acrolein

b. Acrylonitrile

E. Packaging Requirements:

1. Toxics in packaging:

- a. The manufacturer shall demonstrate that paint cans and their components are not fabricated with lead.

1.06 DEFINITIONS

- A. Anti-corrosive Paints: Coatings formulated and recommended for use in preventing the corrosion of ferrous metal substrates.
- B. Paint: Liquid, liquefiable or mastic composition that is converted to a solid protective, decorative, or functional adherent film after application as a thin layer. These coatings are intended for on-site application to interior or exterior surfaces of residential, commercial, institutional or industrial buildings.
- C. Flat coatings are coatings that register a specular gloss of less than 15 on an 85 degree meter or less than 5 on a 60 degree meter, per ASTM D523.
- D. Non-flat coatings are coatings that register a specular gloss of 5 or greater on a 60 degree meter or a specular gloss of 15 or greater on an 85 degree meter, per ASTM D523.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the job site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:
1. Product name or title of material.
 2. Product description (generic classification or binder type).
 3. Federal Specification number, if applicable.
 4. Manufacturer's stock number and date of manufacture.
 5. Contents by volume, for pigment and vehicle constituents.
 6. VOC content.
 7. Thinning instructions.
 8. Application instructions.
 9. Color name and number.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 degrees F (7 degrees C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.
1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and

application.

- C. Provide coating systems which are VOC compliant as specified.

1.08 JOB CONDITIONS

- A. Section 01 60 00 – Product Requirements.
- B. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by paint manufacturer.
- C. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F (10 degrees C) and 90 degrees F (32 degrees C).
- D. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F (7 degrees C) and 95 degrees F (35 degrees C).
- E. Do not apply paint in snow, rain, fog or mist, when the relative humidity exceeds 85 percent, at temperatures less than 5 degrees F (3 degrees C) above the dew point, or to damp or wet surfaces.
 - 1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.
- F. Provide lighting level of 80-foot candle measured mid-height at substrate surface.

1.09 EXTRA MATERIAL

- A. Provide one gallon of each different paint system and color with manufacturer's name and color clearly labeled on the top of each container.

1.10 PRE-PAINTING CONFERENCE

- A. Prior to finish painting, exterior and interior, General Contractor shall schedule a "Pre-Painting Conference" to be attended by the Architect, Contractor, painting subcontractor and Manufacturer's Representative. (Manufacturer's Rep. to attend when required for special finishes.)
- B. Agenda to include submittal of color and finishes sample (RE: Article 1.04 "Submittals" and review of color schedule.
- C. Contractor to record discussions of conference including agreements and/or disagreements and distribute a copy of record to each party in attendance.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design: Contract Documents are based on manufacturer and product named below to establish a standard of quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and does not change concept as expressed in Contract Documents as judged by Architect.

1. Basis of Design Product Selections: Sherwin-Williams.
- B. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of the manufacturers named alphabetically below. If not named, submit as substitution according to Conditions of the Contract and appropriate Division 1 sections.
 1. Benjamin Moore and Co.
 2. Pratt & Lambert

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions under which painting will be performed for compliance with requirements for application of paint. Do not begin paint application until unsatisfactory conditions have been corrected.
 1. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

3.02 PREPARATION

- A. General Procedures: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items in place that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.
 1. Clean surfaces before applying paint or surface treatments. Remove oil and grease prior to cleaning. Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- B. Surface Preparation: Clean and prepare surfaces to be painted in accordance with the manufacturer's instructions for each particular substrate condition and as specified.
 1. Provide barrier coats over incompatible primers or remove and reprime. Notify Architect in writing of problems anticipated with using the specified finish-coat material with substrates primed by others.
 2. Ferrous Metals: Clean non-galvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of the Steel Structures Painting Council.
 - a. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by the paint manufacturer and touch up with the same primer as the shop coat.
 3. Galvanized Surfaces: Allow to weather a minimum of 6 months prior to coating. Clean per SSPC-SP1 using detergent and water or a degreasing cleaner, then prime as required. When weathering is not possible or the surface has been

treated with chromates or silicates, first Solvent Clean per SSPC-SP1 and apply a test area, priming as required. Allow the coating to dry at least one week before testing. If adhesion is poor, Brush Blast per SSPC-SP7 as necessary to remove these treatments.

4. Drywall: Surface must be clean and dry. All nail or screw heads must be set and spackled. Joints must be taped and covered with joint compound. Spackled fastener heads and tape joints must be sanded smooth and all dust removed prior to painting.
 - a. Where Level 5 Finish is provided, ensure finish is level and smooth and ready for priming and painting.
 5. Previously coated surfaces including previously primed surfaces: Remove all surface contamination such as oil, grease, loose paint, mill scale, dirt, rust, mold, mildew, mortar efflorescence and scalers. Glossy surfaces of old paint films shall be clean and dull before painting. Clean and dull surface either by washing with an abrasive cleaner, or by washing and sanding. Spot prime bare areas with appropriate primer. Check for compatibility by applying a test patch of the specified system, coating an area of 3 square feet. Allow to dry for one week before testing adhesion as per ASTM D3359. If coating is incompatible, prepare surface in conformance with ASTM D4259.
- C. Materials Preparation: Carefully mix and prepare paint materials in accordance with manufacturer's directions.
1. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
 2. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and if necessary, strain material before using.
 3. Use only thinners approved by the paint manufacturer, and only within recommended limits.

3.03 APPLICATION

- A. Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Non-zinc coated architectural metals, steel doors and steel frames shall have all coatings spray applied. Brush application is not acceptable.
- B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, form release agents, sealers or conditions detrimental to formation of a durable paint film.
1. Paint colors, surface treatments, and finishes are indicated in "schedules."
 2. Provide finish coats that are compatible with primers used.
 3. The number of coats and film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where

- sanding is required to produce an even smooth surface in accordance with the manufacturer's directions.
4. Apply additional coats when undercoats, stains or other conditions show through final coat of paint until paint film is of uniform finish, color and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.
 5. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned tube radiation, grilles, and similar components are in place. Extend coatings in these areas as required to maintain the system integrity and provide desired protection.
 6. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.
 7. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint.
 8. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 9. Finish exterior doors on tops, bottoms, side edges and interior surfaces same as exterior faces.
 10. Sand lightly between each succeeding enamel or varnish coat.
 11. Apply a primer as scheduled over all surfaces that are shop primed from the manufacturer/fabricator that are scheduled to be painted.
- C. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pre-treated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure and where application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.
- D. Minimum Coating Thickness: Apply materials at not less than the manufacturer's recommended spreading rate. Provide a total dry film thickness of the entire system as recommended by the manufacturer.
- E. Mechanical and Electrical work: Painting mechanical and electrical work is limited to items exposed in mechanical equipment rooms and in occupied spaces.
- F. Prime Coats: Before application of finish coats, apply a prime coat of material as scheduled to material that is required to be painted or finished. Reprime surfaces that are factory primed. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears to assure a finish coat with no burn through or other defects due to insufficient sealing.
- G. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps,

brush marks, runs, sags, ropiness or other surface imperfections will not be acceptable.

- H. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

3.04 CLEANING

- A. Cleanup: At the end of each work day, remove empty cans, rags, rubbish and other discarded paint materials from the site.
- B. Upon completion of painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping, using care not to scratch or damage adjacent finished surfaces.

3.05 PROTECTION

- A. Protect work of other trades, whether to be painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing and repainting, as acceptable to Architect.
- B. Provide "wet paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.
 - 1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.06 EXTERIOR PAINT SCHEDULE

- A. General: Provide the following paint systems for the various substrates, as indicated:
- B. Metals
 - 1. Ferrous Metal:
 - a. Gloss Waterbased Acrylic Polyurethane Enamel: 2 finish coats over primer on properly prepared surface.
 - b. Primer (bare/unpainted steel surface):
 - 1) Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer (B66-310 Series) (5.0-10.0 mils wet, 1.8-3.6 mils dry).
 - c. First and Second Coats:
 - 1) Sherwin-Williams Waterbased Acrolon 100 Polyurethane Gloss (B65-700 Series) (4.0 – 8.0 mils wet, 2.0 – 4.0 mils dry per coat) spray applied.
 - 2. Zinc-Coated Metal:
 - a. Gloss: Waterbased Acrylic Polyurethane Enamel: 2 finish coats over primer on properly prepared surface.
 - b. Primer (bare/unpainted steel surface):
 - 1) Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer (B66-310 Series) (5.0-10.0 mils wet, 1.8-3.6 mils dry).

- c. First and Second Coats:
 - 1) Sherwin-Williams Waterbased Acrolon 100 Polyurethane Gloss (B65-700 Series) (4.0 – 8.0 mils wet, 2.0 – 4.0 mils dry per coat) spray applied

3.07 INTERIOR PAINT SCHEDULE

- A. General: Provide the following paint systems for the various substrates as indicated.
- B. Drywall (walls): Furnish sample on 2 feet by 2 feet piece of drywall for Architect to approve prior to application.
 - 1. Gypsum Drywall Systems:
 - a. Semi-gloss latex enamel: 2 finish coats over primer on properly prepared surface.
 - b. Texture: Level 5 Finish:
 - 1) Refer to Section 09 21 16 – Gypsum Board Assemblies for Level 5 finish.
 - c. Primer: VOC 0 g/L < maximum VOC content of 50 g/L.
 - 1) Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer (B28W2600 Series) (4.0 mils wet, 1.5 mils dry).
 - d. First and Second Coats: VOC 0 g/L < maximum VOC content of 50 g/L.
 - 1) Sherwin-Williams ProMar 200 Zero VOC Latex Semi-Gloss (B31-2600 Series) (4 mils wet, 1.7 mils dry per coat).
 - 2. Gypsum Drywall Systems, previously coated surfaces:
 - a. Semi-gloss latex enamel: 2 finish coats over primer on properly prepared surface.
 - b. Primer (Verify compatibility of primer with existing paint system): **VOC 0 g/L < maximum VOC content of 50 g/L.**
 - 1) Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer (B28W2600 Series) (4.0 miles wet, 1.5 mils dry).
 - c. First and Second Coats: **VOC 0 g/L < maximum VOC content of 50 g/L.**
 - 1) Sherwin-Williams ProMar 200 Zero VOC Latex Semi-Gloss (B31-2600 Series) (4 mils wet, 1.7 mils dry per coat).
- C. Drywall (Ceilings): Furnish sample on 2' x 2' piece of drywall for Architect to approve prior to application.
 - 1. Gypsum Drywall System:
 - a. Texture: Level 5 finish where glass mat gypsum wall board is installed.
 - b. Flat latex: 2 finish coats over primer on properly prepared surface.

- c. Primer: VOC 0 g/L < maximum VOC content of 50 g/L.
 - 1) Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, (B28W2600 Series) (4.0 mils wet, 1.5 mils dry)
- d. First and second coats: VOC: 0 g/L < maximum VOC content of 50 g/L.
 - 2) Sherwin-Williams ProMar 200 Zero VOC Flat Interior Latex (B30-2600 Series) (4.0 mils wet, 1.8 mils dry per coat)

END OF SECTION

SECTION 10 28 00 – TOILET, BATH AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Toilet, washroom accessories.
- B. Grab bars.
- C. Attachment hardware.
- D. Molded pipe insulation.

1.02 RELATED SECTIONS

- A. Section 06 10 53 – Miscellaneous Carpentry: Wood backing.
- B. Section 09 22 16 – Non-Structural Metal Framing: Wood and steel backing.

1.03 REFERENCES

- A. ASTM International:
 - 1. ASTM A125/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 2. ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 3. ASTM A269 – Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - 4. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 5. ASTM A666 – Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - 6. ASTM B456 – Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
 - 7. ASTM C1036 – Standard Specification for Flat Glass.
- B. Federal Specification Unit:
 - 1. FS A-A-3002 – Mirrors, Glass.

1.04 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures.
- B. Product Data: Provide data on accessories describing size, finish, details of function,

attachment methods.

C. Manufacturer's Installation Instructions.

1.05 REGULATORY REQUIREMENTS

A. Conform to ADA (Americans with Disabilities Act) code for access for the handicapped.

1.06 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on product data.

1.07 COORDINATION

A. Coordinate the work with the placement of internal wall reinforcement and reinforcement of toilet partitions to receive anchor attachments.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ASI.
- B. Bobrick Washroom Equipment, Inc.
- C. Bradley Inc.
- D. Truebro, Inc. Model No. 102.
- E. Substitutions: Under provisions of Section 01 60 00.

2.02 MATERIALS

- A. Sheet Steel: ASTM A366.
- B. Stainless Steel Sheet: ASTM A666, Type 304.
- C. Tubing: ASTM A269, stainless steel.
- D. Mirror Glass: Float glass, Type I, Class 1, Quality q1 (ASTM C1036), with silvering, copper coating, and suitable protective organic coating to copper backing in accordance with FS A-A-3002.
 - 1. Provide tempered glass.
- E. Adhesive: Two-component epoxy type, waterproof.
- F. Fasteners, Screws and Bolts: Hot-dip galvanized, tamper-proof.
- G. Expansion Shields: Fiber, lead or rubber as recommended by accessory manufacturer for component and substrate.
- H. Anchor Plates: Provide grab bar manufacturer's standard anchor plates for grab bar

installation required. Anchor plates shall be a minimum of 12-gauge steel with mounting holes.

- I. Piping Insulation: Fully molded, closed-cell vinyl, complying with ASTM D635 for burning characteristics and ASTM C177, thermal conductivity.

2.03 FABRICATION

- A. Weld and grind joints of fabricated components, smooth.
- B. Form exposed surfaces from single sheet of stock, free of joints. Form surfaces flat without distortion. Maintain surfaces without scratches or dents.
- C. Fabricate grab bars of tubing, free of visible joints, return to wall with end attachment flanges. Form bar with 1-1/2 inches clear of wall surface. Knurl grip surfaces.
- D. Shop assemble components and package complete with anchors and fittings.
- E. Provide steel anchor plates, adapters and anchor components for installation.

2.04 KEYING

- A. Master key all accessories; supply 6 keys to Owner.

2.05 FINISHES

- A. Galvanizing: ASTM A123 to 1.25 oz/sq.yd. Galvanize ferrous metal and fastening devices.
- B. Shop Primed Ferrous Metals: Pre-treat and clean, spray apply one coat primer and bake.
- C. Chrome/Nickel Plating: ASTM B456, Type SC 2 satin finish.
- D. Stainless Steel: No. 4 satin luster finish.
- E. Back paint components where contact is made with building finishes to prevent electrolysis.
- F. Molded Pipe Insulation: Light Grey.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that site conditions are ready to receive work and dimensions are as instructed by the manufacturer.
- B. Verify exact location of accessories for installation.

3.02 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions and ADA.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. At all specified "handicapped" lavatories, provide molded insulation at P-traps and hot and cold-water angle valves.

3.04 SCHEDULE (Note: Toilet accessories listed are based on products from Bobrick unless otherwise indicated.)

- TA-1 Grab bar: B-6806.99-42" (NOTE: In locations where the flush valve conflicts with the grab bar, the rear grab bar shall be 36" long and located on the open side of the toilet area. Center the grab bar between the flush control and the wall or lavatory)
- TA-2 Grab bar: B-6806.99-48"
- TA-3 Not Used
- TA-4 Not Used
- TA-5 Not Used
- TA-6 Surface mounted dual roll toilet tissue dispenser (OFCI)
- TA-7 Surface mounted soap dispenser (OFCI)
- TA-8 Steel channel frame tempered mirror, custom size, B-1658-1840.
- TA-9 Not used
- TA-10 Not used
- TA-11 Not used
- TA-12 Surface-mounted sanitary napkin disposal: B-270.
- TA-13 Not used
- TA-14 Not used
- TA-15 Not used
- TA-16 Not used
- TA-17 Surface-Mounted Paper Towel Dispenser (OFCI)

END OF SECTION

SECTION 22 00 01 – BASIC PLUMBING REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Basic Plumbing Requirements specifically applicable to each Division 22 Section, in addition to Division 1 - General Requirements.

1.02 REFERENCES

- A. All references in Division 22 to codes, standards or other publications shall be the latest edition/version, unless noted otherwise.

1.03 PLANS

- A. These specifications are accompanied by plans indicating typical layouts, pipe and equipment location, etc. The plans and these specifications are complimentary each to the other and what is called for by one shall be as binding as if called for by both. Should there be a conflict between drawings and specifications regarding a material shown of work described or detailed then the material of work having the greater value shall be provided.
- B. The plans as prepared are in general diagrammatic. The contractor shall carefully lay out his work at the site to conform to the architectural, mechanical, electrical and structural conditions to provide grading of piping, to avoid all obstructions and to conform to details of installation as shown on the plans and supplied by the manufacturers of the equipment to be installed, and thereby to provide an integrated satisfactorily operating installation. **The General Contractor must coordinate the work of all trades.** All necessary offsets in piping, fittings, ductwork, etc. required to avoid interferences between piping, equipment, structural and architectural work are not shown but shall be furnished and installed by the contractor without additional expense to the Owner.
- C. These specifications and plans accompanying same are intended to cover systems which will not interfere with the design of the building, which will fit into the available spaces, and which will insure complete and satisfactory systems. Each contractor shall, therefore, carefully examine the plans and the building and shall be responsible for the proper fitting of his material and apparatus into the building.
- D. Contractor's attention is directed that all equipment he proposes to furnish shall fit into the spaces allocated for same on the plans. It shall be the Contractor's responsibility to furnish data to evidence that sufficient space can be provided for the installation of proposed equipment and that adequate access will exist for servicing and maintenance of equipment. Should changes become necessary during construction, the contractor shall make such necessary changes at his (the Contractor's) own expense.
- E. Exceptions and inconsistencies in plans and specifications shall be brought to the Architect's attention no later than ten (10) days prior to the bid date. Otherwise, the Contractor shall be responsible for any and all changes and additions that may be necessary to accommodate his particular apparatus or equipment.

1.04 CHANGES

- A. Any changes from the plans necessary to make this work conform to the building as it is constructed, to make this work fit the work of other trades or to make this work conform to the rules of city and municipal bodies having jurisdiction shall be made by this contractor at no additional cost to the Owner. However, no changes shall be made from the work described on the plans and these specifications except on written order from the Architect.
- B. If any changes are required other than those mentioned above and the changes involve extra work on the part of the contractor, no charges for this extra work shall be allowed unless authorized in advance of the work by a written order from the Owner and/or Architect stating the charges to be made for the work.
- C. Proposed use of item or equipment other than that specified or indicated may require redesign of structure, partitions, foundations, piping, wiring, or other parts of mechanical, electrical, or architectural layout. Redesign, new drawings, and detailing required shall be prepared and submitted to Architect/Engineer for approval.
- D. Where approved deviation requires different quantity, size and arrangement of wiring, conduit, equipment, etc. from that specified or indicated; provide such items and all other additional equipment required by system at no additional cost to the Owner.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Protection:
 - 1. All work, equipment and materials shall be protected at all times to prevent damage or breakage either in transit, storage, installation or testing. All openings shall be closed with caps or plugs during installation.
 - 2. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the owner has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
 - 3. Damaged equipment or material shall be replaced with new as determined and directed by the Architect or Engineer. In particular, piping insulation which becomes saturated will be rejected and must be removed from the job site. Such repair or replacement shall be at no additional cost to the Owner.
 - 4. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
 - 5. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.
- B. Cleanliness of Piping and Equipment Systems:
 - 1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.

2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Owner.
4. Boilers shall be left clean following final internal inspection by the inspector.
5. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.06 EXISTING FACILITIES

- A. All piping, valves, fittings, switches, starters, conduit boxes and/or any other items of plumbing, mechanical or electrical equipment which are not in service at the completion of this contract shall be removed, unless otherwise noted.
- B. Where an existing service to existing building requires disconnection to facilitate installation of this work, this Contractor shall include in his bid the cost of such disconnecting, re-routing and re-connecting. Where any existing facilities, which are to remain occupied, are affected by disconnection, re-routing or re-connection, then such disconnecting, re-connecting and re-routing shall be done in such a manner so as not to interrupt any service to the building. Satisfactory arrangements shall be made with local authorities and/or the various utility companies involved. The method of disconnecting, re-routing and re-connecting shall be as shown on the Drawings, or if not shown on the drawings, subject to the approval of the Architect and Owner.
- C. Unless noted otherwise, all equipment and material indicated or specified to be removed shall become the property of the Contractor.
- D. This Contractor shall carefully coordinate work in and around existing services and equipment and adjoining rooms to remodel areas. Coordinate shut-down, removal, capping, and turn-on of existing services with the Owner's facilities' department and general contractor to provide continuous (uninterrupted) service throughout the construction period. This Contractor shall refer to the architectural plans and specifications and thoroughly familiarize himself with the construction phasing in remodel areas before beginning work.
- E. Building Working Environment: Maintain the architectural and structural integrity of the building and the working environment at all times. Limit the opening of doors, windows or other access openings to brief periods as necessary for rigging purposes. No storm water or ground water leakage permitted. Provide daily clean up of construction and demolition debris on all floor surfaces and on all equipment being operated by the Owner.

1.07 SUBSTITUTIONS

- A. The materials, products and equipment described and specified establish a standard of quality, function, dimension and appearance to be met by any proposed substitutions.
- B. Reference Section 01 60 00 – Product Requirements.
- C. Substitution requests are only required where specific manufacturers are listed or scheduled.

1.08 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. The Contractor shall furnish copies of the manufacturer's literature and drawings describing all proposed equipment and materials indicated in the specifications. The proposed use of the exact equipment and materials specified shall not change this requirement of including literature describing the proposed equipment. Manufactured items proposed for use, whether specified or proposed for substitution, shall be the current, catalogued product of the manufacturer, and replacement parts shall be available.
- C. Manufacturer's regular catalog sheets will not be acceptable under this requirement unless they indicate completely all of the specification requirements. Where drawings cover several sizes or types of construction they shall clearly indicate the size or type of construction to be used on the project. In cases where several sizes of the same type of equipment are required to be furnished, the submittal shall include a schedule identifying each piece of equipment, complete with all capacity information needed to compare every submitted item with its respective specified item. **Annotate all submittal data to indicate exact model, size, and type submitted.**
- D. Brochures shall contain a certification that the equipment or materials are suitable for conditions shown and specified; that the equipment or materials are believed to be in conformity with the plans and specifications, except as may be specifically described and that approval is recommended. The certification shall be signed by the Contractor. Brochures received not in conformity with these requirements will be returned for required actions. Any deviation from the requirements of the specifications shall be clearly noted and marked for the Engineer's consideration.
- E. Approval of the brochures, or any part of the contents therein, shall not eliminate responsibility for compliance with the plans and specifications, unless specific attention has been called in writing to proposed deviations at the time of transmittal of the brochures and such deviations have been approved, nor shall it eliminate the requirements or the responsibilities, if there are errors of any sort in the data submitted.
- F. Sustainable Design Documentation Submittals: Provide any submittals required to document conformity to AISD Sustainability Scorecard criteria on a scheduled basis as requested by Architect. For each submitted material and product requiring sustainability documentation, provide filled out AISD Sustainability Submittal Sheet
 - 1. Basic Requirement Documentation: Provide the following required documentation to verify compliance with AISD Sustainability Scorecard Minimum Requirements:
 - a. Building Systems Commissioning – Mechanical, Electrical, Plumbing: Comply with Division 1 Section 019113 “Commissioning Requirements” and prepare Basis of Design.
 - b. Building Water Use Reduction: Submit cut sheets for all faucets, showerheads, toilets and urinals indicating flow rates (gallons/minute) and flush volumes (gallons/flush).
 - c. Low VOC Interior Adhesives and Sealants, Paints and Coatings: Submit product data and/or Material Safety Data Sheets (MSDS) for all adhesives and sealants, paints and coatings used inside the building's moisture barrier indicating the VOC content of each product and verifying that each product meets the requirements of Green Seal; GS-11, SCAQMD Rule 1113, and SCAQMD Rule 1168 as relevant.

1.09 INTERFERENCES AND COOPERATION

- A. The plans are generally diagrammatic and the Contractor shall coordinate the work of the different trades so that interferences between piping, equipment, structural and architectural work will be avoided. Not all offsets in piping, ductwork, etc., are shown. The Contractor shall cooperate with the General Contractor and all other contractors to coordinate their work to avoid interferences and delays and arrange all parts of the work to harmonize in service and appearance with all other parts.
- B. The General Contractor shall coordinate the work of all trades. The various systems to be installed shall follow the normal, common sense priority of systems installation with the highest system to lowest system installation as follows:
1. HVAC ductwork shall be installed up and against building (floor/roof) structural members.
 2. Sanitary waste and storm drainage piping system shall begin horizontal routing as high as possible between structural members, offsetting vertically only to avoid conflict with structure or to drop below HVAC ductwork where offset is unavoidable.
 3. Electrical conduit shall be installed up, and against building structure, running parallel with HVAC ductwork and offsetting up into structural bay (void) or below HVAC ductwork to obtain a change in direction or branch take-off. Electrical conduit installation shall not control or dictate the routing or installation of the HVAC ductwork storm drain piping or sanitary waste and vent piping.
 4. Domestic water piping (hot water, cold water and hot water return), medical gas piping and HVAC piping shall be installed beside and below the HVAC ductwork and electrical conduit. Preferred installation shall be on trapeze, wall brackets, or racked on vertical channel on the wall above the ceiling line. The completed installation shall not conflict with the installation or removal of ceiling system components or tile. All main and branch take-off isolation valves, strainers, sensors and other plumbing equipment shall be readily identifiable and accessible from a standing position on a step ladder, no more than 18 inches above ceilings.
 5. Fire sprinkler piping system shall be installed below all other systems and components, unless noted otherwise or as coordinated with all other trades. The fire sprinkler piping shall not conflict with the installation or removal of ceiling system components or tile. The fire sprinkler system piping layout and installation shall be coordinated by the fire sprinkler contractor and the General Contractor with all other trades performing work in the affected area, to avoid conflict with the installation or removal of any other systems components, or to prevent ready access to valves, equipment of the other trades. Do not install sprinkler piping until ductwork mains are in place.
- C. Provide an overhead coordination submittal per Section 01 30 00. The submittal shall include all structural, plumbing, mechanical, electrical, and fire protection components.

1.10 MATERIALS AND WORKMANSHIP

- A. All materials shall be new, of the quality specified and free of any defects. Manufacturer's names are listed to establish a standard of quality and construction.

- B. The Contractor will be responsible for transportation of his materials to the job and for their storage and protection until the final acceptance of the job.
- C. Contractor shall furnish all necessary scaffolding, tackle, tools and appurtenances of all kinds and all labor required for the safe and expeditious execution of his contract.

1.11 PERMITS AND INSPECTIONS

- A. The Contractor will be responsible for all permits and inspections required by law for the completion of his work. Cost of all permits and inspections shall be paid for by the Contractor. The Contractor shall obtain and pay for all certificates of approval which must be delivered to the Architect before final acceptance of the job. All materials and labor furnished by the Contractor shall be in strict accordance with the rules and requirements of the National Board of Fire Underwriters, state and municipal regulations and other authorities who may have lawful jurisdiction over the work being done.
- B. Each contractor shall be responsible for coordinating their work with the General Contractor and scheduling AHJ required inspections through the General Contractor to allow inspections to be performed without impeding the progress of construction. Generally, the Contractor shall plan for inspections to occur two (2) weeks prior to the scheduled concealment of work in the area of inspection.

1.12 ENGINEERING DESIGN TEAM OBSERVATIONS

- A. Each contractor shall be responsible for coordinating their work with the General Contractor and scheduling progress observations through the General Contractor to allow for the following observations to be performed without impeding the progress of construction. Generally the Contractor shall plan for observations to occur two (2) weeks prior to the scheduled concealment of work in the area of observation.
- B. The minimum observations required for this project shall include but not be limited to:
 - 1. Exterior Below Grade: Site utilities and services.
 - 2. Interior Below Grade: Utilities, services and systems.
 - 3. Rough Wall: All utilities, services and systems in-place including wall studs, cross bracing, supports, etc. (No sheetrock or insulation).
 - 4. Corrected Rough Wall: (Before Sheetrock).
 - 5. Above Ceiling: All utilities, services and systems in place, labeling on exposed piping (No insulation on piping systems. Ceiling grid/channels may be installed but no sheetrock or ceiling tile).
 - 6. Above Ceiling Final: All utilities, services and systems complete including hangers, insulation, and labeling (ceiling grid and/or channel may be in place but no sheetrock or ceiling tile shall be installed).
 - 7. Substantial Completion: All surfaces complete, fixtures installed and trim-out complete.
 - 8. Final: Cleaned and ready for occupancy.

1.13 EXAMINATION OF SITE

- A. All Contractors submitting proposals for this work shall first examine the site and all conditions thereon and therein. All proposals shall take into consideration conditions as may affect the work under this contract. They shall satisfy themselves as to existing grades and the actual formation, and soil conditions.
- B. They shall verify all service locations, depths, sizes, etc. No information given on the plans shall relieve the Contractor of this responsibility.

1.14 QUALITY ASSURANCE

- A. Perform Work in accordance with all codes listed on the drawing sheets, the local authority having jurisdiction (AHJ), and the Architect/Engineer. As the minimum standard for the level of quality, in all cases the greater quantity or better quality shall be the first consideration for the basis of an acceptable product or process. The local authority having jurisdiction, the Architect and the Engineer shall have the final authority on the approval and/or use of any product or process specified or submitted for substitution. The greater quality and/or value specified herein for the system(s) and various components and installation procedures shall take precedence over the minimum requirements of the herein before mentioned codes.
- B. Equipment and Components: Bear UL, ASME, ANSI and/or NSF label or marking, as specified in appropriate Section.
- C. Valves: Provide manufacturer's name and pressure rating marked on valve body.
- D. Piping: All piping installed on this project shall bear the complete ASTM and Manufacturer's marking. Labeling and identification requirements as required by ASTM. All installed piping 5'-0" or greater in length shall be readily identifiable per ASTM labeling criteria. Piping not bearing this identification upon installation shall be removed and replaced by the correctly labeled piping. Piping shall not be re-stenciled after it is installed, to meet this requirement.
- E. Lead free components: All wetted surfaces of piping, fittings, valves and other products in contact with the potable water system shall be certified as lead free, as per current requirements of NSF/ANSI 61 and/or NSF/ANSI 372.
- F. Welding Materials and Procedures: Perform to ASME Code.

1.15 CONTROLS

- A. Where "automatic controls" are called for in the plans and specifications, all the control instruments, such as motorized valves, etc., shall be provided by the Contractor. The Drawings may show some power connections to controls equipment; however, if more power is required, then the Contractor shall provide this power.

1.16 UNIONS

- A. No unions are to be placed in any pipe in a location which will be concealed or inaccessible after completion of the building unless furnished with an access panel either as shown on the drawings or as specified herein. Unions must be installed on each side of all pieces of equipment such as water heaters, water softeners, thermostatic mixing valves, flow regulators, pumps, etc., so that such equipment may be readily disconnected

in location that equipment can be disconnected and removed.

1.17 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Prepare equipment layout drawings to coordinate proper location and personnel access of all facilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the drawings.
- C. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- E. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- F. Electrical and Pneumatic Interconnection of Controls and Instruments: This is generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.
- G. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- H. Work in Existing Building: Cut required openings through existing masonry and reinforced concrete using 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 Owner. Locate openings that will least effect structural slabs, columns, ribs or beams.

1.18 TEMPORARY PIPING AND EQUIPMENT

- A. Continuity of operation of existing facilities may require temporary installation or relocation of equipment and piping. Temporary equipment or pipe installation or relocation shall be provided to maintain continuity of operation of existing facilities, when required by the phasing or called for specifically on the plans.
- B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities.

- C. When construction is complete, temporary facilities and piping shall be completely removed back to the nearest active distribution branch or main pipe line and any openings in structures sealed. Dead legs in potable water systems will not be allowed. Provide necessary blind flanges and caps to seal open piping remaining in service.

1.19 PLUMBING DEMOLITION

- A. Rigging access, other than indicated on the drawings, shall be provided by the Contractor. Such access shall be provided without additional cost or time to the Owner. Where work is in an operating facility, provide approved protection from dust and debris at all times for the safety of plant personnel and maintenance of plant operation and environment of the facility.
- B. In an operating facility, maintain the operation, cleanliness and safety. The Owner's personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and facility operation. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Do not permit debris to accumulate in the area to the detriment of facility operation. Perform all flame cutting to maintain the fire safety integrity of this facility. Adequate fire extinguishing facilities shall be available at all times. Perform all work in accordance with recognized fire protection standards.
- C. Completely remove all piping, wiring, conduit, and other devices associated with the equipment not to be re-used in the new work. This includes all pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.
- D. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from the property expeditiously and shall not be allowed to accumulate.

1.20 UTILITIES

- A. The Contractor shall arrange and pay for any necessary revisions to existing utility services, including meter deposits and connection fees to all serving utility companies and shall install utilities, where applicable.
- B. The Contractor shall be responsible for all costs associated with the extension of utilities to the Building, including but not limited to natural gas, domestic water, sanitary sewage and storm drain piping.

1.21 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.01 FACTORY-ASSEMBLED PRODUCTS

- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
 - 1. All components of an assembled unit need not be products of same manufacturer.
 - 2. Constituent parts that are alike shall be products of a single manufacturer.
 - 3. Components shall be compatible with each other and with the total assembly for intended service.
 - 4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment, which serve the same function, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

2.02 COMPATIBILITY OF RELATED EQUIPMENT

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

2.03 ESCUTCHEONS AND PLATES

- A. Where pipes pass through ceilings (any type: i.e. lay-in, gypsum, etc.) or walls in finished spaces, install sectional plates or escutcheons to cover the annular opening between pipe and sleeve. Solid plates with set screws shall be used where the sectional plates will not stay in place or are not available in the required size, or where other individual specification section(s) require one piece or greater quality escutcheons or plates.
- B. Inside diameter of escutcheons shall fit around insulation and around pipe when not insulated; outside diameter shall cover sleeve. Secure escutcheons or plates to pipe or sleeve but not to insulation. All escutcheons shall be triple nickel-chromium plated brass, or type 316L stainless steel.

2.04 INSULATION

- A. All insulation materials used inside the building on this project, including finishes and adhesives on the exterior surfaces of ducts, pipes and equipment shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less as determined by an independent testing laboratory in accordance with NFPA 255 as required by NFPA 90A, unless noted otherwise acceptable.

2.05 SOLENOID VALVES

- A. All solenoid valves used in piping systems shall be the slow acting type.

2.06 ASBESTOS

- A. Materials containing asbestos are not permitted.

2.07 LEAD

- A. Materials containing lead are not permitted.

PART 3 EXECUTION

3.01 ACCESS PANELS

- A. All valves, traps, drains, cleanouts, equipment, etc., must be accessible. The Contractor shall, wherever required to service his installation, coordinate size and location of access panels with General Contractor. Refer to Section 08 31 13 – Access Doors and Frames.

3.02 FIRESTOPPING

- A. Firestopping: Unused slots, sleeves and other penetrations in floors, walls or other general construction shall be closed and sealed with an approved firestopping material.
 - 1. Reference Section 07 84 00 – Firestopping for appropriate firestopping material and method of installation required for each wall rating and penetration size and type to comply with the appropriate UL listing.
 - 2. Floor slots and openings shall be closed with 16 gauge galvanized steel sheet supported on 1-inch by 1-inch by 1/8-inch structural angle drilled or supported with powder-driven studs into the building structure. Firestop with a layer of silicone elastomer not less than 1-inch thick which completely fills the opening. The top surface of the silicone elastomer shall be approximately 1-inch below the finished floor slab.
 - 3. Openings in walls shall be closed with 16 gauge galvanized steel sheet securely attached at the midpoint of the wall thickness and firestopped on both sides of the steel sheet with not less than 1/8-inch thick layer of non-sagging silicone elastomer to fully cover the opening.
 - 4. Single or multiple pipes passing through walls and floors shall have the annular space between pipes or between pipes and structure filled with silicone elastomer to provide a rated firestop (rated to match the assembly) for floors and walls.
- B. The annulus between exposed pipe and walls or floors in finished spaces shall be refilled, sealed and painted to match adjacent surfaces.
- C. Future Slots: Cap ends of sleeve and mark as future.

3.03 CUTTING AND PATCHING

- A. All cutting and patching of floors, walls and ceilings for installation of work covered in these sections will be done by the General Contractor.

- B. Where it becomes necessary to drill into or cut through any existing or completed floors, walls or ceilings to permit the installation of any work under this contract or to repair any defects that may appear up to the expiration of the guarantee, such cutting and patching shall be done by the General Contractor under the supervision of the Architect.
- C. No joists, beams, girders or columns shall be cut without first obtaining written permission from the Architect.
- D. All drilling methods for expansion bolts, hangers and other supports shall be done subject to be approval of the Architect. Labor and materials required to replace or rebuild parts or injured portions shall be furnished at the Contractor's expense, subject to the satisfaction of the Architect.
- E. The annulus between exposed pipe and walls or floors in finished spaces shall be refilled, sealed and painted to match adjacent surfaces.

3.04 PAINTING

- A. Types of paint shall be as specified in the Architectural specifications. Surfaces to be painted are identified in Section 09 90 00 and on the drawings. All exposed gas piping shall be painted as noted in Section 22 11 23.
- B. All surfaces to be painted shall be thoroughly cleaned, all rust scraped off and all oil and grease removed before any paint is applied.
- C. Finishing paint coats shall not be applied until all the work is completed. Cloths shall be spread where necessary to prevent drops of paint, oil, etc. from defacing walls, floors, etc., and the Contractor shall be held responsible for all damage by neglect of such precautions. The finished conditions of the painting shall be subject to the approval of the Architect, who may require retouching or repainting of surfaces not properly finished.

3.05 PRODUCTS NOT FURNISHED BUT INSTALLED UNDER DIVISION 22.

- A. Rough-in for and make final connection to Owner furnished fixtures and equipment requiring plumbing services.
- B. Rough-in for and make final connection to fixtures and equipment furnished under other divisions of these Contract Specifications requiring plumbing services.

3.06 EXCAVATING AND BACKFILLING

- A. The Contractor shall do all excavating and backfilling necessary for the installation of the work, including shoring, bailing and pumping to maintain his trenches and keep them in dry condition until the work in question has been tested and approved.
- B. Care shall be taken that piping is properly and uniformly graded and that trench beds are well rammed and that ground under pipelines is firm and secure before piping is laid. All trenches must be backfilled with clean sand, four inches under pipe, rammed down, soaked with water and made solid. All surplus material shall be removed and carted away.
- C. The Contractors will be responsible for resurfacing all areas after trenches have been backfilled.

- D. The Contractor is directed to comply with all OSHA Requirements and State Requirements regarding trench safety.
- E. Perform all work with the highest regard to safety and in accordance with U.S. 29 CFR 1926 "Safety and Health Regulations for Construction". Special attention shall be directed to Subpart P – Excavations. Refer also to 230010.1.12 – Safety.
1. Safety Precautions and Programs
 - a. In excavations that are four (4) feet or more in depth, means of egress shall be provided by stairway, ladder, ramp or other safe means so as to require no more than twenty-five (25) feet of lateral travel for employees.
 - b. In addition, on projects in which trench excavation will have a depth of five feet or more, the Contractor, and all of their subcontractors, shall comply with all requirements of 29 CFR 1926 Subpart P 652 "Safety and Health Regulations for Construction – Excavations" and all Appendices related thereto.
 - c. Before commencing any trench excavation that will be five (5) feet deep or deeper, provide Owner, through A/E, with detailed plans and specifications regarding the safety systems to be utilized. Said plans and specifications shall include a certification from a registered professional engineer indicating full compliance with the 29 CFR 1926 Subpart P -- Excavations.
 - d. Contractor shall ascertain, prior to proposal, whether or not such conditions prevail and services are needed, and shall include cost of same in proposal.
 2. All shoring and bracing shall be designed so that it is effective to the bottom of the excavation. Sheet piling, sheet piling, bracing, shoring, trench boxes, and other methods of protection, including sloping, shall be based upon the condition and nature of the materials to be retained, and by loads (including surcharge) imparted to the sides of excavation by equipment and stored materials.
 3. Store excavated or other materials a minimum of two feet (2') from the edge of any excavation. Retain such materials to prevent their falling or sliding into the excavation, and to prevent excessive pressure on the sides of the excavation.
 4. Maintain sides and slopes of excavations in a safe condition by scaling, benching or barricading.
 5. Take other precautions via shoring and bracing to prevent slides or cave-ins. Take special precautions when trenches are located adjacent to backfilled excavations, or subjected to vibrations from railroads, highway traffic, operation of machines, etc.
- F. Verify locations of all existing utilities in the area prior to start of excavation (gas, electrical, water, sanitary, storm, telephone, cable TV, optical cable, etc.). Coordinate with utility companies as required.
1. Excavation within four feet (4') of existing utilities shall be done by hand digging only.
- G. Where conditions require concrete or other materials to be placed against undisturbed

earth surfaces, any loosened or disturbed materials shall be removed from such surfaces.

H. Trenching

1. Trenches shall be large enough to permit handling of pipe and accessories and making connections. For cast iron pipe installation, trench bottom width shall exceed bell or coupling diameters by at least twelve inches (12").
2. Trenches in rock, soil containing rocks larger than two (2) inches in any dimension, and other non-uniform materials, shall be four (4) inches minimum and twelve inches (12") maximum below the bottom of the pipe to provide for a bedding course.

I. Preparation of Trench Bottom

1. If the excavation is carried below the finished flow line grade of the pipe in order to remove unsuitable material or for any other reason, the trench shall be course bedded to within six inches (6") of the finished flow line grade of the pipe bottom with compacted load-bearing backfill. A bedding course as specified below shall then be placed over the load-bearing backfill.
2. Trenches shall be dry when the trench bottom is prepared. A continuous trough with compacted bedding course shall be prepared to receive the bottom quadrant of the pipe barrel. Remove loose or disturbed material and bring the trench bottom up to grade with bedding material as follows:
 - a. For active soils where metallic piping is used, washed pea gravel with material no larger than 1/2 inch in largest dimension shall be utilized. Provide a Bentonite plug in the trench at the building perimeter where site drainage or other conditions could permit water intrusion into the trench under the building. Bentonite plug to extend 2 ft. on either side of the perimeter grade beam. (Sand bedding material may be substituted beyond ten (10) feet from building line only.)
 - b. NOTE: Confirm soil conditions prior to trenching. In general, soils with a plasticity index (PI) over 10 at depths to be encountered are considered active. Refer to Geotechnical Report included in project Specifications for PI value and additional information.
3. In addition, for bell joint pipe, excavation for the bell or coupling shall be so that the pipe will bear on the trench bottom along the entire length of the barrel.
4. Prepare the trench bottom carefully so that when placed in its final position, the pipe will be true to line and grade and uniformly supported.

J. Laying Pipe

1. All pipe shall be clean at the time it is placed in the line. Open ends of pipe sections already in place shall be tightly plugged to prevent the entrance of trench water, mud, dirt, etc.
2. Keep trench bottom free of frost, frozen earth or standing water at the time of pipe laying and jointing.

K. Compaction

1. Where compaction is indicated by specifications, accomplish same with vibratory or rammer type compactor, minimum of two full width passes.
2. Compaction below slabs, roads, flatwork, or other construction elements shall be performed to the requirements of compaction for those elements. Coordinate with general construction trades and other Division's specifications.

L. Backfilling

1. Clean trenches and backfill material of any organic material, roots, trash, lumber, other debris and frozen material prior to backfilling. Backfill material shall contain no organic material, roots, trash, lumber, other debris or frozen material. Backfill material under slabs inside building shall match adjacent materials and be of density acceptable to the A/E.
2. Backfilling by means of sluicing or flooding with water is not permitted. Backfill shall not be placed on frozen ground.
3. Partially backfill immediately after the pipe is laid (unless other methods for anchoring pipe are provided). Leave joints exposed for hydrostatic testing. Water shall not be permitted to rise in unbackfilled trenches after pipe has been placed.
4. Whenever timber or other sheeting is driven to a depth below the elevation of the top of the pipe, that portion of the sheeting below a point four feet above the elevation of the top of the pipe shall not be disturbed or removed.
5. Pipe layer backfill (bedding material under the bottom quadrant of the pipe, around sides, and up to a point one foot above the top of the pipe) shall be: sand or select material containing rocks no larger than 1/2 inch in greatest dimension (sand only shall be used with all plastic piping systems or plastic jacketed piping systems); except that pipe layer backfill below slabs in active soils shall be washed pea gravel of 1/2 inch minus dimensions. Backfill below slabs may utilize flowable fill.
6. Backfill material shall be placed and compacted in six inch (6") layers. Backfill shall be brought up evenly on both sides of the pipe simultaneously to avoid damage or displacement from unbalanced loading.
7. Joints shall not be covered with backfill until pressure and leak testing is completed.
8. Backfill to grade (above pipe layer).
 - a. Active Soils: Where active soils are encountered backfill to grade within ten (10) feet of building line shall be uncompacted washed pea gravel to match the pipe layer backfill specified above.

M. The Contractor shall also comply with requirements set forth in Division 31 Drawings and Specifications.

3.07 RIGGING

- A. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Government under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.
- C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Owner operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility.
- E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Restore building to original condition upon completion of rigging work.

3.08 CLOSE OUT DOCUMENTATION AND TESTING REPORTS

- A. Contractor shall provide Project Record Documents, Operation and Maintenance data and all product warranty data as specified in Section 01 70 00.
- B. Contractor shall also provide copies of all plumbing system test and certification reports for inclusion in project close out documents. Reports shall include, but shall not be limited to, the following:
 - 1. Piping system pressure test reports (per Sections 22 11 00, 22 11 23, 22 13 00 and 22 14 00),
 - 2. Domestic water disinfection tests (per Section 22 11 00),
 - 3. Backflow prevention assembly certifications (per Section 22 11 00),
 - 4. Domestic hot water systems tests (per Section 22 11 00),

END OF SECTION

SECTION 22 01 00
COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes commissioning process requirements for Plumbing systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section 019113- “GENERAL COMMISSIONING REQUIREMENTS” for general commissioning process requirements.
 - 2. Division 23 Section 230100 – “COMMISSIONING OF MECHANICAL SYSTEMS”.
 - 3. Division 26 Section 260100 - “COMMISSIONING OF ELECTRICAL SYSTEMS”.

1.3 DEFINITIONS

- A. Commissioning Authority (CxA): Independent agent hired by Owner and not associated with General Contractor or its subcontractors, Architect or its sub-consultants, or Construction Administrator or its staff or consultants. Under Owner’s direction, and not General Contractor’s direction, CxA will conduct third-party commissioning activities to verify installation and performance of systems.
- B. Refer to section 019113- GENERAL COMMISSIONING REQUIREMENTS for additional definitions and assignment of responsibilities.

1.4 CONTRACTOR’S COMMISSIONING RESPONSIBILITIES

- A. Refer to section 019113 - GENERAL COMMISSIONING REQUIREMENTS.
- B. Prepare submittals
- C. Review pre-functional/installation checklists prepared by CxA for plumbing system components.
- D. Complete pre-functional/installation checklists prepared by CxA.

- E. Provide competent technical personnel, tools, equipment, and manpower to assist CxA during field-verification of pre-functional checklists completed by Contractor.
- F. Provide competent technical personnel, tools, equipment, and manpower to assist CxA during functional testing of plumbing systems and equipment.
- G. Correct deficiencies identified by CxA in Commissioning Log, as directed by Design Team.
- H. Accompany CxA during verification of corrective action.
- I. Provide training.
- J. Provide O&M and As-built documentation
- K. Provide test data, inspection reports, and certificates.

1.5 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing pre-functional/installation checklists and manufacturer's pre-start and startup checklists for plumbing systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certification that installation, pre-start checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that plumbing systems, subsystems, equipment, and associated controls are ready for pre-functional third-party verification by CxA.
 - 6. Certificate of readiness certifying that plumbing systems, subsystems, equipment, and associated controls are ready for functional third-party testing by CxA.
 - 7. Test and inspection reports and certificates.
 - 8. Corrective action documents.

1.6 SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, pre-start, and startup activities.
- C. Plumbing equipment submittals and installation manuals.
- D. Plumbing shop and coordination drawings required for Commissioning.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to section 019113 - GENERAL COMMISSIONING REQUIREMENTS.

3.2 PRE-FUNCTIONAL CHECKLISTS

- A. Contractor shall conduct Pre-functional Testing to document compliance with installation and pre-functional checklists prepared by Commissioning Authority for Division-22 items.
- B. Refer to Section 019113 - GENERAL COMMISSIONING REQUIREMENTS for issues relating to pre-functional checklists and testing, description of process, details on non-conformance issues relating to pre-functional checklists and test.
- C. Do not proceed with system start-up or functional testing until after CxA has conducted third-party verification of pre-functional checklists.

3.3 SYSTEM START-UP

- A. Contractor is solely responsible for system start-up. CxA may, at his discretion, witness start up procedures, but will not perform any Functional Testing of systems until Contractor has completed start-up and resolved all operating deficiencies.

3.4 FUNCTIONAL TESTING PREPARATION

- A. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that plumbing instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that any required testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, and alarm conditions).
- E. Inspect and verify the position of each device and interlocks identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as required.

3.5 GENERAL FUNCTIONAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of plumbing testing shall include entire plumbing installation. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. Tests will be performed using design conditions whenever possible.
- E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. The CxA may direct that set points be altered when simulating conditions is not practical.
- F. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- G. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- H. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.6 GENERAL TESTING PROCEDURES FOR PLUMBING SYSTEMS, SUBSYSTEMS, AND EQUIPMENT

- A. Pipe system cleaning, flushing, hydrostatic test and chemical treatment requirements are specified in Division 22 piping Sections. Plumbing Subcontractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
 - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
 - 2. Description of equipment for flushing operations.
 - 3. Minimum flushing water velocity.
 - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- B. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of energy systems and equipment at the direction of the CxA. The CxA shall

determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

- C. Plumbing Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of hydronic and other distribution plumbing systems.

3.7 FUNCTIONAL TEST PROCEDURES FOR SYSTEMS TO BE COMMISSIONED

A. General

- 1. The following paragraphs outline the functional test procedures for the various Div. 22 items to be commissioned. Functional testing will take place only after pre-functional checklists have been completed, equipment has been started-up, TAB has been verified, and GC has certified that systems are ready for functional testing.

B. All Equipment

- 1. Verify nameplate information (serial numbers, model numbers, etc.); verify that equipment capacity is in accordance with requirements of construction documents.
- 2. Verify unit runs smoothly and quietly.
- 3. Verify operation of safeties.
- 4. Verify electrical wiring and grounding is correct.
- 5. Verify maintenance and NEC clearances are maintained.
- 6. Verify Pre-Functional Checklists have completed.

C. Domestic Water Heaters

- 1. Verify accuracy of temperature sensors and thermometers.
- 2. Verify operation of hot water heater control thermostats and thermometer.
- 3. Verify water pressure within appropriate pressure range.
- 4. Verify system cycles and ramps up/down to maintain DHW temperature setpoint.
- 5. Witness manufacturer startup.

D. Domestic Water System

- 1. Verify operation of all interior plumbing fixtures (water closets and urinals flush, all faucets work, no leaks are present, etc.)
- 2. Verify lack of water hammer, and water hammer arrestors are installed where called for.
- 3. Verify operation of trap primers.
- 4. Verify temperature control of thermostatic mixing valves, and that hot water is present at all hot water outlets, at desired temperature.
- 5. Verify correct piping and operation of domestic hot water circulating pumps.

E. Pumps

- 1. Verify operation of domestic hot water circulation pump.
- 2. Verify On/Off controls for domestic hot water circulation pump.
- 3. Verify operation of elevator sump pump.
- 4. Verify elevator sump pump controls and alarms.

- F. Other Plumbing Systems: Testing requirements for additional plumbing systems shall be identified by CxA prior to beginning of construction.

3.8 TRAINING

- A. Refer to section 019113 - GENERAL COMMISSIONING REQUIREMENTS.

3.9 O&M MANUALS

- A. Refer to section 019113 - GENERAL COMMISSIONING REQUIREMENTS and section 017800 CLOSEOUT SUBMITTALS.

END OF SECTION 22 01 00

SECTION 22 05 29 – HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Sleeves.
6. Mechanical sleeve seals.
7. Formed steel channel.
8. Equipment bases and supports.
9. Roof Supports.
10. Roof top pipe chase housing.

B. Related Sections:

1. Section 07 84 00 – Firestopping: Product requirements for firestopping for placement by this section.
2. Section 07 90 00 – Joint Protection: Product requirements for sealant materials for placement by this section.
3. Section 22 00 01 – General Plumbing Requirements.
4. Section 22 05 48 – Vibration Controls for Plumbing Piping and Equipment.
5. Section 22 11 00 – Facility Water Distribution: Execution requirements for placement of hangers and supports specified by this section.
6. Section 22 13 00 – Facility Sanitary Sewerage: Execution requirements for placement of hangers and supports specified by this section.
7. Section 22 14 00 – Facility Storm Drainage: Execution requirements for placement of hangers and supports specified by this section.

1.02 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B31.9 – Building Services Piping.
- B. ASTM International:
1. ASTM E84 – Test Method for Surface Burning Characteristics of Building Materials.
 2. ASTM E119 – Method for Fire Tests of Building Construction and Materials.
 3. ASTM E814 – Test Method of Fire Tests of Through Penetration Firestops.
 4. ASTM F708 – Standard Practice for Design and Installation of Rigid Pipe Hangers.
 5. ASTM E1966 – Standard Test Method for Fire-Resistive Joint Systems.
- C. American Welding Society:
1. AWS D1.1 – Structural Welding Code – Steel.
- D. FM Global:
1. FM – Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
- E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 – Pipe Hangers and Supports – Materials, Design and Manufacturer.
 2. MSS SP 69 – Pipe Hangers and Supports – Selection and Application.
 3. MSS SP 89 – Pipe Hangers and Supports – Fabrication and Installation Practices.
- F. Underwriters Laboratories Inc.:
1. UL 263 – Fire Tests of Building Construction and Materials.
 2. UL 723 – Tests for 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.
 5. UL – Fire Resistance Directory.
- G. Intertek Testing Services (Warnock Hersey Listed):
1. WH – Certification Listings.

1.03 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or

assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.04 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.
- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
- D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- G. UL/FM assembly sheets or WH assembly sheets for fire rated penetrations.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three (3) years of documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum 3 years of documented experience.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 – Product Requirements: Requirements for transporting, handling, storing and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 – Product Requirements: Environmental conditions affecting products on site.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.
- B. Contractor shall review all drawings, including structural drawings, for details regarding pipe supports, housekeeping pads, anchors, hangers, and guides.

1.09 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

- A. Plumbing Piping – DWV:
 - 1. Conform to ASTM F708, MSS SP58, MSS SP69, MSS SP89.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
 - 3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
 - 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
 - 6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
 - 7. Vertical Support: Steel riser clamp.
 - 8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 9. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.
 - 10. Crawl Space: Hangers and accessories shall be hot-dipped galvanized.
- B. Plumbing Piping – Water, Med Gas, Non-Med Gas.
 - 1. Conform to ASTM F708, MSS SP58, MSS SP69, MSS SP89.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.

5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp at every floor.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, Carbon-steel ring. Provide non-metallic coatings or inserts on attachments for electrolytic protection where attachments are in direct contact with copper piping.
16. Each hanger shall be properly sized to fit the supported pipe or fit the outside of the insulation on lines, hangers shall not penetrate insulation. Hangers shall bear on the outside of the insulation, which shall be protected by support shields as specified. Protect insulation from crushing by means of a section of rigid insulation to be installed at hanger points.
17. Hangers and accessories in crawlspace shall be hot-dipped galvanized.
18. Provide adjustable spring type hangers/isolators on all pipe hangers on the first 15 feet of pipe entering the building and where piping offsets vertically from one floor level to another.
19. Provide adjustable spring type vibration isolation hangers for piping connected to isolated equipment (i.e. pumps, etc.) Refer to Section 22 05 48.
20. Perforated strap iron or wire will not, under any circumstances, be acceptable as hanger material.

2.02 ACCESSORIES

- A. Hanger Rods: Galvanized mild steel threaded both ends, threaded on one end, or

continuous threaded.

- B. Saddles: Metallic supports: ANSI/MSS SP-69 & SP-58 Type 40 shields and Type 30 saddles, galvanized, with partial bottom rib to center clevis hanger.

2.03 ATTACHMENT TO STRUCTURE

A. Attachment:

1. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required.
2. Inserts shall be of a type which will not interfere with reinforcing as shown on the structural Drawings and which will not displace excessive amounts of structural concrete.
3. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc. All piping shall be installed with due regard to expansion and contraction and the type of hanger method of support, location of support, etc. shall be governed in part by this Specification.
4. Hangers shall be attached to the structure as follows:
 - a. Poured-In-Place Concrete: Where pipes and equipment are supported under poured in place concrete construction, each hanger rod shall be fitted with a nut at its upper end, which nut shall be set into an Underwriters Laboratories, Inc. listed universal concrete insert placed in the form work before concrete is poured. Where inserts are placed in the bottom faces of concrete joists which are too narrow to provide adequate strength of concrete to hold the insert properly or where a larger insert would require displacement of the bottom joist steel, the hanger rod shall be suspended from the center of a horizontal angle iron, channel iron, I-beam, etc. spanning across two adjacent joists. The horizontal support shall be bolted to nonadjustable concrete inserts of the "spot" type, of physical size small enough to avoid the bottom joist steel.
 - b. Steel Bar Joists: Where pipes and loads are supported under bar joists, hanger rods may be run through the space between the bottom angles and secured with a washer and two nuts. Where larger lines are supported beneath bar joists, hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded to the joists or otherwise permanently fixed thereto.
 - c. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.
 - d. Wood Framing: Where pipes and loads are supported from wood framing, hanger rods shall be attached to framing with side beam brackets or angle clips.
 - e. Pre-Cast Tee Structural Concrete: Hanger supports, anchors, etc. required for mechanical systems attached to the precast, double tee, structural concrete system are to be installed in accord with approved shop Drawings only. Holes required for hanger rods shall be core drilled

in the "flange" of the double tee only; impact type tools are not allowed under any circumstances. Core drilling in the "stem" portions of the double tee is not allowed. Holes core drilled through the "flange" for hanger rods shall be no greater than 1/4" larger than the diameter of the hanger rod. Hanger rods shall be supported by means of bearing plates of size and shape acceptable to the Architect/Engineer, with welded double nuts on the hanger rod above the bearing plate. Cinch anchors, lead shields, expansion bolts, and studs driven by explosion charges are not allowed under any circumstances in the lower 15" of each stem and in the "shadow" of the stem on the top side of the "double tees."

f. If it is necessary to install a method of fastening a hanger after the structure has been installed, then only clamps or drilled anchors shall be used.

5. Power-actuated fasteners (shooting) will not be acceptable under any circumstances.

(Note: Under no circumstances will the use of plastic anchors or plastic expansion shields be permitted for any purpose whatsoever.)

2.04 FLASHING

- A. Metal Flashing: 20 gage thick galvanized steel.
- B. Metal Counterflashing: 20 gage thick galvanized steel.
- C. Lead Flashing:
 - 1. Waterproofing: 5 lb./sq. ft sheet lead.
 - 2. Soundproofing: 1 lb./sq. ft sheet lead.
- D. Flexible Flashing: Compatible with roofing.
- E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.05 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sealant: Refer to Section 07 90 00.
- D. Provide UL/FM or Warnock Hersey approved assembly for sleeves through fire rated floors or walls.

2.06 MECHANICAL SLEEVE SEALS

- A. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when

tightened, providing watertight seal and electrical insulation.

2.07 FORMED STEEL CHANNEL

- A. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.08 ROOF NON-PENETRATING PIPE SUPPORTS

- A. Adjustable height, single pipe support for pipe sizes 3" and smaller: UV resistant, high density polypropylene, polycarbonate or fiberglass reinforced nylon base with support strut channel, threaded rod, nuts, washers and pipe clamp. All metal components to be hot dipped galvanized or stainless steel.

1. PHP model PP10
2. Miro Industries, Inc. model 2.5-SB-HCS
3. Mapa model MS-12SA10
4. Substitutions: Under provisions of Section 01 60 00.

- B. Adjustable height, multiple pipe support: Two base type support system with UV resistant high density polypropylene, UV resistant polycarbonate or stainless steel bases. Provide with support hangers appropriate for the type of pipe as specified in this section. Provide with threaded rod, nuts and washers. All metal components, unless indicated otherwise, to be hot dipped galvanized or stainless steel.

1. PHP model PSE series
2. Miro Industries, Inc. models 6-H, 8-H or 16-H as appropriate
3. Mapa model MB series
4. Substitutions: Under provisions of Section 01 60 00.

- C. Gas piping shall be mounted not less than 10" above the roof.

2.09 ROOFTOP PIPE CHASE HOUSING

- A. Manufacturers:

1. Roof Penetration Housing, LLC: The Vault
2. Substitutions: Under provisions of Section 01 60 00.

- B. Rooftop Pipe Chase Housing:

1. Constructed of heavy gage powder coated welded aluminum with stainless steel hardware consisting of three pieces, a removable vandal resistant lid, a middle housing and a wide flanged 14 inch high curb.
2. Size, unless noted otherwise on drawings:

- a. Length: 20 ½ inches.
 - b. Width: 14 ½ inches.
 - c. Height: 12 inches.
3. Exit seals to be of aluminum or stainless steel using SilX14 gasket seal. Each seal shall accommodate the specified size of the pipe, cable or conduit ranging in size from .25 inches up to 7.09 inches OD.
 - a. Where noted on the drawings, provide pipe chase housing prepped with a hole and cover plate for a GFCI outlet to be installed by the electrician.
 4. ICC-500 and FEMA 320/361 wind rated and rain tight.
 5. Furnish each unit with factory installed one inch thick insulation in the curb, housing and lid. Insulation to have a minimum R value of 4.3.
- C. Warranty:
1. The rooftop pipe chase housing shall carry an insured 20 year warranty accommodating multiple penetrations including piping and conduits.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.

3.02 PREPARATION

- A. Do not drill or cut structural members.
- B. Obtain permission from Architect/Engineer before drilling or cutting structural members.
- C. All auxiliary steel required for supports, anchors, guides, etc. shall be provided by the Contractor unless specifically indicated to be provided by others.
- D. All supports shall be of type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.
- E. Contractor shall be responsible for structural integrity of all supports, anchors, guides, etc. All structural hanging materials shall have a minimum safety factor of 5 built in.

3.03 INSTALLATION – INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.04 INSTALLATION – PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME 31.9, ASTM F708, MSS SP 69 and MSS SP 89.
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment.
- F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- I. Support riser piping independently of connected horizontal piping.
- J. Provide non-metallic coatings or inserts on attachments for electrolytic protection where attachments are in direct contact with copper piping.
- K. Design hangers for pipe movement without disengagement of supported pipe.
- L. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- M. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 22 07 00.
- N. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.
- O. Cast iron soil pipe 6 inches and smaller shall be supported at each joint, within 18 inches of joint. Cast iron soil pipe 8 inches and larger shall be supported on both sides of each joint when horizontal run exceeds five (5) feet.
- P. Where piping runs in multiple and at the same level, trapeze hangers (or roof curbs/rails) shall be installed.

- Q. Insulated Piping: Insulated piping shall be supported with inserts of the same thickness as the insulation, or with other approved methods. Refer also to Section 22 07 00 – Piping Systems Insulation.

3.05 INSTALLATION – EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 22 05 48.

3.06 INSTALLATION – FLASHING

- A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.
- C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.
- D. Seal all drains watertight to adjacent materials.
- E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.07 INSTALLATION – SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 2 inches above finished floor level. Caulk sleeves.
- E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with stuffing insulation and caulk [airtight]. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- F. Install stainless steel escutcheons at finished surfaces.
- G. Where installed in fire rated wall, floors, etc., install in accordance with UL/FM or

Warnock Hersey fire rated assembly instructions.

3.08 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Quality Requirements, 01 70 00 – Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

3.09 CLEANING

- A. Section 01 70 00 – Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean adjacent surfaces of firestopping materials.

3.10 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 – Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

3.11 SCHEDULES

PIPE HANGER SPACING		
PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
Cast Iron, up to 2 inches	5	3/8
Cast Iron, 3 inches	5	1/2
Cast Iron, 4 inches	5	5/8
Cast Iron, 6 - 8 inches	5	3/4
Cast Iron, 10 – 12 inches	5	7/8
CPVC, 1 inch and smaller	3	1/2
CPVC, 1-1/4 inches and larger	4	1/2
Copper Tube, 1-1/2 inches and smaller	6	3/8
Copper Tube, 2 inches thru 4 inches	8	1/2
Polypropylene	4	3/8
PVC (All Sizes)	4	3/8
PVDF	4	3/8
Steel, 3 inches and smaller	12	1/2
Steel, 4 inches and larger	12	5/8

END OF SECTION

SECTION 22 05 53 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Equipment markers.
2. Valve tags.
3. Valve schedules.
4. Pipe markers.
5. Ceiling tacks.
6. Signs.
7. Detectable Underground Warning Tape.

B. Related Sections:

1. Section 09 90 00 - Painting and Coating: Execution requirements for painting specified by this section.

1.02 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A13.1 – Scheme for the Identification of Piping Systems.

B. American National Standards Institute:

1. ANSI Z535.1 – Safety Color Standard.
2. ANSI Z535.2 – Environmental and Facility Safety Signs.

C. National Fire Protection Association:

1. NFPA 99 – Health Care Facilities Code.

1.03 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit manufacturer's catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification. Submit a valve chart and schedule, including valve tag number,

location, function and valve manufacturer's name and model number.

- D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.05 QUALITY ASSURANCE

- A. Conform to ASME A13.1 and ANSI Z535.1 for color scheme for identification of piping systems and accessories.
- B. Conform to ASME A13.1 for length of field and letter height for pipe markers.
- C. Conform to ANSI Z535.1 and ANSI Z535.2 for emergency operating, information and warning signs.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years of experience.

1.07 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.01 PIPE MARKERS

- A. General: Conform to ASME A13.1 for background and letter colors, length of color field and letter height.
- B. Self-Adhesive Pipe Markers: Flexible, indoor/outdoor grade vinyl with factory-applied pressure-sensitive adhesive. Provide with minimum 1-1/2 inch wide banding tape.
- C. Mechanically Applied Pipe Markers:
 - 1. For pipes with an overall diameter up to 6 inches, including insulation, provide semi-rigid plastic wrap around pipe marker that extends 360 degrees around the pipe at each marker location. The semi-rigid marker should include the legend

and a directional flow arrow. The marker shall be supplied as a pre-tensioned device and be equipped with a 1/2 inch strip of adhesive on the inside to further secure the marker in a permanent position on vertical locations.

2. For pipes with an overall diameter greater than 6 inches, including insulation, provide a semi-rigid plastic strap-on pipe marker with a height no less than 3 times the letter height. The marker shall include a legend and a directional flow arrow. Markers to be installed indoors shall be supplied with no less than two nylon straps to secure the marker in place. Markers to be installed outdoors shall be supplied with stainless steel or aluminum strapping.

2.02 DIRECTIONAL ARROWS

- A. Flow Direction: Provide flow directional arrows either as part of pipe markers, banding tape or separately, attached to pipes.
 1. Conform to requirements for markers.
 2. Size to conform to ANSI A13.1 (1 inch wide minimum).

2.03 DETECTABLE UNDERGROUND WARNING TAPE

- A. Description: Polyethylene tape resistant to acids, alkalis and other destructive soil components with metallic core for detection and location of piping with metal detector. Tape shall be a minimum of 6 inches wide with a minimum thickness of 5 mils. Utilize manufacturer's standard legends to identify water lines, pipe lines, gas lines, fuel lines, steam lines and sewer lines. Provide a continuous printed message with bold black lettering similar to "Caution Buried Water Line Below." Tape color and lettering shall be unaffected by moisture and other substances contained in the backfill material. The tape color shall conform to the American Public Works Association Uniform Color Code.

2.04 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
 1. Green: Plumbing valves.

2.05 PLASTIC EQUIPMENT MARKERS

- A. General: Provide laminated plastic equipment markers for all scheduled items of plumbing equipment installed indoors.
- B. Size: Size laminated plastic markers not less than one inch in height and three inches in length with engraved lettering white on black not less than 1/4 inch in height. For larger pieces of equipment, size markers 1-1/2 inch in height by 4-1/2 inches long, of 3/32 inch laminated plastic melamine with white on black lettering engraved not less than 1/16 inch deep and 1/2 inch high.
- C. Attachment: Attach nameplates with rivets, stainless steel screws or bolts. On equipment such as tanks and pumps which cannot be drilled or pierced, attach nameplates with brass chains and "S" hooks.

- D. For plumbing equipment installed above ceiling, provide 3/4 inch by 2-1/2 inches laminate tags attached with rivets to the ceiling grid below.

2.06 ALUMINUM EQUIPMENT MARKERS

- A. General: Provide engraved anodized aluminum equipment markers for all scheduled items of plumbing equipment installed outdoors.
- B. Size: Size engraved aluminum markers not less than 1 inch in height and 3 inches in length with engraved lettering white on black background not less than 5/8 inch in height. For larger pieces of equipment, size markers 3 inches in height by 6 inches long, with lettering not less than 1 inch in height.
- C. Attachment: Attach nameplates with rivets, stainless steel screws or bolts. On equipment such as tanks and pumps which cannot be drilled or pierced, attach nameplates with stainless steel chains and "S" hooks.

2.07 VALVE TAGS

- A. Materials: Provide indoor valve tags of solid brass with stamped or engraved lettering or numbers. Provide outdoor valve tags of aluminum with stamped or engraved lettering or numbers.
 - 1. Fill lettering and numbers with black paint.
 - 2. Lettering shall be not less than 1/4 inch in height.
 - 3. Numbers shall be not less than 1/2 inch in height.
- B. Attachment: For valve tags in mechanical rooms, provide with brass jack chain and "S" hook attachment. For all other indoor valve tags, provide with brass beaded chain attachment. For all outdoor valve tags, provide with stainless steel jack chain and "S" hook attachment.

2.08 ENGRAVED PLASTIC LAMINATE SIGNS

- A. General: Where indicated in other sections of the specifications, provide engraved instruction signs, warning signs, operational instructions or other signs designated.
- B. Emergency Operating Signs: For emergency operating instructions, provide engraved, laminate, melamine plastic, white on red, not less than 1/8 inch thick.
 - 1. Provide concise written instructions on the emergency operation of the device.
 - 2. Letters shall be not less than 5/16 inch in height, engraved 1/16 inch deep in block capital letters.
- C. Information and Warning Signs: Provide general information and warning signs of laminated, melamine plastic, not less than 1/8 inch thick, with white engraved lettering on black, with letters not less than 1/4 inch in height, block capitals.
- D. Attachment: Attach signs directly to the equipment with rivets, bolts or screws, if possible. Otherwise, attach signs with angle brackets, U-bolts, or metal plates held in place to

piping with stainless steel draw-bands.

1. Attachment with adhesives will not be permitted.
2. Locate signs not less than 4 feet nor more than 6 feet above the operating floor, directly visible from an operating aisle.
3. Locate signs to preclude damage during maintenance and repair or by operating traffic.

2.09 VALVE SCHEDULES AND FRAMES

- A. General: Provide valve schedules for all valves provided by Division 22.
- B. Schedules: Provide typed or machine printed schedules, one item per line, double spaced.
 1. Printing shall be black on 8-1/2-inch by 11-inch white paper. Paper shall be waterproof or laminated after printing.
 2. For each valve, list the valve number, location, size and use or operating function.
 3. Support schedules in full extruded aluminum frames with removable, non-yellowing, clear plastic faces.
 4. Screw or bolt schedules to equipment room walls where directed.
 5. Coordinate valve numbers with valve tags so that no two valves or scheduled devices have the same number.

PART 3 EXECUTION

3.01 GENERAL

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Install identifying devices after completion of coverings and painting.
- C. Install labels with sufficient adhesive for permanent adhesion. For unfinished canvas covering, apply paint primer before applying labels.

3.02 CONCEALED VALVES AND EQUIPMENT

- A. Equipment Above Ceilings: Provide valve tagging and identification to equipment located above ceilings, such as valves, trap primers and other items before the ceilings are installed.
- B. Finished Surfaces: Where identification is to be provided on surfaces which require insulation, painting and finishing, install identification after covering and painting is complete.
- C. Provide ceiling tacks to locate valves or equipment above T-bar type panel ceilings.

Locate in corner of panel closest to equipment.

3.03 PIPING SYSTEM IDENTIFICATION

- A. Install pipe markers on all piping systems and include arrows to show the normal direction of flow. Where flow can be in both directions, arrows in both directions shall be displayed.
- B. Identify piping exposed to view and concealed by accessible ceilings, including hard ceilings provided with access panels. Identify piping outdoors, in crawlspaces, on roof, above grade and within parking structures. Only piping located within walls or inaccessible areas need not be identified.
- C. Identify the temperature of domestic hot water piping systems, i.e. "140°F HOT WATER."
- D. Locate pipe markers as follows:
 - 1. Every 15 feet on straight runs.
 - 2. At each valve and control device.
 - 3. At each branch or take-off. Provide flow arrows on the branch pipe as well as on the main on both sides of the branch.
 - 4. At any change in piping direction.
 - 5. Above and below every floor or roof penetration.
 - 6. On either side of every wall or partition. Ensure there is a minimum of one marker per pipe in every room.
 - 7. On either side of large obstructions, ductwork or equipment that piping passes above.
 - 8. At 5-foot intervals where piping is obscured by close proximity to walls or other pipes.
 - 9. Provide only one label per unit drain connection for condensate drain piping on roof.
- E. Install pipe markers so they are visible and legible from a normal standing position.
- F. Secure each end of self-adhesive pipe markers with a full wrap of banding tape of the same background color. Banding tape shall overlap itself a minimum of 3 inches.
- G. Provide mechanically applied pipe markers for all piping in mechanical rooms and outdoors.
- H. Install detectable underground warning tape 12 inches below finished grade, directly above buried pipe. If piping is buried more than 36 inches below finished grade, then provide an additional continuous length of tape buried 12 inches above the piping.

3.04 VALVE IDENTIFICATION

- A. General: Provide a valve tag on every valve, cock and control device in each piping system. Exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs and shut-off valves at plumbing fixtures. List each tagged valve in valve schedule for each piping system. In existing buildings, coordinate valve tags and schedules such that no valve numbers are duplicated.
 - 1. Tagging Schedule: Comply with requirements of "Valve Tags" and "Valve Schedules and Frames" paragraph.
- B. Install valve schedule frames and schedules in machine rooms where indicated or where directed.

3.05 PLUMBING EQUIPMENT IDENTIFICATION

- A. General: Install equipment markers on or near each major item of plumbing equipment. Provide signs for the following general categories of equipment and operational devices:
 - 1. Main control and operating valves.
 - 2. Meters and gauges.
 - 3. Fuel-burning units including boilers and water heaters.
 - 4. Pumps, compressors and motor-driven units.
 - 5. Primary balancing valves.
- B. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.06 COLOR AND IDENTIFICATION SCHEDULE

- A. Provide final coat of paint, label surface, or lettering of color listed below.

<u>FLUID SERVICE TYPE</u>	<u>PIPE MARKER LEGEND</u>	<u>PIPE MARKER BACKGROUND / LETTERING COLOR</u>	<u>VALVE TAG LETTERING</u>
Domestic Cold Water	COLD WATER	Green / White	CW
Domestic Hot Water - 110°F	110°F HOT WATER	Green / White	HW
Domestic Hot Water Recirculation - 110°F	110°F HOT WATER RETURN	Green / White	HWC
Domestic Hot Water - 115°F	115°F HOT WATER	Green / White	HW
Domestic Hot Water Recirculation - 115°F	115°F HOT WATER RETURN	Green / White	HWC
Domestic Hot Water - 140°F	140°F HOT WATER	Green / White	HW

Domestic Hot Water Recirculation - 140°F	140°F HOT WATER RETURN	Green / White	HWC
Sanitary Waste	SANITARY WASTE	Green / White	
Sanitary Vent	SANITARY VENT	Green / White	

END OF SECTION

SECTION 22 07 00 – PLUMBING INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Piping – Glass Fiber.
2. Piping – Jackets.
3. Cellular Foam.
4. Equipment Jackets.

B. Related Sections:

1. Section 07 84 00 – Firestopping: Product requirements for firestopping for placement by this section.
2. Section 09 90 00 – Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.
3. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment: Product and Execution requirements for inserts at hanger locations.
4. Section 22 05 53 – Identification for Plumbing Piping and Equipment.

1.02 REFERENCES

A. ASTM International:

1. ASTM A167 – Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
3. ASTM C177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
4. ASTM C195 – Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C449/C449M – Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C518 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
7. ASTM C533 – Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

8. ASTM C534 – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 9. ASTM C547 – Standard Specification for Mineral Fiber Pipe Insulation.
 10. ASTM C552 – Standard Specification for Cellular Glass Thermal Insulation.
 11. ASTM C553 – Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 12. ASTM C591 – Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
 13. ASTM C592 – Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
 14. ASTM C610 – Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.
 15. ASTM C612 – Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 16. ASTM C795 – Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 17. ASTM C921 – Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 18. ASTM C1126 – Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
 19. ASTM C1136 – Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 20. ASTM D1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 21. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 22. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials.
 23. ASTM E162 – Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
 24. ASTM G21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- B. Sheet Metal and Air Conditioning Contractors':
1. SMACNA – HVAC Duct Construction Standard – Metal and Flexible.

1.03 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures: Submittal procedures.

- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- C. Samples: Submit one sample of representative size illustrating each insulation type.
- D. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 – Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 – Product Requirements: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- C. Maintain temperature during and after installation for minimum period of 24 hours.

1.07 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.01 PIPING – GLASS FIBER

- A. Insulation: ASTM C547; rigid molded, non-combustible.
 - 1. 'K' value: ASTM C335, 0.24 at 75 degrees F.
 - 2. Minimum Service Temperature: -20 degrees F.
 - 3. Maximum Service Temperature: 300 degrees F.
 - 4. Maximum Moisture Absorption: 0.2 percent by volume.

5. Maximum Flame Spread: ASTM F84:25.
 6. Maximum Smoke Developed: ASTM E84:50.
- B. Vapor Barrier Jacket
1. ASTM C921, white kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
 3. Secure with self sealing longitudinal laps and butt strips.
 4. Secure with outward clinch expanding staples and vapor barrier mastic.
- C. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch centers.
- D. Vapor Barrier Lap Adhesive
1. Compatible with insulation.
- E. Insulating Cement/Mastic
1. ASTM C195; hydraulic setting on mineral wool.
- F. Fibrous Glass Fabric
1. Cloth: Untreated; 9 oz/sq. yd. weight.
 2. Blanket: 1.0 lb./cu. ft. density.
- G. Indoor Vapor Barrier Finish
1. Vinyl emulsion type acrylic, compatible with insulation, white color.
- 2.02 PIPING – JACKETS
- A. PVC Plastic
1. Jacket: ASTM C921, One piece molded type fitting covers and sheet material, off white color.
 - a. Minimum Service Temperature: -40 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
 - d. Maximum Flame Spread: ASTM E84; 25.
 - e. Maximum Smoke Developed: ASTM E84; 50.
 - f. Thickness: 20 mil.
 - g. Connections: Brush on welding adhesive.
 2. Covering Adhesive Mastic
 - a. Compatible with insulation.
- B. Aluminum Jacket: ASTM B209.

1. Thickness: 0.016 inch.
2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: 0.016 mm thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.03 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. 'K' Value: ASTM C177 or C518; 0.27 at 75 degrees F.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 220 degrees F.
4. Maximum Moisture Absorption: ASTM D1056; 1.0 by volume.
5. Moisture Vapor Transmission: ASTM E96; 0.20 perm inches.
6. Maximum Flame Spread: ASTM E84; 25.
7. Maximum Smoke Developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.

B. Elastomeric Foam Adhesive

1. Air dried, contact adhesive, compatible with insulation.

2.04 EQUIPMENT JACKETS

A. Canvas Equipment Jacket:

1. UL listed.
2. Fabric: 6 oz/sq yd, plain weave cotton.
3. Fire retardant lagging adhesive. Composite of insulation, jacket and lagging adhesive having flame spread index not greater than 25 and smoke developed index not greater than 50 when tested to ASTM E84.

2.05 INSERT AND SHIELDS

A. Shields:

1. Galvanized steel, ASTM 653, service temp -150° F to +500° F.
2. Round corner design and flared edges with partial bottom rib, 180° formed arc.

3. Shields to comply with MSS SP 58 Type 39 for vapor barrier application.
- B. Inserts:
1. Compression Resistant Insulating Material; 7.5lb/cu ft density cellular glass or equal suitable for planned temperature range and service.
 2. Inserts shall be a minimum of 6" long, of thickness and contour matching adjoining insulation; factory fabricated is acceptable.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.
- B. Verify piping and equipment has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION – PIPING

- A. Install materials in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- D. Insulated pipes conveying fluids below ambient temperature:
 1. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.
- E. Insulated pipes conveying fluids above ambient temperature:
 1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- F. Inserts and Shields:
 1. Application: Piping or Equipment 1 inch diameter or larger.
 2. Shields: Between pipe hangers, pipe supports or pipe hanger rolls and inserts.

- 3. Insert location: Between support shield and piping and under finish jacket.
- G. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 00 for penetrations of assemblies with fire resistance rating greater than one hour.
- H. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers or aluminum jacket.
- I. Exterior Applications: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal equipment.

3.03 INSTALLATION – EQUIPMENT

- A. Install in accordance with manufacturer's instructions.
- B. Factory Insulated Equipment: Do not insulate.
- C. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
- F. Finish insulation at supports, protrusions, and interruptions.
- G. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- H. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

3.04 PIPING – GLASS FIBER INSULATION SCHEDULE

PIPING SYSTEMS	PIPE SIZE Inch	THICKNESS Inch
A. Domestic Water:		
Hot Water	1-1/2" & smaller 2" & larger	1" 1-1/2"
Hot Water Return/Circulating	1-1/2" & smaller 2" & larger	1" 1-1/2"
Cold Water	ALL	1/2"

3.05 PIPING – CELLULAR FOAM INSULATION SCHEDULE

A. Sanitary Drain:

Above floor piping receiving condensate from AC equipment. Insulate drainbody, trap, trap arm, tailpiece, and 20 ft of pipe vertical and horizontal and/or when it ties into the main. Includes lavatories.

ALL

1"

END OF SECTION

SECTION 22 11 00 – FACILITY WATER DISTRIBUTION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Domestic water piping, below grade.
2. Domestic water piping, above grade.
3. Unions and flanges.
4. Valves.
5. Pipe hangers and supports.
6. Pressure gauges and taps.
7. Flow control valves.
8. Relief valves.
9. Strainers.
10. Hose bibs and hydrants.
11. Recessed valve box.
12. Backflow preventers.
13. Water hammer arrestors.
14. Thermostatic mixing valves.
15. Diaphragm-type compression tanks.
16. In-line circulator pumps.
17. Di-electric connections.
18. Trap primers.

B. Related Sections:

1. Section 07 84 00 – Firestopping: Product requirements for firestopping for placement by this section.
2. Section 08 31 13 – Access Doors and Frames: Product requirements for access doors for placement by this section.
3. Section 22 00 01 – General Plumbing Requirements.

4. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports for placement by this section.
5. Section 22 05 53 – Identification for Plumbing Piping and Equipment: Product requirements for pipe identification and valve tags for placement by this section.
6. Section 22 07 00 – Plumbing Insulation: Product and execution requirements for pipe insulation.
7. Section 26 05 03 – Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.02 REFERENCES

A. American National Standards Institute:

1. ANSI Z21.22 – Relief Valves for Hot Water Supply Systems.
2. ANSI/NSF 61 – Drinking Water Components – Health Effects.
3. NSF/ANSI 14 – Plastic Piping System Components and Related Materials

B. American Society of Mechanical Engineers:

1. ASME B16.18 – Cast Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
3. ASME B16.26 – Cast Copper Alloy Fittings for Flared Copper Tubes.
4. ASME B31.9 – Building Services Piping.
5. ASME B40.1 – Gauges - Pressure Indicating Dial Type - Elastic Element.
6. ASME Section VIII – Boiler and Pressure Vessel Code - Pressure Vessels.
7. ASME Section IX – Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

C. American Society of Sanitary Engineering:

1. ASSE 1010 – Performance Requirements for Water Hammer Arresters.
2. ASSE 1011 – Performance Requirements for Hose Connection Vacuum Breakers.
3. ASSE 1012 – Performance Requirements for Backflow Preventer with Intermediate Atmospheric Vent.
4. ASSE 1013 – Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.

5. ASSE 1017 – Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems.
6. ASSE 1019 – Performance Requirements for Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type.
7. ASSE 1070 – Performance Requests for Water Temperature Limiting Devices.

D. ASTM International:

1. ASTM A182 – Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
2. ASTM A269 – Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
3. ASTM A276– Standard Specification for Stainless Steel Bars and Shapes.
4. ASTM A312– Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
5. ASTM B32 – Standard Specification for Solder Metal.
6. ASTM B42 – Standard Specification for Seamless Copper Pipe, Standard Sizes.
7. ASTM B88 – Standard Specification for Seamless Copper Water Tube.
8. ASTM B584 – Standard Specification for Copper Alloy Sand Castings for General Applications.
9. ASTM E1 – Standard Specification for ASTM Thermometers.
10. ASTM E77 – Standard Test Method for Inspection and Verification of Thermometers.
11. ASTM F708 – Standard Practice for Design and Installation of Rigid Pipe Hangers.
12. ASTM F1476 – Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
13. ASTM D2765 – Standard Test Method for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics
14. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials
15. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials

E. American Welding Society:

1. AWS A5.8 – Specification for Filler Metals for Brazing and Braze Welding.

- F. American Water Works Association:
 - 1. AWWA C651 – Disinfecting Water Mains.
 - 2. AWWA C700 – Cold-Water Meters - Displacement Type, Bronze Main Case.
 - 3. AWWA C701 – Cold-Water Meters - Turbine Type, for Customer Service.
 - 4. AWWA C702 – Cold-Water Meters - Compound Type.
 - 5. AWWA C706 – Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
 - 6. AWWA M6 – Water Meters – Selection, Installation, Testing and Maintenance.
 - 7. AWWA M14 – Backflow Prevention and Cross-Connection Control.

- G. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 58 – Pipe Hangers and Supports – Materials, Design and Manufacturer.
 - 2. MSS SP 67 – Butterfly Valves.
 - 3. MSS SP 69 – Pipe Hangers and Supports – Selection and Application.
 - 4. MSS SP 70 – Cast Iron Gate Valves, Flanged and Threaded Ends.
 - 5. MSS SP 71 – Cast Iron Swing Check Valves, Flanged and Threaded Ends.
 - 6. MSS SP 78 – Cast Iron Plug Valves, Flanged and Threaded Ends.
 - 7. MSS SP 80 – Bronze Gate, Globe, Angle and Check Valves.
 - 8. MSS SP 85 – Cast Iron Globe & Angle Valves, Flanged and Threaded.
 - 9. MSS SP 89 – Pipe Hangers and Supports – Fabrication and Installation Practices.
 - 10. MSS SP 110 – Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

- H. National Electrical Manufacturers Association:
 - 1. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).

- I. Plumbing and Drainage Institute:
 - 1. PDI WH201 – Water Hammer Arrester Standard.

- J. Plastic Pipe Institute
 - 1. PPI TR-3 / 2007 – Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), Strength Design

Basis (SDB), and Minimum Required Strength (MRS) Ratings for
Thermoplastic Piping Materials or Pipe

K. Underwriters' Laboratories

1. ANSI/UL 263 – Standard Fire Tests of Building Construction and Materials

1.03 SUBMITTALS

A. Section 01 33 00 – Submittal Procedures: Submittal procedures.

B. Product Data:

1. Piping: Submit data on pipe materials, fittings and accessories. Submit manufacturer's catalog information and pipe joining methods: Solder, primer and glue, brazing, etc..
2. Valves: Submit manufacturer's catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturer's catalog information including load capacity.
4. Domestic Water Specialties: Submit manufacturer's catalog information, component sizes, rough-in requirements, service sizes, and finishes.
5. Pumps: Submit pump type, capacity, certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Submit installation instructions for pumps, valves and accessories.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

E. Shop Drawings of water system.

1.04 CLOSEOUT SUBMITTALS

A. Section 01 70 00 – Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of valves and equipment.

C. Operation and Maintenance Data: Submit spare parts list, exploded assembly views and recommended maintenance intervals.

D. Record actual locations of valves, etc. and prepare valve charts.

E. Test reports and inspection certification for all systems listed herein.

F. Provide a certificate of completion detailing the domestic water system chlorination procedure and all laboratory test results.

G. Submit location of access panels which vary from quantities or locations indicated on

Contract Drawings.

- H. Provide full written description of manufacturer's warranty.
- I. Backflow preventer test report.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years of documented experience.
- C. Backflow prevention assembly tester shall be licensed by the State of Texas.

1.06 QUALITY ASSURANCE

- A. All work shall be in accordance with Texas Commission on Environmental Quality (TCEQ) Chapter 290 – Public Drinking Water.
- B. All piping materials shall be manufactured and tested according to applicable ANSI, ASTM, ASME, AWWA and CISPI standards.
- C. Unless otherwise noted, all piping materials shall be domestically manufactured in the USA.
- D. Piping Systems Materials:
 - 1. Note: Piping systems shall use consistent materials throughout each system. Materials for each piping system shall not be "mixed". Exception: where required due to above/below grade conditions; allowed due to inside building/outside building conditions; or where indicated by drawings or specifications.
 - 2. Note: Lead containing solders shall not be used at any place in any system.
 - 3. All domestic water piping, fittings, valves and appurtenances shall be certified to ANSI/NSF 61.
- E. Manufacturer's name and pressure rating shall be permanently marked on valve body.
- F. The Contractor shall notify the manufacturer's representative prior to installing any copper press fittings. The Contractor shall obtain the representative's guidance in any unfamiliar installation procedures. The manufacturer's representative of copper press fittings shall conduct periodic inspections of the installation and shall report in writing to the Contractor and Owner of any observed deviations from manufacturer's recommended installation practices.
- G. Manufacturer Qualifications: Company shall have minimum three years documented experience specializing in manufacturing the products specified in this section.
- H. All grooved joint couplings, fittings, flanges, valves, and specialties of the same type shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

I. Installer Qualifications:

1. Company shall have minimum three years documented experience specializing in performing the work of this section.
2. Installation of plumbing systems shall be performed by individuals licensed by the Texas State Board of Plumbing Examiners as a Journeyman or Master Plumber. Installation may be performed by Apprentice Plumbers provided they are registered with the Texas State Board of Plumbing examiners and under direct supervision of a licensed plumber. All installation shall be supervised by a licensed Master Plumber.
3. All installers of copper press fittings shall be trained by the fitting manufacturer's appointed representative. Written notification of training shall be submitted to Owner prior to any installation.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 – Product Requirements: Product storage and handling requirements.
- B. Accept valves and equipment on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- F. Store piping and equipment in a safe place, dry, enclosed, under cover in a well ventilated area.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 – Product Requirements.
- B. Do not install underground piping when bedding is wet or frozen.

1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish 1-year manufacturer warranty for domestic water piping.

1.11 EXTRA MATERIALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Spare parts and maintenance

products.

PART 2 PRODUCTS

2.01 DOMESTIC WATER PIPING – BELOW GRADE

- A. Copper Tubing: ASTM B88, Type K, annealed.
 - 1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
 - 2. Joints: Brazed, AWS A5.8, lead free, BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.
- B. Copper Tubing: ASTM B42, annealed.
 - 1. Fittings: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper and bronze.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F. or Braze, AWS A5.8 lead free, BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.
- C. Buried pressurized piping sizes 2" and smaller shall be type "K" soft copper. No joints shall be allowed below slab.

2.02 DOMESTIC WATER PIPING – ABOVE GRADE

- A. Copper Tubing: ASTM B88, Type L, hard drawn.
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F. or Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.
 - 3. Thread fitting: Pipe joint compound shall be lead free, non-toxic, low VOC and ANSI/NSF6/compliant. Temperature service range 10°F to 300°F.
 - 4. Press fittings: At contractor's option, copper piping 2 inch and smaller may be joined using copper or copper alloy press fittings with factory installed sealing elements of EPDM material.
- B. Buried pressurized piping sizes 2" and smaller shall be type "K" soft copper. No joints shall be allowed below slab.

2.03 GLOBE VALVES

- A. 2 inches and Smaller: MSS SP 80, Class 125, bronze body, bronze trim, threaded bonnet, hand wheel, Buna-N composition discs.

2.04 BALL VALVES

- A. 2 inches and Smaller: MSS SP 110, 400 psi WOG two-piece bronze body, chrome-plated brass ball, full port, Teflon seats, blow-out proof stem, locking lever handle with balancing stops.
- B. 2 inches and Smaller: MSS SP 110, Class 150, bronze, two-piece body, chrome-plated bronze ball, full port, Teflon seats, blow-out proof stem, locking lever handle with balancing stops.
- C. Neck Extensions: Provide valves with extended round stem/necks where valves are installed in piping to be insulated. Stem/necks must permit operation of valve without damage to the insulation vapor barrier system. Nibco Nibseal or equal.

2.05 CHECK VALVES

- A. Horizontal Swing Check Valves:
 - 1. 2 inches and Smaller: MSS SP 80, Class 150, bronze body and cap, bronze seat, Buna-N disc.
 - 2. 2-1/2 inches and Larger: MSS SP 71, Class 125, cast iron body, bolted cap, bronze or cast iron disc, renewable disc seal and seat, flanged ends.
- B. Spring Loaded Check Valves:
 - 1. 2 inches and Smaller: MSS SP 80, Class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat.
 - 2. 2-1/2 inches and Larger: MSS SP 71, Class 125, wafer style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends.

2.06 PRESSURE GAUGES AND TAPS

- A. Gauges shall comply with ASME B40.1, Grade 2A, and have ± 0.5 percent of full scale accuracy, with type 304 stainless steel or aluminum case, bronze wetted parts and brass socket. Dial face shall be 3½" diameter where installed within eight feet of floor level and 6" diameter where installed higher than eight feet above floor level. Dial face shall be aluminum with white background, black graduations and black markings. Pointer shall be adjustable with black finish. Provide remote read-out gauges for isolated or hard to access monitoring points.
- B. Units of measure shall be in pounds per square inch (psi). The proper range shall be selected so that the average operating pressure falls approximately in the middle of the scale selected.
- C. All pressure gauges shall be equipped with brass or stainless steel needle valves and pressure snubbers.
- D. Pressure Gauge Taps:
 - 1. Needle Valve: Brass or stainless steel, 1/4 inch NPT for minimum 300 psi.
 - 2. Ball Valve: Brass or stainless steel 1/4 inch NPT for 250 psi.

3. Pulsation Damper: Pressure snubber, brass or stainless steel with 1/4 inch (6 mm) NPT connections.

2.07 STEM TYPE THERMOMETERS

- A. Thermometers shall be vapor or liquid actuated, direct-mounted, universal adjustable angle dial type with stainless steel or cured polyester powder coated cast aluminum case, stainless steel friction ring and glass window. Dial face shall be white with black figures; pointer shall be friction adjustable type. Movement shall be brass with bronze bushings. Bourdon tube shall be phosphor bronze with a brass socket.
- B. Thermometer range shall be 30 - 240° Fahrenheit and have an accuracy of ± 1 scale division.
- C. Dial face shall be 4½" diameter where installed within eight feet of floor level and 6" diameter where installed higher than eight feet above floor level. Provide remote read-out gauges for isolated or hard to access monitoring points.
- D. Provide a brass or stainless steel separable thermowell for each thermometer.
- E. Thermometers shall have a sensing bulb with an insertion length of roughly half of the pipe diameter; minimum insertion length shall be 2". Thermometers installed on tanks shall have a minimum insertion length of 5".
- F. Where insulation thickness exceeds 2", provide proper bulb length and an extension neck thermowell at least 2" long.

2.08 FLOW CONTROL VALVES

- A. Construction: Class 150, Brass or bronze body, temperature and pressure test plug on inlet, combination blow-down or back-flush drain.
- B. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 5 psi.

2.09 RELIEF VALVES

- A. Pressure Relief:
 1. ANSI Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.
- B. Temperature and Pressure Relief:
 1. ANSI Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME certified and labeled.

2.10 STRAINERS

- A. 2 inch and Smaller: Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

- B. 2-1/2 inch to 4 inch: Class 125, flanged iron body, Y pattern with 1/16-inch stainless steel perforated screen.
- C. 5 inch and Larger: Class 125, flanged iron body, basket pattern with 1/8 inch stainless steel perforated screen.

2.11 HOSE BIBS AND HYDRANTS

- A. Manufacturers:
 - 1. Chicago.
 - 2. T&S.
 - 3. MIFAB.
 - 4. Zurn.
- B. Refer to Plumbing Miscellaneous Schedule on Project Drawings.

2.12 RECESSED VALVE BOX

- A. Washing Machine: Plastic preformed rough-in box with brass long shank valves with wheel handles, socket for 2 inch waste, slip in finishing cover, integral water hammer arrestor.
- B. Refrigerator: Plastic preformed rough-in box with brass valves with wheel handle slip in finishing cover, integral water hammer arrestor.

2.13 BACKFLOW PREVENTERS

- A. All potable water systems shall be installed to prevent contamination from non-potable liquids, solids or gases through cross connection or any other connection to the system. Provide backflow prevention devices to serve all connections to non-potable water systems.
- B. Provide vacuum breakers for all elements or systems requiring vacuum breakers for code, function, and/or protection of equipment/systems. These locations shall include, but not necessarily be limited to service/janitor/mop sinks, etc..
- C. All backflow prevention devices and assemblies shall be tested and listed by University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USC FCCC&HR) or other agency approved by Texas Commission on Environmental Quality (TCEQ).
- D. Backflow preventer types. Provide the correct backflow preventer for each hazard.
 - 1. Double check valve type backflow preventer valve assemblies shall prevent the reverse flow of polluted water from entering into the potable water supply. Double check valve backflow prevention devices shall be used at low hazard sources of contamination where no potential health risks exists.
 - 2. Reduced pressure zone (RPZ) type backflow preventer valve assemblies shall prevent the reverse flow of polluted water from entering into the potable water

supply due to backsiphonage and or backpressure. Reduced pressure zone backflow prevention devices shall be used at high hazard sources of contamination where a potential health risk exists and for containment at the water service entrance.

- E. Reduced Pressure Backflow Preventers:
 - 1. Comply with ASSE 1013.
 - 2. Bronze body, with bronze internal parts and stainless steel springs.
 - 3. Two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve opening under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.
- F. Double Check Valve Assemblies: Comply with ASSE 1012; Bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.

2.14 WATER HAMMER ARRESTORS

- A. ASSE 1010: Copper construction, piston type sized in accordance with PDI WH-201.
- B. Pre-charged suitable for operation in temperature range -100 to 300 degrees F and maximum 150 psi working pressure.
 - 1. Bellows Type
 - 2. Piston Operated

2.15 THERMOSTATIC MIXING VALVES

- C. Point of use mixing valve. Thermostatic mixing valve shall have body of brass or bronze with paraffin based thermal actuation. Valve shall be complete with integral checks with screens, and an adjustment cap with locking feature. Valve shall be ASSE Standard 1070 listed and shall maintain control down to 0.5 gpm. Valve shall maintain a mixed water temperature from 80° to 120°F ± 3°F. Set to deliver 110°F (unless indicated otherwise). Valve shall be capable of controlling mixed temperature while hot supply temperature ranges from 120°F to 180°F and withstand a maximum pressure of 150 psi. The minimum required differential between entering cold and hot water and mixed water shall be 15°F or lower.

2.16 DIAPHRAGM-TYPE COMPRESSION TANKS

- A. Manufacturers and Capacity: Refer to plumbing schedules.
- B. Construction: Welded steel, tested and stamped in accordance with ASME Section VIII; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.

2.17 IN-LINE CIRCULATOR PUMPS

- A. Casing: Bronze rated for 125 psig working pressure with stainless steel rotor assembly.

- B. Impeller: Bronze.
- C. Shaft: Alloy steel with integral thrust collar and two, oil lubricated bronze sleeve bearings.
- D. Seal: Carbon rotating against stationary ceramic seat.
- E. Drive: Flexible coupling.
- F. Performance: Refer to Plumbing Equipment Schedule on project Drawings.

2.18 DIELECTRIC CONNECTION

- A. Provide Dielectric isolation between dissimilar metal piping. NOTE: Brass/bronze valves shall not be acceptable for dielectric isolation under this specification.
- B. Two inch connections may be either dielectric union or isolating flange as required.
- C. Two and one-half inch and larger connections shall incorporate isolating flange kits. Flanges copper pipe shall consist of Class 150 cast copper alloy companion flange with flat face
- D. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- E. Dielectric waterway fittings shall have a copper-silicon casting or a zinc electroplated steel pipe body with high temperature stabilized polyolefin polymer liner; manufactured by Victaulic, Style 647 or PPP, Inc. Series 19000, or Owner approved equal by Anvil.
- F. Dielectric unions shall be rated at 250 psi, ground-joint type with inert, non-corrosive thermoplastic sleeve. End connection materials shall be compatible with respective piping materials; manufactured by EPCO Sales, Inc or Watts. Provide models to suit applicable transitions.
- G. Dielectric flanges shall be rated at 175 psi, have nylon bolt isolators and dielectric gasket. Materials shall be compatible with respective piping materials; manufactured by EPCO Sales, Inc or Watts. Provide models to suit applicable transitions.
- H. Flange insulation kit contain one "E: full face Trojan style insulation gasket manufactured from Nema grade G-10 glass reinforced epoxy retainer with a Nitrile seal, two insulation washers manufactured from Neman grade G-10, two steel (SEA zinc plated steel) back-up washers and one Nema Grade G-10 sleeve for each bolt.
- I. Dielectric Nipples:
 - 1. Manufacturer's: Subject to compliance with requirements.
 - 2. Grinnell Mechanical Products.
 - 3. Precision Plumbing Products, Inc.
 - 4. Victaulic Company.
 - a. Description :

- 1) Standard: IAPMO PS 66
- 2) Electroplated steel nipple, complying with ASTM F1545
- 3) : 300 psig at 250 deg.F
- 4) End connection: Male Thread or grooved.
- 5) Lining: Inert and non corrosive, propylene.

2.19 TRAP PRIMER ASSEMBLIES

- A. Trap Priming devices that rely upon line pressure differential for activation are not allowed.
- B. Electronic Trap Primers
 1. Electronic trap primers shall provide 10 second water injection to traps every twenty-four hours, complete with galvanized steel box and cover, copper inlet connection, brass ball type stop valve, slow closing 24 VAC solenoid valve with integral strainer, 120-24 VAC transformer, brass atmospheric vacuum breaker, and copper waterway. Refer to schedules on drawings for specifics for each device.
- C. Sink or Lavatory Tailpiece Type Trap Primers
 1. Provide polished chrome plated cast bronze p-trap with ground joint outlet, threaded wall tube, slip joint nuts, washers and escutcheons, 1/2" polished chrome plated bronze primer tube with compression fitting connection at wall. Assembly shall be Jay R. Smith Model 2698, Precision Plumbing Products LTP-1500 or approved equal of a referenced acceptable manufacture. This type of device shall not serve more than one trap.
- D. Vacuum Breaker Trap Primer for use with exposed Flushometers:
 1. Priming assembly shall consist of one piece, chrome plated flush connection, water deflector to control the amount of water diverted from the flush 3/8" elbow and flex-bend tube connection from vacuum breaker to wall, diverter wall flange and fittings, chrome plated wall flange and fitting to connect 1/2" NPT pipe, high back pressure vacuum breaker; one-piece bottom hex coupling nut. Basis of design: Sloan Model VBF-72-A1. This type of device shall not serve more than one trap.

2.20 THERMOWELLS

- A. Provide thermowells where indicated on the drawings and where temperature measurement is needed for service or troubleshooting. Locations for thermowells shall include, but not be limited to: hot water return. Thermowells shall be matched with thermometers to be used as far as bore and depth. Thermowells shall be sized so that they will penetrate not less than 25 percent nor more than 50 percent of the pipe diameter in which it is installed.
- B. Where possible, install thermowells in tee fittings where changes in flow directions occur.
- C. Contractor may substitute extended length stainless steel pressure/temperature test ports with integral checks ("Pete's Plugs") for thermowells or where required due to small pipe size (2" or below). Provide with dual seal core inserts of Nordel, rated 0F to 350F. Test port base/pipe connection size shall be 1/2", except that 1/4" may be substituted for pipe

sizes 1" and below.

- D. In all cases, ensure installation allows for easy insertion and removal of temperature and pressure probes/instrumentation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.

3.03 INSTALLATION – THERMOMETERS AND GAUGES

- A. Install one pressure gauge for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gauge.
- B. Install gauge taps in piping
- C. Install pressure gauges with pulsation dampers. Provide needle valve or ball valve to isolate each gauge.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.
- E. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- F. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- G. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.04 INSTALLATION – HANGERS AND SUPPORTS

- A. Install hangers and supports in accordance with Section 22 05 29. Provide non-metallic coatings or inserts on attachments for electrolytic protection where attachments are in direct contact with copper piping.

3.05 INSTALLATION – BURIED PIPING SYSTEMS

- A. Verify connection to utility piping system size, location and invert are as indicated on Drawings.

- B. Establish elevations of buried piping with not less than 24 inches of cover (36 inches below paved areas).
- C. Establish minimum separation from sanitary sewer piping in accordance with applicable plumbing code.
- D. Remove scale and dirt on inside of piping before assembly.
- E. Excavate pipe trench in accordance with Section 22 00 01.
- F. Install pipe to elevation as indicated on Drawings.
- G. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.
- H. Install pipe on prepared bedding.
- I. Route pipe in straight line.
- J. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- K. Install shutoff and drain valves at locations indicated on Drawings.
- L. Install plastic ribbon tape continuous buried 9 inches above pipe line.
- M. Install trace wire continuous over top of plastic pipe buried 9 inches above pipe line.
- N. Pipe Cover and Backfilling:
 - 1. Backfill trench in accordance with Section 22 00 01.
 - 2. Maintain optimum moisture content of fill material to attain required compaction density.
 - 3. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
 - 4. Do not use wheeled or tracked vehicles for tamping.

3.06 INSTALLATION – ABOVE GROUND PIPING

- A. Install non-conducting dielectric connections wherever jointing dissimilar metals.
- B. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- C. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.
- D. Group piping whenever practical at common elevations.
- E. Slope piping and arrange systems to drain at low points.

- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 00.
- H. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 13.
- I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- J. Provide support for utility meters in accordance with requirements of utility companies.
- K. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 90 00.
- L. Install domestic water piping in accordance with ASME B31.9.
- M. Sleeve pipes passing through partitions, walls and floors. Refer to Section 22 05 29.
- N. Install unions downstream of valves and at equipment or apparatus connections.
- O. Install valves with stems upright or horizontal, not inverted.
- P. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- Q. Install gate, ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- R. Install ball valves for throttling, bypass, or manual flow control services.
- S. Provide lug end butterfly valves adjacent to equipment when functioning to isolate equipment.
- T. Provide spring loaded check valves on discharge of water pumps.
- U. Provide flow controls in water circulating systems.
- V. Install potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibs.
- W. Pipe relief from valves, back-flow preventers and drains to nearest floor drain.
- X. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to each fixture or group of fixtures.
- Y. Utilize slow closing valves only. Do not install or allow quick closing valves.

3.07 PIPE JOINTS

- A. Welded: Beveling, spacing and other details shall conform to ASME B31.9 and AWS B2.1.
- B. Threaded: Treads shall conform to ASME B1.20. Joint compound shall be applied to male threads only and joints shall be made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound for corrosion protection.
- C. Soldered: Solder joints shall be made in accordance with ASTM B828. The temperature of the joint during soldering shall not be raised above the maximum temperature limitation of the flux.
- D. Press Fittings:
 - 1. The installer of copper press type fittings shall be a factory qualified installer, licensed within the jurisdiction and familiar with the installation of the specific copper press joint system being utilized.
 - 2. Copper press fittings shall be installed using the proper tool, actuator, jaws and ring as instructed by the press fitting manufacturer.
 - 3. Copper and copper alloy press connections shall be made in accordance with the manufacturer's installation instructions.
 - 4. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark to assure the tubing is fully engaged in the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer.

3.08 INSTALLATION – PUMPS

- A. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings.
- C. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve, balancing valve, and shut-off valve on pump discharge.
- D. Provide air cock and drain connection on horizontal pump casings.
- E. Provide drains for bases and seals.
- F. Check, align and certify alignment of base mounted pumps prior to start-up.
- G. Lubricate pumps before start-up.
- H. Contractor shall install pumps and packaged pumping systems in accordance with the manufacturer's instructions. All base mounted pumps to be aligned upon receipt at jobsite, during installation, and after system fill. Contractor shall level and grout each pump according to the manufacturer recommendations to insure proper alignment prior to operation.

- I. Pipe connections to pumps shall be made in such a manner so as not to exert any stress on pump housings. If necessary to meet this requirement, provide additional pipe supports and flex connectors.
- J. Pumps shall NOT be run dry to check rotation.
- K. Provide resilient rubber isolators for piping hangers and stanchions for the first two support locations in suction and discharge piping.
- L. Ensure pumps operate at specified or intended system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

3.09 BACKFLOW PREVENTORS

- A. Backflow prevention devices and assemblies shall be installed in compliance with American Water Works Association Manual M-14 "Backflow Prevention," and the following:
 - 1. Devices and assemblies shall be located as shown on plans.
 - 2. The highest part of any device or assembly shall not be installed over 5 feet above the finish floor. There shall be a minimum of 12 inches clearance above the device/assembly.
 - 3. The lowest part of any double check backflow preventer assembly shall be installed a minimum of 12 inches above finish floor.
 - 4. The service side of any device/assembly shall have a minimum clearance of 24 inches from the outermost dimension.
 - 5. The non-service side of a double check backflow assembly shall have a minimum clearance of 4 inches from the outermost dimension.
 - 6. All backflow and/or back siphonage assemblies/devices shall be tested in accordance with the rules and regulations of Texas Commission on Environmental Quality and the utility supplying the domestic water before substantial completion inspection is requested.
 - 7. Final reports shall be submitted to local code/inspection authorities and to A/E and utility prior to scheduling Substantial Completion reviews by the A/E.
 - 8. Persons performing the test on backflow and/or back siphonage assemblies/devices shall meet the following requirements:
 - a. Licensed by the Texas Commission on Environmental Quality as a Backflow Prevention Assembly Technician, and
 - b. If required by the utility supplying the water, registered with the utility for testing backflow preventer assemblies.
 - c. Testing of backflow preventer assemblies serving fire protection systems shall be performed by a person or organization with a current certificate of registration from the State Fire Marshal as an independent fire protection sprinkler contractor (Registered Firm) under the direct supervision of a licensed Responsible Managing Employee (RME) as

defined by Texas Insurance Code (TIC), Chapter 6003 (formerly Article 5.43-3), Fire Protection Sprinkler System Service and Installation and the Texas Administrative Code Title 28, Chapter 34, Subchapter G – Fire Sprinkler Rules.

3.10 WATER-HAMMER ARRESTORS

- A. Provide water hammer arrestors as shown on the plans and as necessary to prevent water hammer from occurring. As a minimum, provide as follows.
1. A minimum of one arrestor shall be installed for each fixture header serving up to three fixtures. A minimum of two arrestors shall be installed for each fixture header serving four to seven fixtures. A minimum of three shall be installed for each fixture header serving eight or more fixtures.
 2. Note: "Header" refers to horizontal pipe from which adjacent fixtures are directly connected without intervening horizontal or vertical runs or offsets.
 3. Provide permanently sealed air chamber type water-hammer arrestor at all water closet locations.
 4. Provide an arrestor for each single fixture with a quick closing valve (e.g. single lever handles; wrist blades, push/pull faucets, self-closing faucets, flush valves, solenoid valves, etc.).
 5. NOTE: Washing machines and other solenoid operated equipment shall have arrestor (not air chamber) provided for each piece of equipment/fixture.
 6. Air chambers are not acceptable under any circumstance.
 7. Where indicated, provide water hammer arrestors integral to the fixture (lavatory, sink etc.) supplies equal to Precision Plumbing Products "Mini-Angle Stop". Provide all washing machine and icemaker connections with water hammer arrestors integral to the connection box.

3.11 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Quality Requirements and 01 70 00 – Execution and Closeout Requirements: Field inspecting, testing, adjusting and balancing.

3.12 CLEANING AND DISINFECTION

- A. Domestic Water Piping: Domestic cold water and hot water piping shall be thoroughly flushed, cleaned and disinfected in accordance with the appropriate procedure described in the latest edition of ANSI/AWWA C651 or as described in this section. Cold and hot domestic water piping shall be thoroughly flushed with potable water to remove all foreign particles. The piping shall then be sterilized by filling the systems with a solution of chlorine containing 50 PPM of chlorine this solution shall stay in the piping for a minimum period of 24 hours; or the piping shall be filled with a solution of chlorine containing 200PPM of chlorine and this solution shall stay in the piping for a minimum of 3 hours. During which time all valves shall be opened and closed several times in order that all parts of the valve shall be in contact with the solution. After the sterilization period, the system shall be drained and flushed with clean potable water until the residual chlorine

content is not greater than 0.2 PPM.

- B. Bacteriological test shall be performed by a third party testing lab hired by the contractor. SUBMIT testing lab qualification for review and approval by the Owner and A/E. The testing lab shall not have less than five (5) years experience with water testing.
- C. The above procedure shall be performed prior to final connections to utility or existing piping systems in the building to assure no chlorine or other contamination migrates into systems.
- D. Within one week (7 days) days after cleaning is completed, submit written report signed by supervising craftsman and contractor principal certifying cleaning and sterilization was conducted as specified.
- E. Take samples no sooner than 24 hours after flushing, from at minimum of 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.
- F. The cleaning and disinfection of water lines shall not be done sooner than 3 weeks prior to owner occupancy. If it has been more than 3 weeks then the contractor shall , at his own expense, clean and disinfect the pipe again not sooner than 3 weeks before owner occupancy.

3.13 TESTING

- A. Each system installed under this contract shall be cleaned and tested to appropriate plumbing code for each particular application.
- B. Testing shall also include any additional requirements from the authority having jurisdiction.
- C. Equipment, material, power, and labor necessary for the cleaning, flushing, sterilization, inspection and testing of systems covered within this Specification Section shall be furnished by the Plumbing Contractor. All testing and inspection procedures shall be in accordance with Division 01 and Special Condition requirements of this Contract.
- D. For any requested inspection, the Contractor shall complete prior inspections and tests to ensure that items are ready for inspection and acceptance by the Owner and/or Architect/Engineer. The Contractor shall be responsible for any and all costs incurred by Owner and/or Owner representatives, including consultants, resulting from a review or inspection that was scheduled prematurely.
- E. The Contractor shall conduct the tests and the Owner's Construction Inspector will witness and approve the results.
- F. Verify systems are complete, flushed and clean prior to testing. Isolate all equipment subject to damage from test pressure. Test and inspect for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. Piping being tested shall not leak nor show any loss in test pressure for duration specified.
- G. Leave piping uninsulated, uncovered and unconcealed until it has been tested and approved. Where any portion of piping system must be concealed before completion of entire system, the portion shall be tested separately as specified for the entire system prior to concealment. Contractor shall expose all untested covered or concealed piping.

- H. In cases of minor installation and repairs where specified water and/or air test procedures are deemed impractical, Contractor shall obtain written approval from Owner's Representative to perform alternate testing and inspection procedures. Alternate testing and inspection procedures for minor installation and repairs shall include visual evaluation of installed components by Owner's Representative during a simulation of use.
- I. The water utilized for tests shall be obtained from a potable source of supply.
- J. Prepare testing reports. If testing is performed in segments, submit separate report for each segment, complete with diagram or clear description of applicable portion of piping. After inspection has been approved or portions thereof, certify in writing the time, date, name and title of the persons reviewing the test. This shall also include the description of what portion of the system has been approved. Obtain approval signature by Owner's Representative. A complete record shall be maintained of all testing that has been approved, and shall be made available at the job Site. Upon completion of the work, all records and certifications approving testing requirements shall be submitted to the Owner's Representative before final payment is made.
- K. Gauges used for testing shall have increments as follows:
 - 1. Tests requiring a pressure of 10 psi or less shall utilize a testing gauge having increments of 0.10 psi or less.
 - 2. Tests requiring a pressure of greater than 10 psi but less than or equal to 100 psi shall utilize a testing gauge having increments of 1 psi or less.
 - 3. Tests requiring a pressure of greater than 100 psi shall utilize a testing gauge having increments of 2 psi or less.
- L. Separately test above and below ground piping.
- M. Do not introduce test water into piping systems when exposure to freezing temperatures is possible.
- N. Do not introduce test water into sections of piping located above existing sensitive areas and/or equipment that may be damaged or contaminated by water leakage. Coordinate with Owner's Representative to determine areas and/or equipment considered as being sensitive.
- O. Defective work or material shall be reworked and replaced, and inspection and test repeated. Repairs shall be made with new materials. Pipe dope, caulking, tape, dresser couplings, etc., shall not be used to correct deficiencies.
- P. The Contractor shall be responsible for cleaning up any leakage during flushing, testing, repairing and disinfecting to the original condition any building parts subjected to spills or leakage.
- Q. All backflow and/or back siphonage assemblies/devices shall be tested in accordance with the rules and regulations of Texas Commission on Environmental Quality and the utility supplying the domestic water before substantial completion inspection is requested.
 - 1. Final reports shall be submitted to local code/inspection authorities and to A/E

and utility prior to scheduling Substantial Completion reviews by the A/E.

2. Persons performing the test on backflow and/or back siphonage assemblies/devices shall meet the following requirements:
 - a. Licensed by the Texas Commission on Environmental Quality as a Backflow Prevention Assembly Technician, and
 - b. If required by the utility supplying the water, registered with the utility for testing backflow preventer assemblies.
- R. Domestic hot water system:
 1. Test Remote fixtures to determine hot water is available within 30 seconds. Provide a report and a drawing indicated fixtures tested and the duration of time to provide 110 °F.
 2. Record temperature at each return pump.
- S. Pressure test all water piping in accordance with the applicable plumbing code and local AHJ.
- T. All testing of pumps shall be by owner representative and a report shall be provided.
- U. Equipment, material, power, and labor necessary for the cleaning, flushing, sterilization, inspection and testing of systems covered within this Specification Section shall be furnished by the Plumbing Contractor. All testing and inspection procedures shall be in accordance with Division 01 and Special Condition requirements of this Contract.
- V. For any requested inspection, the Contractor shall complete prior inspections and tests to ensure that items are ready for inspection and acceptance by the Owner and/or Architect/Engineer. The Contractor shall be responsible for any and all costs incurred by Owner and/or Owner representatives, including consultants, resulting from a review or inspection that was scheduled prematurely.

END OF SECTION

SECTION 22 13 00 – FACILITY SANITARY SEWERAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Sanitary sewer and vent piping buried below grade.
2. Sanitary sewer and vent piping above grade.
3. Floor drains.
4. Floor sinks.
5. Cleanouts.

B. Related Sections:

1. Section 07 84 00 – Firestopping: Product requirements for firestopping for placement by this section.
2. Section 08 32 13 – Access Doors and Frames: Product requirements for access doors for placement by this section.
3. Section 09 90 00 – Painting and Coating: Product and execution requirements for painting specified by this section.
4. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports and firestopping for placement by this section.
5. Section 22 05 53 – Identification for Plumbing Piping and Equipment: Product requirements for pipe identification for placement by this section.
6. Section 22 07 00 – Plumbing Insulation: Product and execution requirements for pipe insulation.

1.02 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A112.14.1 – Backwater Valves.
2. ASME A112.21.1 – Floor Drains.
3. ASME B16.1 – Cast Iron Pipe Flanges and Flanged Fittings.
4. ASME B16.3 – Malleable Iron Threaded Fittings.
5. ASME B16.4 – Gray Iron Threaded Fittings.

6. ASME B31.9 – Building Services Piping.
- B. ASTM International:
1. ASTM A47/A47M – Standard Specification for Ferritic Malleable Iron Castings.
 2. ASTM A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 3. ASTM A74 – Standard Specification for Cast Iron Soil Pipe and Fittings.
 4. ASTM A234/A234M – Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 5. ASTM A395/A395M – Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 6. ASTM A536 – Standard Specification for Ductile Iron Castings.
 7. ASTM A746 – Standard Specification for Ductile Iron Gravity Sewer Pipe.
 8. ASTM C478 – Standard Specification for Precast Reinforced Concrete Manhole Sections.
 9. ASTM C478M – Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric).
 10. ASTM C564 – Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
 11. ASTM D1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 12. ASTM D1785 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 13. ASTM D2241 – Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
 14. ASTM D2464 – Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 15. ASTM D2466 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 16. ASTM D2467 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 17. ASTM D2564 – Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
 18. ASTM D2855 – Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
 19. ASTM D3311 – Standard Specification for Drain, Waste and Vent (DWV) Plastic

Fitting Patterns.

20. ASTM F493 – Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
21. ASTM F2618 – Standard for Chlorinated Poly Vinyl Chloride (CPVC) Chemical Waste Drainage Systems

C. Cast Iron Soil Pipe Institute:

1. CISPI 301 – Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
2. CISPI 310 – Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

D. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 – Pipe Hangers and Supports – Materials, Design and Manufacturer.
2. MSS SP 69 – Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 – Pipe Hangers and Supports – Fabrication and Installation Practices.

E. Plumbing and Drainage Institute:

1. PDI G101 – Standard – Testing and Rating Procedure for Grease Interceptors.

1.03 SUBMITTALS

A. Section 01 33 00 – Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes for sewage-ejectors, and manholes.

C. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
4. Sanitary Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
5. Pumps: Submit pump type, capacity, certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and

connection requirements.

- D. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of equipment and clean-outs.
- C. Operation and Maintenance Data: Submit frequency of treatment required for interceptors. Include, spare parts lists, exploded assembly views for pumps and equipment.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 – Product Requirements: Product storage and handling requirements.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 – Product Requirements.
- B. Do not install underground piping when bedding is wet or frozen.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.09 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish 1-year manufacturer warranty for material.

1.10 EXTRA MATERIALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Spare parts and maintenance products.

- B. Furnish 1 set of pump seals.

PART 2 PRODUCTS

2.01 SANITARY SEWER AND VENT PIPING – BELOW GRADE

- A. All cast iron soil, waste and vent pipe and fittings shall conform to the requirements of CISPI Standard 301, ASTM A888 or ASTM A74. All cast iron pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and shall be listed by NSF International. Acceptable manufacturers of cast iron soil pipe and fittings are AB&I, Charlotte Pipe and Tyler Pipe.
- B. Cast Iron Soil Pipe: ASTM A74, service weight, bell and spigot ends.
 - 1. Fittings: Cast iron, ASTM A74.
 - 2. Joints: Hub-and-spigot with compression gaskets conforming to the requirements of ASTM C-564 and ASTM C-1563.
- C. Cast Iron Pipe: CISPI 301, hub-less, service weight.
 - 1. Fittings: Cast iron, CISPI 301.
 - 2. Joints: Hubless pipe and fittings shall be joined by No-Hub couplings conforming to CISPI Standard 310 and listed by NSF International.
 - 3. Below grade piping shall be joined by heavy-duty shielded stainless steel couplings with rubber sleeves and stainless steel bands and tightening devices, conforming to ASTM C564; equivalent to Clamp-All 125 or Husky SD 4000.
- D. PVC Pipe: ASTM D1785, Schedule 40, polyvinyl chloride (PVC) material, bell and spigot style solvent sealed joints.
 - 1. Fittings: PVC, ASTM D2665, Schedule 40.
 - 2. Joints: ASTM D2855; solvent weld with ASTM D2564 solvent cement.

2.02 SANITARY SEWER AND VENT PIPING – ABOVE GRADE

- A. All cast iron soil, waste and vent pipe and fittings shall conform to the requirements of CISPI Standard 301, ASTM A888 or ASTM A74. All cast iron pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and shall be listed by NSF International. Acceptable manufacturers of cast iron soil pipe and fittings are AB&I, Charlotte Pipe and Tyler Pipe.
- B. Cast Iron Pipe: ASTM A74, service weight.
 - 1. Fittings: Cast iron, ASTM A74.
 - 2. Joints: Hub-and-spigot with compression gaskets conforming to the requirements of ASTM C-564 and ASTM C-1563.

- C. Cast Iron Pipe: CISPI 301, hub-less, service weight.
 - 1. Fittings: Cast iron, CISPI 301.
 - 2. Joints: Hubless pipe and fittings shall be joined by No-Hub couplings conforming to CISPI Standard 310 and listed by NSF International.
 - a. Above grade waste piping shall be joined by mid-duty shielded stainless steel couplings with rubber sleeves and stainless steel bands and tightening devices, conforming to ASTM C564; equivalent to Tyler Wide Body, Mission Heavyweight or Husky HD 2000.
 - b. Above grade vent piping shall be joined by standard duty shielded stainless steel couplings with rubber sleeves and stainless steel bands and tightening devices, conforming to ASTM C564; as manufactured by Tyler Pipe, Mission Rubber Co. or ANACO.

2.03 FLOOR DRAINS, AREA DRAINS AND FLOOR SINKS

- A. Refer to Plumbing Equipment Schedule on Drawings.

2.04 CLEANOUTS

- A. Refer to Plumbing Equipment Schedule on Drawings.
- B. Exterior Surfaced Areas: Round cast nickel bronze access frame and non-skid cover.
- C. Exterior Unsurfaced Areas: Line type with lacquered cast iron body and round epoxy coated cover with gasket.
- D. Interior Finished Floor Areas: Galvanized cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round scored cover with gasket in service areas and round depressed cover with gasket to accept floor finish in finished floor areas.
- E. Interior Finished Wall Areas: Line type with lacquered cast iron body and round epoxy coated cover with gasket, and round stainless steel access cover secured with machine screw.
- F. Interior Unfinished Accessible Areas: Calked or threaded type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.

- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.03 INSTALLATION – HANGERS AND SUPPORTS

- A. Inserts:
 - 1. Provide inserts for placement in concrete forms.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
- B. Pipe Hangers and Supports:
 - 1. Install in accordance with MSS SP 89.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - 7. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
 - 8. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts and suspended ceiling spaces are not considered exposed.

3.04 INSTALLATION – BURIED PIPING SYSTEMS

- A. Verify connection to site utility piping system; size, location, and invert are as indicated on Drawings.
- B. Establish elevations of buried piping with not less than 1.5 ft of cover.

- C. Establish minimum separation of other services piping in accordance with Plumbing Code.
- D. Remove scale and dirt on inside of piping before assembly.
- E. Excavate pipe trench in accordance with Division 31 specifications.
- F. Install pipe to elevation as indicated on Drawings.
- G. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches loose depth; compact to 95 percent maximum density.
- H. Install pipe on prepared bedding.
- I. Route pipe in straight line.
- J. Install plastic ribbon tape continuous over top of pipe, 9 inches above pipe line.
- K. Install trace wire continuous over top of plastic pipe buried 9 inches above pipe line.
- L. Pipe Cover and Backfilling:
 - 1. Install underground Thermoplastic piping soil and waste drainage piping according to ASTM D 2321.
 - 2. Backfill trench in accordance with Division 31 specifications.
 - 3. Maintain optimum moisture content of fill material to attain required compaction density.
 - 4. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches compacted layers to 12 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
 - 5. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
 - 6. Do not use wheeled or tracked vehicles for tamping.

3.05 INSTALLATION – ABOVE-GROUND PIPING

- A. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum. Maintain gradients.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Provide clearances at cleanout for snaking drainage system.
- C. Encase exterior cleanouts in concrete flush with grade.
- D. Install floor cleanouts at elevation to accommodate finished floor.
- E. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

- F. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- G. Install piping to maintain headroom. Do not spread piping, conserve space.
- H. Group piping whenever practical at common elevations.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints or connected equipment.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 22 07 00.
- K. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 13.
- M. Install piping penetrating roofed areas to maintain integrity of roof assembly.
- N. Where pipe support members are welded to structural building framing, scrape, brush clean and apply one coat of zinc rich primer to welding.
- O. Prepare exposed, unfinished pipe, fittings, supports and accessories ready for finish painting. Refer to Section 09 90 00.
- P. Install bell and spigot pipe with bell end upstream.
- Q. Sleeve pipes passing through partitions, walls and floors.
- R. Support cast iron drainage piping at every joint.
- S. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section 07 84 00.

3.06 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Quality Requirements and Section 01 70 00 – Execution and Closeout Requirements: Field inspecting, testing, adjusting and balancing.
- B. Test sanitary waste, grease waste, chemical resistant waste and vent piping system in accordance with applicable code and local authority having jurisdiction.
- C. Testing:
 - 1. After each section of the sanitary waste, acid waste and grease waste systems have been set within project area, all outlets shall be temporarily "plugged up", except as are required for testing as described herein. Each section of piping shall be tested to a level of at least 10 feet above the pipe being tested. The pipes being tested shall be filled with water to a verifiable and visible level as described above and be allowed to remain so for a minimum of 2 hours. If after 2 hours the level of the water has been lowered by leakage, the leaks must be found and stopped, and the water level shall again be raised to the level described, and the test repeated until, after a 2 hour retention period, there shall be no perceptible lowering of the water level in the system being tested.

2. Should the completion of these tests leave any reasonable question of a doubt relative to the integrity of the installation, additional tests or measures shall be performed to demonstrate the reliability of these systems to the complete satisfaction of the Owner's duly authorized representative. Such tests shall be conducted and completed before any joints in plumbing are concealed or made inaccessible.
- D. Protect piping and drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work of other trades.
 - E. Place temporary caps or plugs in ends of uncompleted piping and when work stops at the end of each day.

END OF SECTION

SECTION 22 17 00 – FACILITY NATURAL GAS PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Natural gas piping above grade.
2. Unions and flanges.
3. Valves.
4. Pipe hangers and supports.
5. Strainers.
6. Natural gas pressure regulators.
7. Natural gas pressure relief valves.

B. Related Sections:

1. Section 07 84 00 – Firestopping: Product requirements for firestopping for placement by this section.
2. Section 08 31 13 – Access Doors and Frames: Access doors for concealed valves and accessories.
3. Section 09 90 00 – Painting and Coating: Product requirements for painting for placement by this section.
4. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports [and firestopping] for placement by this section.
5. Section 22 05 53 – Identification for Plumbing Piping and Equipment: Product requirements for valve and pipe identification for placement by this section.

1.02 REFERENCES

A. American National Standards Institute:

1. ANSI Z21.15 – Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.

B. American Society of Mechanical Engineers:

1. ASME B16.3 – Malleable Iron Threaded Fittings.
2. ASME B16.26 – Cast Copper Alloy Fittings for Flared Copper Tubes.

3. ASME B16.33 – Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (sizes 1/2 - 2).
 4. ASME B31.9 – Building Services Piping.
 5. ASME Section IX – Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
- C. ASTM International:
1. ASTM A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 2. ASTM A234/A234M – Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 3. ASTM B88 – Standard Specification for Seamless Copper Water Tube.
 4. ASTM B88M – Standard Specification for Seamless Copper Water Tube (Metric).
 5. ASTM B280 – Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 6. ASTM B749 – Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
 7. ASTM F708 – Standard Practice for Design and Installation of Rigid Pipe Hangers.
- D. American Welding Society:
1. AWS D1.1 – Structural Welding Code - Steel.
- E. American Water Works Association:
1. AWWA C105 – American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
- F. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 – Pipe Hangers and Supports - Materials, Design and Manufacturer.
 2. MSS SP 67 – Butterfly Valves.
 3. MSS SP 69 – Pipe Hangers and Supports - Selection and Application.
 4. MSS SP 78 – Cast Iron Plug Valves, Flanged and Threaded Ends.
 5. MSS SP 89 – Pipe Hangers and Supports - Fabrication and Installation Practices.
 6. MSS SP 110 – Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

- G. National Fire Protection Association:
 - 1. NFPA 54 – National Fuel Gas Code.
- H. Underwriters Laboratories Inc.:
 - 1. UL 842 – Valves for Flammable Fluids.
- I. International Code Council:
 - 1. International Fuel Gas Code.

1.03 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves, equipment.
- C. Provide pipe hangers and supports in accordance with ASME B31.9, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.
- D. Use plug or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

1.04 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 - 3. Piping Specialties: Submit manufacturers catalog information including capacity, rough-in requirements, and service sizes for the following:
 - a. Strainers.
 - b. Natural gas pressure regulators.
 - c. Natural gas pressure relief valves.
- C. Test Reports: Indicate results of piping system pressure test.
- D. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.
- E. Provide a table of all regulators which indicate, Mark, size, spring size and/or color, pressure, area of equipment served.

- F. Provide required documentation to Texas Gas (or local purveyor) as required to provide a full designj

1.05 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of valves, piping system, and system components.
- C. Operation and Maintenance Data: Submit for valves and gas pressure regulators installation instructions, spare parts lists, and exploded assembly views.

1.06 QUALITY ASSURANCE

- A. Perform natural gas Work in accordance with NFPA 54 and International Fuel Gas Code.
- B. Perform work in accordance with International Fuel Gas Code and local gas company requirements.
- C. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- D. Perform Work in accordance with authority having jurisdiction and AWS D1.1 for welding hanger and support attachments to building structure.
- E. Furnish shutoff valves complying with ASME B16.33 or ANSI Z21.15.

1.07 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years of documented experience.
- C. Technicians performing fusion process shall be currently certified by the Texas Railroad Commission and shall **submit a resume showing experience on comparable fusion procedures within the last twelve (12) months.**

1.08 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 – Product Requirements: Product storage and handling requirements.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation. Furnish temporary protective coating on cast iron and steel valves.

1.09 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 – Product Requirements.

- B. Do not install underground piping when bedding is wet or frozen.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 COORDINATION

- A. Section 01 30 00 – Administrative Requirements: Requirements for coordination.
- B. Coordinate trenching, excavating, bedding and backfilling of buried piping systems with requirements of Section 31 23 33.

1.12 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish 1-year manufacturer warranty for valves excluding packing.

1.13 EXTRA MATERIALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two packing kits for each type and size valve.

PART 2 PRODUCTS

2.01 NATURAL GAS PIPING – ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M forged steel welding type.
 - 2. Joints: Threaded for pipe 2 inches and smaller; welded for pipe 2-1/2 inches and larger.

2.02 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
 - 1. Ferrous Piping: Class 150, malleable iron, threaded.
 - 2. Copper Piping: Class 150, bronze unions with [soldered] [brazed joints].
 - 3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- B. Flanges for Pipe 2-1/2 inches and Larger:
 - 1. Ferrous Piping: Class 150, forged steel, slip-on flanges.

2. Copper Piping: Class 150, slip-on bronze flanges.
3. Gaskets: 1/16 inches thick preformed neoprene gaskets.

2.03 BALL VALVES

- A. 1/4 inch to 1 inch: MSS SP 110, Class 125, two piece, threaded ends, bronze body, chrome-plated bronze ball, reinforced teflon seats, anti-static device, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, full port.
- B. 1-1/4 inch to 3 inch: MSS SP 110, Class 125, two piece, threaded ends, bronze body, chrome-plated bronze ball, reinforced teflon seats, anti-static device, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, conventional port.

2.04 PLUG VALVES

- A. 2 inches and Smaller: MSS SP 78, Class 150, semi-steel construction, round port, full pipe area, pressure lubricated, Teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.
- B. 2-1/2 inches and Larger: MSS SP 78, Class 150, semi-steel construction, round port, full pipe area, pressure lubricated, Teflon packing, flanged ends. Furnish wrench-operated.

2.05 STRAINERS

- A. 2 inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- B. 2-1/2 inch to 4 inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

2.06 NATURAL GAS PRESSURE REGULATORS

- A. Product Description: Spring loaded, general purpose, self-operating service regulator including internal relief type diaphragm assembly and vent valve. Diaphragm case can be rotated 360 degrees in relation to body.
 1. Temperatures: minus 20 degrees F to 150 degrees F.
 2. Body: Cast iron.
 3. Spring case, lower diaphragm casing, union ring, seat ring and disk holder: Aluminum.
 4. Disk, diaphragm, and O-ring: Nitrile.
 5. Maximum inlet pressure: 150 psig.
 6. Furnish sizes 2 inches and smaller with threaded ends. Furnish sizes 2-1/2 inches and larger with flanged ends.

2.07 NATURAL GAS PRESSURE RELIEF VALVES

- A. Product Description: Spring loaded type relief valve.

1. Body: Aluminum.
2. Diaphragm: Nitrile.
3. Orifice: Aluminum.
4. Maximum operating temperature: 150 degrees F.
5. Inlet Connections: Threaded.
6. Outlet or Vent Connection: Same size as inlet connection.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION – INSERTS

- A. Provide inserts for placement in concrete forms.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.04 INSTALLATION – PIPE HANGERS AND SUPPORTS

- A. Install pipe hangers and supports in accordance with Section 23 05 29.

3.05 INSTALLATION – ABOVE-GROUND PIPING SYSTEMS

- A. Install natural gas piping in accordance with NFPA 54 and International Fuel Gas Code.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

- C. Route piping in orderly manner and maintain gradient.
- D. Install piping to conserve building space and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Sleeve pipe passing through partitions, walls and floors. Refer to Section 22 05 29.
- H. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section 07 84 00.
- I. Provide clearance for access to valves and fittings.
- J. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 13.
- K. Provide support for utility meters in accordance with requirements of utility company.
- L. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood.
- M. Provide sediment trap at all equipment connections. Trap length shall be 6 inches minimum, 10 inches maximum. The cap at the bottom end shall be a minimum 4 inches above any surface. The cap shall be threaded and accessible.
- N. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Section 09 90 00.
- O. Install identification on piping systems including underground piping. Refer to Section 22 05 53.
- P. Install valves with stems upright or horizontal, not inverted.
- Q. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- R. Install medium pressure gas pressure regulator with tee fitting between regulator and upstream shutoff valve. Cap or plug one opening of tee fitting.
- S. Install gas pressure regulator with tee fitting not less than 10 pipe diameters down stream of regulator. Cap or plug one opening of tee fitting.
- T. Install gas pressure regulator with independent vent full size opening on regulator and terminate outdoors.
- U. Pipe on the roof shall be a minimum of 10 inches above the roof.
- V. Provide pre-manufactured roof supports and penetration: Refer to Section 22 05 29. Wood blocks are p=not allowed.

3.06 SERVICE CONNECTIONS

- A. Coordinate with local gas utility company and pay all fees required to provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure as noted on Drawings.
- B. Install service regulator adjacent to building wall in specified location.
- C. Install pressure regulating valve and riser pipe to prevent undue stress upon service pipe. For plastic service pipe, use steel pipe riser from below ground to regulator.
- D. Install regulator vent with rain and insect proof opening, terminating away from building openings.
- E. Install gas pressure regulator with tee fitting between regulator and upstream shutoff valve. Cap or plug one opening of tee fitting.
- F. Install gas pressure regulator with tee fitting not less than 10 pipe diameters downstream of regulator. Cap or plug one opening of tee fitting.
- G. Branch saddle or service saddles with tapping tee are allowable at taps on existing mains.

3.07 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Quality Requirements: Field inspecting, testing, adjusting and balancing.
- B. Pressure test natural gas piping in accordance with NFPA 54.
- C. Inspect, test and purge gas piping in accordance with NFPA 54 and the local gas company requirements.
- D. When pressure tests do not meet specified requirements, remove defective work, replace and retest.

3.08 PAINT

- A. All exposed gas piping shall be painted safety yellow, unless noted otherwise in Section 09 90 00.

END OF SECTION

SECTION 22 33 00 – ELECTRIC DOMESTIC WATER HEATERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Commercial electric water heaters.

B. Related Sections:

1. Section 22 00 01 – General Plumbing Requirements.
2. Section: 22 11 00 - Facility Water Distribution: Supply connections to domestic water heaters.
3. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.02 REFERENCES

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

B. American Society of Mechanical Engineers:

1. ASME PTC 25 - Pressure Relief Devices.
2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

1.03 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate heat exchanger dimensions, size of taps, and performance data. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, taps, and drains.

C. Product Data: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Submit electrical characteristics and connection locations.

D. Manufacturer's Installation Instructions: Submit mounting and support requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

- B. Operation and Maintenance Data: Submit replacement part numbers and availability.

1.05 QUALITY ASSURANCE

- A. Conform to ASME for construction of water heaters
- B. Water Heater Performance Requirements: Equipment efficiency not less than prescribed by ASHRAE 90.1.
- C. Installer: Company specializing in performing Work of this section with minimum three years of experience.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Products storage and handling requirements.
- B. Accept water heaters on site in original labeled cartons. Inspect for damage.
- C. Protect tanks with temporary inlet and outlet caps. Maintain caps in place until installation.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.09 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish three year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS

2.01 COMMERCIAL ELECTRIC WATER HEATERS

- A. Furnish and install where shown on Drawings water heater(s) equivalent to A.O. Smith "Custom Xi" of capacity and characteristics scheduled on drawings. Water heater(s) shall be U.L. listed and approved by NSF Standard No 5, and ASHRAE 90.1 Compliant.
- B. Water heater(s) shall:
 - 1. Water heater shall have LCD display with built in diagnostic and trouble shooting information.

2. Tank(s) shall be rated for 150 PSI working pressure and equipped with dual extruded high density anodes.
 3. All internal surfaces of the heater(s) exposed to water shall be glass-lined with an alkaline borosilicate composition that has been fused to steel.
 4. Electric heating elements shall be medium watt density screw-in type with Incoloy sheath and ceramic terminal block.
 5. Internal power circuit fusing shall be provided. Element operation shall be linear sequencing through individual magnetic contactors. Control circuit shall be factory fused and include an immersion thermistor temperature probe with built-in ECO control. Control cabinet and jacket shall be of baked enamel finish and shall provide full size control and element compartment and enclose tank with foam insulation.
 6. The heater tank shall have a three year limited warranty and controls and accessories shall have a one year limited warranty as outlined in the written warranty.
 7. Meets or exceeds the thermal efficiency and standby loss requirements of the U.S. Department of Energy and current edition of ASHRAE/IESNA 90.1.
 8. Water heater should incorporate the iCOMM™ system for remote monitoring, leak detection and fault alert.
- C. Certification and Codes: The complete water heater shall be UL listed and shall meet the standards of ASHRAE 90.1-2010. The water heater shall fit properly in the floor space ("footprint") indicated in the Drawings. Installation must be completed in accordance with the codes and standards listed in Section 23 00 00.
- D. Startup: The hot water generators shall be started up by a factory trained technician. The factory technician shall also provide technical and practical operation and maintenance training.

2.03 DOMESTIC HW CIRCULATING PUMPS

- A. Refer to Section 22 11 00 for circulation components.

2.04 SUPPORTS

- A. Refer to Section 22 05 29 " Hangers and Supports for Plumbing

2.04 DIELECTRIC CONNECTION

- A. Refer to Section 22 11 00 for Dielectric Connection.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Maintain manufacturer's recommended clearances around and over water heaters.

- B. Install water heater on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than water heater base on each side. Refer to Section 03 30 00.
- C. Connect domestic cold water piping to supply and return water heater connections.
- D. Install the following piping accessories. Refer to Section 22 11 00.
 - 1. On supply:
 - a. Thermometer well and thermometer.
 - b. Strainer.
 - c. Pressure gage.
 - d. Shutoff valve.
 - 2. On return:
 - a. Thermometer well and thermometer.
 - b. Pressure gage.
 - c. Shutoff valve.
- E. Install discharge piping from relief valves and drain valves to nearest floor drain.
- F. Install water heater trim and accessories furnished loose for field mounting.
- G. Install electrical devices furnished loose for field mounting.
- H. Install control wiring between water heater control panel and field mounted control devices.
- I. Install ASTM Expansion tank on cold water supply.
- J. Provide Drain Pan.
- K. Install hangers and supports in accordance with Section 22 05 29. Provide non-metallic coatings or inserts on attachments for electrolytic protection where attachments are in direct contact with copper piping.
- L. Furnish and install an expansion tank on supply side of the water heater. Locate tank as close to water heater as possible between water heater and all check valves or backflow preventers. Expansion tank capacity shall be as scheduled on Contract Drawings. Install expansion tank in accordance with manufacture's recommendations.
- M. Expansion tank factory pre-charge pressure may not be correct for this installation. Tank must be charged to system design fill pressure before being filled with water. If the system has been filled, the tank must be isolated from the system and the tank emptied before charging. Verify static pressure within the existing domestic hot water system at the Site and adjust tank pressure accordingly.
- N. Furnish and install all necessary valves, traps, gauges, strainers, unions, etc. to facilitate proper functioning and servicing of equipment.

- O. When installed water heaters are not equipped with integral temperature gauge, provide a temperature gauge in the domestic hot water piping within five feet of outlet to each heater. Size and locate gauges to be easily readable from a standing position.
- P. Provide dielectric isolation device where copper lines connect to ferrous lines or equipment, such as dielectric coupling or dielectric flange fitting.
- Q. Install a line size shutoff valve in cold water inlet and hot water outlet close to each heater.
- R. Pipe T&P relief valve discharge and all equipment drains indirectly to appropriate floor drain.
- S. Set the operating and safety controls.
- T. Set thermostats on domestic water heaters to deliver maximum water temperature as indicated on Contract Drawings.

3.02 SCHEDULES – Refer to Drawings

END OF SECTION

SECTION 22 40 00 – PLUMBING FIXTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Water closets.
2. Lavatories.
3. Sinks.
4. Service sinks.

B. Related Sections:

1. Section 07 90 00 – Joint Protection: Product requirements for caulking between fixtures and building components for placement by this section.
2. Section 22 00 01 – General Plumbing Requirements.
3. Section 22 11 00 – Facility Water Distribution: Supply connections to plumbing fixtures.
4. Section 22 13 00 – Facility Sanitary Sewerage: Waste connections to plumbing fixtures.
5. Section 22 45 00 – Emergency shower and eye wash equipment.
6. Section 26 05 03 – Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.02 REFERENCES

A. American National Standards Institute:

1. ANSI A117.1 – Accessible and Usable Buildings and Facilities.
2. ANSI Z124.1 – Plastic Bathtub Units.
3. ANSI Z124.2 – Plastic Shower Units.
4. ANSI Z358.1 – Emergency Eyewash and Shower Equipment.

B. Air-Conditioning and Refrigeration Institute:

1. ARI 1010 – Self-Contained, Mechanically Refrigerated Drinking-Water Coolers.

C. American Society of Mechanical Engineers:

1. ASME A112; Plumbing Fixture Standards

- D. National Sanitation Foundation
 - 1. NSF/ANSI 61: Drinking Water System Components- Health Effects for fixtures material that will be in contact with potable water.
- E. Texas Department of Licensing and Regulation, Texas Accessibility Standards of the Architectural Barriers Act, Article 9102, Texas Civil Statutes
- F. Americans with Disabilities Act, 28 CFR Part 35 Nondiscrimination on the Basis of Disability in State and Local Government Services, Final Rule, as published in the Federal Register
- G. ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities" relative to plumbing fixtures for people with disabilities
- H. Texas Administrative Code, Title 30, Part 1, Chapter 290, Subchapter G - Water Saving Performance Standards.
- I. Refer also to plumbing drawing P1.1 for applicable codes.

1.03 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures: Submittal procedures.
 - 1. Submittal shall have all options and all intended included items clearly identified on submittal.
- B. Product Data: Submit catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim and finishes.
- C. Manufacturer's Installation Instructions: Submit installation methods and procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. Record Documents:
 - 1. Provide full written description of manufacturer's warranty.
 - 2. Manufacturer's installation instructions.
- F. Operation and Maintenance Data:
 - 1. Include installation instructions, exploded assembly views, servicing requirements, inspection data, installation instructions, spare parts lists, replacement part numbers and availability, location and contact numbers of service depot, for all plumbing specialties installed.
- G. Section 01 60 00 – Product Requirements; Substitution Request.
 - 1. Prior to submitting a product or a manufacturer that is not the basis of design or listed as an approved equal; the contractor and/or the vendor shall submit a substitution request.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists. Provide contact number and location of supplier.

1.05 QUALITY ASSURANCE

- A. Provide products requiring electrical connections listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and indicated.
- B. Fixtures, trim, accessories and carriers of any one type shall be by the same manufacturer throughout.
- C. All fixtures and trim shall be new, institutional/commercial quality and free from mars, chips, scratches, blemishes or any defects.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 – Product Requirements: Product storage and handling requirements.
- B. Accept fixtures on site in factory packaging. Inspect for damage
- C. Equipment, fixtures and appurtenances shall not be allowed to be exposed to exterior weather or elements. Equipment, fixtures and appurtenances stored outside shall be covered by a weather-proof covering at all times and shall be stored on pallets or rack systems above the ground. Equipment, fixtures and appurtenances stored inside shall be covered to protect same from construction debris and activities and shall be stored on pallets or rack systems above the floor. Equipment, fixtures and appurtenances shall not be allowed to be stored within the construction area in a disorderly fashion. Cleanliness of the work area and safety of the construction personnel shall be the first consideration.
- D. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.
- E. Do not allow use of installed fixtures or trim, other than testing during construction phase of the project.

1.08 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish 1-year manufacturer warranty for plumbing fixtures. Warranty shall not begin until acceptance by Owner.

1.09 EXTRA MATERIALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.01 GENERAL

- A. The Contractor shall provide plumbing fixtures where indicated on the Drawings. These plumbing fixtures shall be standard products of manufacturers scheduled or listed on Drawings. Where one manufacturer is scheduled or listed on Drawings, the intent is not to limit competition or to write a closed specification, but rather to set a standard of quality. Refer to Section 01 60 00 for product options and substitution procedures. The fixtures shall be free from marks or chips and shall be new, first quality and shall be furnished with sufficient supports in order to adequately hang each and every unit.
- B. The space between fixtures and masonry walls shall be grouted with White General Electric Silicone flexible grout. The space between fixtures and sheetrock or wood panel walls shall not be grouted but the fixture shall fit flat against the wall surface with no more than 1/16" gap.
- C. All faucets, fittings, supply stops and similar devices shall be of one manufacturer unless otherwise specified. All water faucets and valve bodies shall be cast brass with a minimum copper content of 85%. They shall contain standardized interchangeable operating units constructed of a removable and replaceable unit containing all parts subject to wear. All water faucets shall contain an adjustable internal volume control unit. All exposed parts shall be chromium plated.
- D. All accessible fixtures shall meet the requirements of ADA, ANSI A117.1, ANSI Z124.2 and the State of Texas Accessibility Standards (TAS). The Contractor shall confirm locations with the Architectural drawings.
- E. Provide ADA/TAS compliant molded insulation on exposed water and drain components (piping, stops, etc.) beneath ADA accessible lavatories and sinks. Insulation shall be designed to allow removal and re-installation for pipe servicing. Insulation to be molded vinyl with added cushion and thermal resistance.
- F. Provide water hammer arrestors at all quick closing valves such as water closets, sensor faucets, knee or foot operated fixtures, etc.
- G. Coordinate special blocking, other wall supports, floor bracing or other structural bracing with General Contractor.
- H. Point of use thermostatic mixing valves located under sinks and lavatories shall be secured to the wall with a mounting bracket and located under the sink. Supply hoses shall be ordered to the correct length. Excess supply hose shall be removed; wrapping excess supply tubing around other trim is not allowed.
- I. Any condensate connection to the tail piece shall be done with chrome plated brass or copper piping and held tight to the wall. Exposed Rubber hose will not be allowed. Coordinate with mechanical contractor.
- J. All fixtures and equipment shall be lead free and shall be assembled and manufactured with lead free solders in accordance with NSF-61-G and NSF 372.

2.02 FITTINGS AND PIPES

- A. Fittings and piping shall be brass and, wherever exposed, shall be polished chrome-plated. Provide tight fitting wall or floor escutcheons of chrome-plated brass wherever pipes pass through floors, walls or ceilings.
- B. Furnish and install all required water, waste, soil and vent connections to all plumbing fixtures, together with all fittings, supports, fastening devices, cocks, valves, traps, etc., leaving all in complete working order.
- C. Supplies for all lavatories, sinks, tank type water closets and drinking fountains shall be loose key angle stops with female inlets and shall include wall flanges, and O.D. flexible risers with bullnose or flared end outlets. All components to be chrome plated. In all cases, all piping, tubing, fittings, and faucets shall be installed using a mechanical non-slip connection, such as bullnose, flared, flanged, ferrule or threaded fittings. Fittings requiring a friction fit using slip-on or gasketed connections are not acceptable.
- D. Provide water hammers arrestors as indicated on the drawings and/or at all locations with quick closing valves such as water closets, automatic fixtures, knee operated or foot operated fixtures, ice makers, washer boxes, water softeners, etc.

2.03 PLUMBING FIXTURES

- A. Refer to Plumbing Fixture Schedules on the Plumbing drawings for basis of design fixtures and acceptable manufacturers offering equivalent products.
- B. All vitreous china shall be white unless noted otherwise
- C. Lavatory and sink faucets in patient care areas shall have a minimum of 5-inches clearance from the spout of the faucet to the rim of the sink per DSHS Licensing standards.
- D. Fixtures shall have flow control devices to limit flow of water to a maximum rate in accordance with local code or in accordance with the schedules for projects that require a more stringent water use criteria.

2.04 FLUSH VALVE WATER CLOSETS

- A. Water Closets:
 - 1. Complies with ASME A112.19.2
 - 2. Tested by an independent MaP-approved laboratory, MaP tested and rated for a minimum of 350 grams or greater.
 - 3. The bowl shall be rated for a maximum of 1.26GPF unless noted otherwise.
- B. Exposed Flush Valve:
 - 1. Complies with ASME A112.18.1 and ASME A122.19.2.
 - 2. Rated for a maximum 1.28 gallon flush volume unless noted other wise. Flush valve shall match the rating of the water closet.
 - 3. ADA compliant non-hold open handle, solid non-spinning escutcheon, comply with IAPMO/ANSI 2124.5-2013

4. Water closet and urinal flush valves shall be chrome plated brass when exposed.
 5. All electronic flush valves shall be provided with manual override activators. Exception: Flush valves located within specimen collecting toilet rooms shall be hard wired without manual override.
 6. Flush valves in non-ambulatory patient rooms shall be manually operated and have integral bed pan washers. Provide offset tail piece as need to avoid conflict with grab bars in ADA/TAS patient toilet rooms.
- C. Seat:
1. Water closets seats shall be commercial/institutional grade, white in color, have open front and Self-sustaining check hinges with non-corrosive 300 series stainless steel posts and pintles
- D. Wall-Mounted Carrier: ASME A112.6.1; adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, provide optional foot support, threaded fixture studs with nuts and washers.
- E. Water closet bowl gaskets shall be neoprene, felt gaskets and wax rings are not permitted.
- F. Bolts and fasteners shall be non-corrosive stainless steel 300 series.

2.05 LAVATORIES

- A. Vitreous China Wall Hung Basin:
1. Manufacturer: As scheduled.
 2. Other acceptable manufacturers offering equivalent products on AISD Approved manufactures list.
 3. ASME A112.19.2; vitreous china wall-hung lavatory with 4-inch-high back, rectangular basin with splash lip, front overflow, and soap depression.
- B. Supply Fitting:
1. Manufacturer: As scheduled.
 2. Other acceptable manufacturers offering equivalent products on AISD Approved manufactures list.
 3. ASME A112.18.1; chrome-plated supply fitting.
- C. Accessories:
1. Chrome plated 17-gage brass P-trap and arm with escutcheon.
 2. Offset waste with perforated open strainer.
 3. Screwdriver stops.

4. Flexible supplies – Braiden 304 stainless steel; heavy duty plated brass nuts sized appropriately. No more than 3 inches of slack permitted.
- D. Wall-Mounted Carrier: ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, [threaded studs for fixture hanger,] [concealed arm supports,] bearing plate and studs.
- E. Counter-Mounted Basin:
1. Manufacturer: As scheduled.
 2. Other acceptable manufacturers offering equivalent products on AISD Approved manufactures list.
 3. ASME A112.19.2; vitreous china wall-hung lavatory with 4-inch-high back, rectangular basin with splash lip, front overflow, and soap depression.
- F. Supply Fitting:
1. Manufacturer: As scheduled.
 2. Other acceptable manufacturers offering equivalent products on AISD Approved manufactures list.
 3. ASME A112.18.1; chrome plated supply fitting.
- G. Accessories:
1. Chrome-plated 17 gage brass P-trap and arm with escutcheon.
 2. Offset waste with perforated open strainer.
 3. Screwdriver stops.
 4. Flexible supplies – Braiden 304 stainless steel; heavy duty plated brass nuts sized appropriately. No more than 3 inches of slack permitted.

2.06 SINKS

- A. Bowl:
1. Manufacturer: As Scheduled.
 2. Other acceptable manufacturers offering equivalent products on AISD Approved manufactures list.
 3. ASME A112.19.3; 18-gage thick, Type 302 stainless steel, self-rimming and undercoated, with 1-1/2 inch chromed brass drain 3-1/2 inch crumb cup and tailpiece, ledge back drilled for trim.

- B. Trim:
 - 1. Manufacturer: As scheduled.
 - 2. ***Other acceptable manufacturers offering equivalent products on AISD Approved manufactures list.***
 - 3. Accessories: Chrome-plated 17-gage brass P-trap and arm with escutcheon, screwdriver stop, flexible supplies.

2.07 LAVATORY INSULATION KIT

- A. Manufacturers: As scheduled
 - 1. Truebro.
 - 2. Substitutions: Permitted.
- B. Product Description: Where Lavatories are noted to be insulated for ADA compliance, furnish the following: Safety Covers conforming to ANSI A177.1 and consisting of insulation kit of molded closed cell vinyl construction, 3/16 inch thick, white color, for insulating tailpiece, P-trap, valves, and supply piping. Furnish with weep hole and angle valve access covers.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.
- B. Verify walls and floor finishes are prepared and ready for installation of fixtures.
- C. Verify electric power is available and of correct characteristics.
- D. Confirm millwork is constructed with adequate provision for installation of counter top lavatories and sinks.

3.02 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall carriers and bolts.
- E. Seal fixtures to wall and floor surfaces with sealant as specified in Section 09 90 00, color

to match fixture.

- F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.
- G. For ADA accessible water closets, install flush valve with handle to wide side of stall.

3.04 INTERFACE WITH OTHER PRODUCTS

- A. Review millwork Shop Drawings. Confirm location and size of fixtures and openings before rough in and installation.

3.05 ADJUSTING

- A. Section 01 70 00 – Execution and Closeout Requirements: Testing, adjusting and balancing.
- B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.06 CLEANING

- A. Section 01 70 00 – Execution and Closeout Requirements: Final cleaning.
- B. Clean plumbing fixtures and equipment.

3.07 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 70 00 – Execution and Closeout Requirements: Protecting installed construction.
- B. Do not permit use of fixtures before final acceptance.

END OF SECTION

SECTION 23 00 01 – BASIC HVAC REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Basic HVAC Requirements specifically applicable to Division 23 sections, in addition to Division 1 - General Requirements.

1.02 REFERENCES

- A. All references in Division 23 to code standards or other publications shall be the latest edition/version, unless noted otherwise.

1.03 PLANS

- A. These specifications are accompanied by plans indicating typical layouts, pipe and equipment location, etc. The plans and these specifications are complimentary each to the other and what is called for by one shall be as binding as if called for by both. Should there be a conflict between Drawings and specifications regarding a material shown or work described or detailed then the material of work having the greater value shall be provided.
- B. The plans as prepared are in general diagrammatic. The contractor shall carefully lay out his work at the site to conform to the architectural, mechanical, electrical and structural conditions to provide grading of piping, to avoid all obstructions and to conform to details of installation as shown on the plans and supplied by the manufacturers of the equipment to be installed, and thereby to provide an integrated satisfactorily operating installation. **The General Contractor must coordinate the work of all trades.** All necessary offsets in piping, fittings, ductwork, etc. required to avoid interferences between piping, equipment, structural and architectural work are not shown but shall be furnished and installed by the Contractor without additional expense to the Owner.
- C. These specifications and plans accompanying same are intended to cover systems which will not interfere with the design of the building, which will fit into the available spaces, and which will insure complete and satisfactory systems. Each contractor shall, therefore, carefully examine the plans and the building and shall be responsible for the proper fitting of his material and apparatus into the building.
- D. The size of mechanical and electrical equipment indicated on the plans is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space with the manufacturer's recommended clearances allocated for same on the plans. It shall be the Contractor's responsibility to furnish data to evidence that sufficient space can be provided for the installation of proposed equipment and that adequate access will exist for servicing and maintenance of equipment. Should changes become necessary during construction, the contractor shall make such necessary changes at his (the Contractor's) own expense.
- E. Exceptions and inconsistencies in plans and specifications shall be brought to the Architect's attention no later than ten (10) days prior to the bid date, unless specified otherwise in Division 1. Otherwise, the Contractor shall be responsible for any and all changes and additions that may be necessary to accommodate his particular apparatus or equipment.

1.04 CHANGES

- A. Any changes from the plans necessary to make this work conform to the building as it is constructed, to make this work fit the work of other trades or to make this work conform to the rules of city and municipal bodies having jurisdiction shall be made by this contractor at no additional cost to the Owner. However, no changes shall be made from the work described on the plans and these specifications except on written order from the Architect/Engineer.
- B. If any changes are required other than those mentioned above and the changes involve extra work on the part of the Contractor, no charges for this extra work shall be allowed unless authorized in advance of the work by a written order from the Owner and/or Architect/Engineer stating the charges to be made for the work.
- C. Proposed use of item or equipment other than that specified or indicated may require redesign of structure, partitions, foundations, piping, wiring, or other parts of mechanical, electrical, or architectural layout. Redesign, new drawings, and detailing required shall be prepared and submitted to Architect/Engineer for approval.
- D. Where approved deviation requires different quantity, size and arrangement of wiring, conduit, equipment, etc. from that specified or indicated, provide such items and all other additional equipment required by system at no additional cost to the Owner.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Protection:
 - 1. All work, equipment and materials shall be protected at all time to prevent damage or breakage either in transit, storage, installation or testing. All openings shall be closed with caps or plugs during installation.
 - 2. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the owner has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
 - 3. Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the Architect. In particular, ductwork insulation which becomes saturated will be rejected and must be removed from the job. Such repair or replacement shall be at no additional cost to the Owner.
 - 4. Protect interiors of new equipment, ductwork, and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
 - 5. Existing equipment, ductwork, and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.
- B. Cleanliness of Piping, Ductwork, and Equipment Systems:
 - 1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and

welding of piping.

2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Owner.
4. Boilers shall be left clean following final internal inspection by the inspector.
5. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.06 EXISTING FACILITIES

- A. All piping, valves, fittings, switches, starters, conduit boxes and/or any other items of mechanical or electrical equipment which are not in service at the completion of this contract shall be removed, unless otherwise noted.
- B. Where an existing service to existing building requires disconnection to facilitate installation of this work, this Contractor shall include in his bid the cost of such disconnecting, re-routing and re-connecting. Where any existing facilities which are to remain occupied are affected by disconnection, re-routing or re-connection, then such disconnecting, re-connecting and re-routing shall be done in such a manner so as not to interrupt any service to the building. Satisfactory arrangements shall be made with local authorities and/or the various utility companies involved. The method of disconnecting, re-routing and re-connecting shall be as shown on the Drawings, or if not shown on the drawings, subject to the approval of the Architect and Owner.
- C. Unless noted otherwise, all equipment and material indicated or specified to be removed shall become the property of the Contractor.
- D. This Contractor shall carefully coordinate work in and around existing services and equipment and adjoining rooms to remodel areas. Coordinate shut-down, removal, capping, and turn-on of existing services with the Owner's facilities' department and general contractor to provide continuous (uninterrupted) service throughout the construction period. This Contractor shall refer to the architectural plans and specifications and thoroughly familiarize himself with the construction phasing in remodel areas before beginning work.
- E. Building Working Environment: Maintain the architectural and structural integrity of the building and the working environment at all times. Maintain the interior of building at 50 degrees F minimum. Limit the opening of doors, windows or other access openings to brief periods as necessary for rigging purposes. No storm water or ground water leakage permitted. Provide daily clean-up of construction and demolition debris on all floor surfaces and on all equipment being operated by the Owner.

1.07 SUBSTITUTIONS

- A. The materials, products and equipment described and specified establish a standard of quality, function, dimension and appearance to be met by any proposed substitutions.
- B. Reference Section 01 60 00 – Product Requirements.
- C. Substitution requests are only required where specific manufacturers are listed or scheduled.

1.08 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. The Contractor shall furnish copies of the manufacturer's literature and drawings describing all proposed equipment and materials indicated in the specifications. The proposed use of the exact equipment and materials specified shall not change this requirement of including literature describing the proposed equipment. Manufactured items proposed for use, whether specified or proposed for substitution, shall be the current, catalogued product of the manufacturer, and replacement parts shall be available.
- C. Manufacturer's regular catalog sheets will not be acceptable under this requirement unless they indicate completely all of the specification requirements. Where drawings cover several sizes or types of construction they shall clearly indicate the size or type of construction to be used on the project. In cases where several sizes of the same type of equipment are required to be furnished, the submittal shall include a schedule identifying each piece of equipment, complete with all capacity information needed to compare every submitted item with its respective specified item. **Annotate to indicate exact model, size, and type submitted.**
- D. Brochures shall contain a certification that the equipment or materials are suitable for conditions shown and specified; that the equipment or materials are believed to be in conformity with the plans and specifications, except as may be specifically described and that approval is recommended. The certification shall be signed by the Contractor. Brochures received not in conformity with these requirements will be returned for required actions. Any deviation from the requirements of the specifications shall be clearly noted and marked for the Engineer's consideration.
- E. Approval of the brochures, or any part of the contents therein, shall not eliminate responsibility for compliance with the plans and specifications, unless specific attention has been called in writing to proposed deviations at the time of transmittal of the brochures and such deviations have been approved, nor shall it eliminate the requirements or the responsibilities, if there are errors of any sort in the data submitted.

1.09 INTERFERENCES AND COOPERATION

- A. The plans are generally diagrammatic and the Contractor shall coordinate the work of the different trades so that interferences between piping, equipment, structural and architectural work will be avoided. Not all offsets in piping, ductwork, etc., are shown. The Contractor shall cooperate with the General Contractor and all other contractors to coordinate their work to avoid interferences and delays and arrange all parts of the work to harmonize in service and appearance with all other parts.
- B. The General Contractor shall coordinate the work of all trades. The various systems to be installed shall follow the normal, common sense priority of systems installation with the highest system to lowest system installation as follows:
 - 1. HVAC ductwork shall be installed up and against building (floor/roof) structural members.
 - 2. Sanitary waste and storm drainage piping system shall begin horizontal routing as high as possible between structural members, offsetting vertically only to avoid conflict with structure or to drop below HVAC ductwork where offset is

unavoidable.

3. Electrical conduit shall be installed up, and against building structure, running parallel with HVAC ductwork and offsetting up into structural bay (void) or below HVAC ductwork to obtain a change in direction or branch take-off. Electrical conduit installation shall not control or dictate the routing or installation of the HVAC ductwork.
 4. Domestic hot and cold water supply and hot water circulating return piping shall be installed beside and below the HVAC ductwork and electrical conduit. Preferred installation shall be on trapeze, wall brackets, or racked on vertical channel on the wall above the ceiling line. The completed installation shall not conflict with the installation or removal of ceiling system components of tile. All main-run and branch take-off isolation valves shall be readily identifiable and accessible from a standing position on a step ladder.
- C. Provide an overhead coordination submittal per Section 01 30 00. The submittal shall include all structural, plumbing, mechanical, electrical and fire protection components.

1.10 MATERIALS AND WORKMANSHIP

- A. All materials shall be new, of the quality specified and free of any defects. Manufacturer's names are listed to establish a standard of quality and construction.
- B. The Contractor will be responsible for transportation of his materials to the job and for their storage and protection until the final acceptance of the job.
- C. Contractor shall furnish all necessary scaffolding, tackle, tools and appurtenances of all kinds and all labor required for the safe and expeditious execution of his contract.

1.11 PERMITS AND INSPECTIONS

- A. The Contractor will be responsible for all permits and inspections required by law for the completion of his work. Cost of all permits and inspections shall be paid for by the Contractor. The Contractor shall obtain and pay for all certificates of approval which must be delivered to the Architect before final acceptance of the job. All materials and labor furnished by the Contractor shall be in strict accordance with the rules and requirements of the National Board of Fire Underwriters, state and municipal regulations and other authorities who may have lawful jurisdiction over the work being done.
- B. Each contractor shall be responsible for coordinating their work with the General Contractor and scheduling AHJ required inspections through the General Contractor to allow inspections to be performed without impeding the progress of construction. Generally, the Contractor shall plan for inspections to occur two (2) weeks prior to the scheduled concealment of work in the area of inspection.

1.12 ENGINEERING DESIGN TEAM OBSERVATIONS

- A. Each contractor shall be responsible for coordinating their work with the General Contractor and scheduling progress observations through the General Contractor to allow for the following observations to be performed without impeding the progress of construction. Generally the Contractor shall plan for observations to occur two (2) weeks prior to the scheduled concealment of work in the area of observation.

- B. The minimum observations required for this project shall include but not be limited to:
1. Above Ceiling: All utilities, services and systems in place, labeling on exposed piping (No insulation on piping systems. Ceiling grid/channels may be installed but no sheetrock or ceiling tile).
 2. Above Ceiling Final: All utilities, services and systems complete including hangers, insulation, and labeling (ceiling grid and/or channel may be in place but no sheetrock or ceiling tile shall be installed).
 3. Substantial Completion: All surfaces complete, fixtures installed and trim-out complete.
 4. Final: Cleaned and ready for occupancy.

1.13 EXAMINATION OF SITE

- A. All Contractors submitting proposals for this work shall first examine the site and all conditions thereon and therein. All proposals shall take into consideration conditions as may affect the work under this contract. They shall satisfy themselves as to existing grades and the actual formation, and soil conditions.
- B. They shall verify all service locations, depths, sizes, etc. No information given on the plans shall relieve the Contractor of this responsibility.

1.14 QUALITY ASSURANCE

- A. Perform Work in accordance with codes listed on the drawing sheets the local authority having jurisdiction (AHJ), and the Architect/Engineer. As the minimum standard for the level of quality, in all cases the greater quantity or better quality shall be the first consideration for the basis of an acceptable product or process. The local authority having jurisdiction, the Architect and the Engineer shall have the final authority on the approval and/or use of any product or process specified or submitted for substitution. The greater quality and/or value specified herein for the system(s) and various components and installation procedures shall take precedence over the minimum requirements of the herein before mentioned codes.
- B. Equipment and Components: Bear UL and FM label or marking.
- C. Welding Materials and Procedures: Perform to ASME Code.
- D. Valves: Bear UL/FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- E. Piping: All piping installed on this project shall bear the complete ASTM and Manufacturer's marking. Labeling and identification requirements as required by ASTM. All installed piping 5'-0" or greater in length shall be readily identifiable per ASTM labeling criteria. Piping not bearing this identification upon installation shall be removed and replaced by the correctly labeled piping. Piping shall not be re-stenciled after it is installed, to meet this requirement.

1.15 CONTROLS

- A. Where "automatic controls" are called for in the plans and specifications, all the control instruments, such as motorized valves, etc., shall be provided by the Contractor. The

Drawings may show some power connections to controls equipment. However, if more power is required, then the Contractor shall provide this power.

1.16 UNIONS

- A. No unions are to be placed in any pipe in a location which will be concealed or inaccessible after completion of the building unless furnished with an access panel either as shown on the drawings or as specified herein. Unions must be installed on each side of all pieces of equipment such as heating/cooling equipment, coils, pumps, etc., so that such equipment may be readily disconnected in location that equipment can be disconnected and removed.

1.17 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Prepare equipment layout drawings to coordinate proper location and personnel access of all facilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the drawings.
- C. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- E. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.
- F. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- G. Electrical and Pneumatic Interconnection of Controls and Instruments: This is generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.
- H. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- I. Work in Existing Building: Cut required openings through existing masonry and reinforced concrete using 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 Owner. Locate openings that will least effect structural slabs,

columns, ribs or beams.

1.18 TEMPORARY PIPING AND EQUIPMENT

- A. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.
- B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities.
- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining in service.
- D. Temporary equipment shall be provided when required by the phasing or called for specifically on the plans. The contractor shall maintain and operate temporary equipment or new equipment operated during construction strategically to provide desired indoor air conditions or for "dust" control.
- E. Temporary filters shall be provided throughout the entire construction period if the systems are operational. The frequency of replacement shall be directly related to the amount of airborne debris during the particular phase of construction. Different areas in different phases of the construction may require different frequencies of temporary filter replacement.
- F. Contractor shall keep building sealed weather tight if HVAC is turned 'ON' prior to substantial completion.

1.19 MECHANICAL DEMOLITION

- A. Rigging access, other than indicated on the drawings, shall be provided by the Contractor. Such access shall be provided without additional cost or time to the Owner. Where work is in an operating facility, provide approved protection from dust and debris at all times for the safety of plant personnel and maintenance of plant operation and environment of the facility.
- B. In an operating facility, maintain the operation, cleanliness and safety. The Owner's personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and facility operation. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Do not permit debris to accumulate in the area to the detriment of facility operation. Perform all flame cutting to maintain the fire safety integrity of this facility. Adequate fire extinguishing facilities shall be available at all times. Perform all work in accordance with recognized fire protection standards.
- C. Completely remove all piping, wiring, conduit, and other devices associated with the equipment not to be re-used in the new work. This includes all pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.

- D. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from the property expeditiously and shall not be allowed to accumulate.

PART 2 PRODUCTS

2.01 FACTORY-ASSEMBLED PRODUCTS

- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
 - 1. All components of an assembled unit need not be products of same manufacturer.
 - 2. Constituent parts that are alike shall be products of a single manufacturer.
 - 3. Components shall be compatible with each other and with the total assembly for intended service.
 - 4. Contractor shall guarantee performance of assemblies of components and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment, which serve the same function, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

2.02 COMPATIBILITY OF RELATED EQUIPMENT

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

2.03 ESCUTCHEONS AND PLATES

- A. Where pipes or ducts pass through ceilings or walls in finished spaces, install sectional plates or escutcheons to cover the annular opening between pipe and sleeve. Solid plates with set screws shall be used where the sectional plates will not stay in place or are not available in the required size, or where other individual specification section(s) require one piece or greater quality escutcheons or plates.
- B. Inside diameter of escutcheons shall fit around insulation and around pipe or duct when not insulated; outside diameter shall cover sleeve. Secure escutcheons or plates to pipe or duct or sleeve but not to insulation. All escutcheons shall be triple nickel-chromium plated brass, or type 316L stainless steel.

2.04 INSULATION

- A. All insulation materials used inside the building on this project, including finishes and adhesives on the exterior surfaces of ducts, pipes and equipment shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less as determined by an independent testing laboratory in accordance with NFPA 255 as required by NFPA 90A, unless noted otherwise acceptable.

2.05 SOLENOID VALVES

- A. All solenoid valves used in hydronic systems shall be the slow acting type.

2.06 ASBESTOS

- A. Materials containing asbestos are not permitted.

PART 3 EXECUTION

3.01 ACCESS PANELS

- A. All valves, traps, drains, cleanouts, equipment, etc., must be accessible. The Contractor shall, wherever required to service his installation, coordinate size and location of access panels with General Contractor. Refer to Section 08 31 13 – Access Doors and Frames.

3.02 FIRESTOPPING

- A. Firestopping: Unused slots, sleeves and other penetrations in floors, walls or other general construction shall be closed and sealed with an approved firestopping material.
 - 1. Reference Section 07 84 00 – Firestopping for appropriate firestopping material required for each wall rating and penetration size and type.
 - 2. Floor slots and openings shall be closed with 16 gauge galvanized steel sheet supported on 1-inch by 1-inch by 1/8-inch structural angle drilled or supported with powder-driven studs into the building structure. Firestop with a layer of silicone elastomer not less than 1-inch thick which completely fills the opening. The top surface of the silicone elastomer shall be approximately 1-inch below the finished floor slab.
 - 3. Openings in walls shall be closed with 16 gauge galvanized steel sheet securely attached at the midpoint of the wall thickness and firestopped on both sides of the steel sheet with not less than 1/8-inch thick layer of non-sagging silicone elastomer to fully cover the opening.
 - 4. Single or multiple pipes passing through walls and floors shall have the annular space between pipes or between pipes and structure filled with silicone elastomer to provide a rated firestop (rated to match the assembly) for floors and walls.
- B. Pipe and Ducts: The annulus between exposed pipe and ductwork and walls or floors in finished spaces shall be refilled, sealed and painted to match adjacent surfaces.
- C. Future Slots: Cap ends of sleeve and mark as future.

3.03 CUTTING AND PATCHING

- A. All cutting and patching of floors, walls and ceilings for installation of work covered in

these sections will be done by the General Contractor.

- B. Where it becomes necessary to drill into or cut through any existing or completed floors, walls or ceilings to permit the installation of any work under this contract or to repair any defects that may appear up to the expiration of the guarantee, such cutting and patching shall be done by the General Contractor under the supervision of the Architect.
- C. No joists, beams, girders or columns shall be cut without first obtaining written permission from the Architect.
- D. All drilling methods for expansion bolts, hangers and other supports shall be done subject to be approval of the Architect. Labor and materials required to replace or rebuild parts or injured portions shall be furnished at the Contractor's expense, subject to the satisfaction of the Architect.

3.04 PAINTING

- A. Types of paint shall be as specified in the Architectural specifications. Surfaces to be painted are identified in Section 09 90 00 and the drawings.
- B. All surfaces to be painted shall be thoroughly cleaned, all rust scraped off and all oil and grease removed before any paint is applied.
- C. Finishing paint coats shall not be applied until all the work is completed. Cloths shall be spread where necessary to prevent drops of paint, oil, etc. from defacing walls, floors, etc., and the Contractor shall be held responsible for all damage by neglect of such precautions. The finished conditions of the painting shall be subject to the approval of the Architect, who may require retouching or repainting of surfaces not properly finished.

3.05 EXCAVATING AND BACKFILLING

- A. The Contractor shall do all excavating and backfilling necessary for the installation of the work, including shoring, bailing and pumping to maintain his trenches and keep them in dry condition until the work in question has been tested and approved.
- B. Care shall be taken that piping is properly and uniformly graded and that trench beds are well rammed and that ground under pipelines is firm and secure before piping is laid. All trenches must be backfilled with clean sand, four inches under pipe, rammed down, soaked with water and made solid. All surplus material shall be removed and carted away.
- C. The Contractors will be responsible for resurfacing all areas after trenches have been backfilled.
- D. The Contractor is directed to comply with all OSHA Requirements and State Requirements regarding trench safety.
- E. Perform all work with the highest regard to safety and in accordance with U.S. 29 CFR 1926 "Safety and Health Regulations for Construction". Special attention shall be directed to Subpart P – Excavations. Refer also to 230010.1.12 – Safety.
 - 1. Safety Precautions and Programs
 - a. In excavations that are four (4) feet or more in depth, means of egress shall be provided by stairway, ladder, ramp or other safe means so as to

- require no more than twenty-five (25) feet of lateral travel for employees.
 - b. In addition, on projects in which trench excavation will have a depth of five feet or more, the Contractor, and all of their subcontractors, shall comply with all requirements of 29 CFR 1926 Subpart P 652 "Safety and Health Regulations for Construction – Excavations" and all Appendices related thereto.
 - c. Before commencing any trench excavation that will be five (5) feet deep or deeper, provide Owner, through A/E, with detailed plans and specifications regarding the safety systems to be utilized. Said plans and specifications shall include a certification from a registered professional engineer indicating full compliance with the 29 CFR 1926 Subpart P -- Excavations.
 - d. Contractor shall ascertain, prior to proposal, whether or not such conditions prevail and services are needed, and shall include cost of same in proposal.
 - 2. All shoring and bracing shall be designed so that it is effective to the bottom of the excavation. Sheet piling, sheet piling, bracing, shoring, trench boxes, and other methods of protection, including sloping, shall be based upon the condition and nature of the materials to be retained, and by loads (including surcharge) imparted to the sides of excavation by equipment and stored materials.
 - 3. Store excavated or other materials a minimum of two feet (2') from the edge of any excavation. Retain such materials to prevent their falling or sliding into the excavation, and to prevent excessive pressure on the sides of the excavation.
 - 4. Maintain sides and slopes of excavations in a safe condition by scaling, benching or barricading.
 - 5. Take other precautions via shoring and bracing to prevent slides or cave-ins. Take special precautions when trenches are located adjacent to backfilled excavations, or subjected to vibrations from railroads, highway traffic, operation of machines, etc.
- F. Verify locations of all existing utilities in the area prior to start of excavation (gas, electrical, water, sanitary, storm, telephone, cable TV, optical cable, etc.) Coordinate with utility companies as required.
- 1. Excavation within four feet (4') of existing utilities shall be done by hand digging only.
- G. Where conditions require concrete or other materials to be placed against undisturbed earth surfaces, any loosened or disturbed materials shall be removed from such surfaces.
- H. Trenching
- 1. Trenches shall be large enough to permit handling of pipe and accessories and making connections. For cast iron pipe installation, trench bottom width shall exceed bell or coupling diameters by at least twelve inches (12").
 - 2. Trenches in rock, soil containing rocks larger than two (2) inches in any dimension, and other non-uniform materials, shall be four (4) inches minimum and twelve inches (12") maximum below the bottom of the pipe to provide for a bedding course.

I. Preparation of Trench Bottom

1. If the excavation is carried below the finished flow line grade of the pipe in order to remove unsuitable material or for any other reason, the trench shall be course bedded to within six inches (6") of the finished flow line grade of the pipe bottom with compacted load-bearing backfill. A bedding course as specified below shall then be placed over the load-bearing backfill.
2. Trenches shall be dry when the trench bottom is prepared. A continuous trough with compacted bedding course shall be prepared to receive the bottom quadrant of the pipe barrel. Remove loose or disturbed material and bring the trench bottom up to grade with bedding material as follows:
 - a. For active soils where either metallic piping is used, washed pea gravel with material no larger than 1/2 inch in largest dimension. Provide a Bentonite plug in the trench at the building perimeter where site drainage or other conditions could permit water intrusion into the trench under the building. Bentonite plug to extend 2 ft. on either side of the perimeter grade beam. (Sand bedding material may be substituted beyond ten (10) feet from building line only.)
 - b. NOTE: Confirm soil conditions prior to trenching. In general, soils with a plasticity index (PI) over 10 at depths to be encountered are considered active.
3. In addition, for bell joint pipe, excavation for the bell or coupling shall be so that the pipe will bear on the trench bottom along the entire length of the barrel.
4. Prepare the trench bottom carefully so that when placed in its final position, the pipe will be true to line and grade and uniformly supported.

J. Laying Pipe

1. All pipe shall be clean at the time it is placed in the line. Open ends of pipe sections already in place shall be tightly plugged to prevent the entrance of trench water, mud, dirt, etc.
2. Keep trench bottom free of frost, frozen earth or standing water at the time of pipe laying and jointing.

K. Compaction

1. Where compaction is indicated by specifications, accomplish same with vibratory or rammer type compactor, minimum of two full width passes.
2. Compaction below slabs, roads, flatwork, or other construction elements shall be performed to the requirements of compaction for those elements. Coordinate with general construction trades and other Division's specifications.

L. Backfilling

1. Clean trenches and backfill material of any organic material, roots, trash, lumber, other debris and frozen material prior to backfilling. Backfill material shall contain no organic material, roots, trash, lumber, other debris or frozen material. Backfill material under slabs inside building shall match adjacent materials and be of density acceptable to the A/E.

2. Backfilling by means of sluicing or flooding with water is not permitted. Backfill shall not be placed on frozen ground.
 3. Partially backfill immediately after the pipe is laid (unless other methods for anchoring pipe are provided). Leave joints exposed for hydrostatic testing. Water shall not be permitted to rise in unbackfilled trenches after pipe has been placed.
 4. Whenever timber or other sheeting is driven to a depth below the elevation of the top of the pipe, that portion of the sheeting below a point four feet above the elevation of the top of the pipe shall not be disturbed or removed.
 5. Pipe layer backfill (bedding material under the bottom quadrant of the pipe, around sides, and up to a point one foot above the top of the pipe) shall be: sand or select material containing rocks no larger than 1/2 inch in greatest dimension (sand only shall be used with all plastic piping systems or plastic jacketed piping systems); except that pipe layer backfill below slabs in active soils shall be washed pea gravel of 1/2 inch minus dimensions. Backfill below slabs may utilize flowable fill.
 6. Backfill material shall be placed and compacted in six inch (6") layers. Backfill shall be brought up evenly on both sides of the pipe simultaneously to avoid damage or displacement from unbalanced loading.
 7. Joints shall not be covered with backfill until pressure and leak testing is completed.
 8. Backfill to grade (above pipe layer).
 - a. Active Soils: Where active soils are encountered backfill to grade within ten (10) feet of building line shall be uncompacted washed pea gravel to match the pipe layer backfill specified above.
- M. The Contractor shall also comply with requirements set forth in Division 31 Drawings and Specifications.

3.06 RIGGING

- A. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Government under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.
- C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Owner operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility.
- E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.

- F. Restore building to original condition upon completion of rigging work.

END OF SECTION

SECTION 23 01 00**COMMISSIONING OF MECHANICAL SYSTEMS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section includes commissioning process requirements for mechanical (HVAC&R and Plumbing) systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section 019113 – “GENERAL COMMISSIONING REQUIREMENTS” for general commissioning process requirements.
 - 2. Division 22 Section 220100 - “COMMISSIONING OF PLUMBING SYSTEMS”.
 - 3. Division 23 Section 230926c – “COMMISSIONING OF BUILDING AUTOMATION SYSTEM (LON)”.
 - 4. Division 26 Section 260100 - “COMMISSIONING OF ELECTRICAL SYSTEMS”.

1.3 DEFINITIONS

- A. Commissioning Authority (CxA): Independent agent hired by Owner and not associated with General Contractor or its subcontractors, Architect or its sub-consultants, or Construction Administrator or its staff or consultants. Under Owner’s direction, and not General Contractor’s direction, CxA will conduct third-party commissioning activities to verify installation and performance of systems.
- B. Refer to section 019113- GENERAL COMMISSIONING REQUIREMENTS for additional definitions and assignment of responsibilities.

1.4 REFERENCES

- A. National Environmental Balancing Bureau (NEBB) - Procedural Standards for Building Systems Commissioning
- B. American Air Balance Council (AABC) - Commissioning Guideline

- C. SMCNA - HVAC Systems commissioning Manual

1.5 CONTRACTOR'S COMMISSIONING RESPONSIBILITIES

- A. Refer to section 019113 - GENERAL COMMISSIONING REQUIREMENTS.
- B. Prepare submittals
- C. Review pre-functional/installation checklists prepared by CxA for mechanical system components.
- D. Complete pre-functional/installation checklists prepared by CxA.
- E. Provide competent technical personnel, tools, equipment, and manpower to assist CxA during field-verification of pre-functional checklists completed by Contractor.
- F. Provide competent technical personnel, tools, equipment, and manpower to assist CxA during functional testing of mechanical systems and equipment.
- G. Correct deficiencies identified by CxA in Commissioning Log, as directed by Design Team.
- H. Accompany CxA during verification of corrective action.
- I. Provide training.
- J. Provide O&M and As-built documentation
- K. Provide test data, inspection reports, and certificates.

1.6 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing pre-functional/installation checklists and manufacturer's pre-start and startup checklists for mechanical systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certification that installation, pre-start checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that mechanical systems, subsystems, equipment, and associated controls are ready for pre-functional third-party verification by CxA.
 - 6. Certificate of readiness certifying that mechanical systems, subsystems, equipment, and associated controls are ready for functional third-party testing by CxA.
 - 7. Test and inspection reports and certificates.
 - 8. Corrective action documents.

1.7 SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, pre-start, and startup activities.
- C. Mechanical equipment submittals and installation manuals.
- D. Mechanical shop and coordination drawings required for the Commissioning process.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to section 019113 - GENERAL COMMISSIONING REQUIREMENTS.

3.2 PRE-FUNCTIONAL CHECKLISTS

- A. Contractor shall conduct Pre-functional Testing to document compliance with installation and pre-functional checklists prepared by Commissioning Authority for Division-23 items.
- B. Refer to Section 019133 - GENERAL COMMISSIONING REQUIREMENTS for issues relating to pre-functional checklists and testing, description of process, details on non-conformance issues relating to pre-functional checklists and test.
- C. Do not proceed with system start-up or functional testing until after CxA has conducted third-party verification of pre-functional checklists.

3.3 SYSTEM START-UP

- A. Contractor is solely responsible for system start-up. CxA may, at his discretion, witness start up procedures, but will not perform any Functional Testing of systems until Contractor has completed start-up and resolved all operating deficiencies.

3.4 FUNCTIONAL TESTING PREPARATION

- A. Certify that mechanical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that mechanical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, and alarm conditions).
- E. Inspect and verify the position of each device and interlocks identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed.

3.5 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Provide technicians, instrumentation, and tools to verify testing and balancing of mechanical systems at the direction of the CxA.
 - 1. The CxA will notify Contractor 4 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
 - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.6 GENERAL FUNCTIONAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of mechanical testing shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each space served. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. Tests will be performed using design conditions whenever possible.

- E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the Contracting Officer and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- F. The CxA may direct that set points be altered when simulating conditions is not practical.
- G. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the mechanical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.7 GENERAL TESTING PROCEDURES FOR HVAC SYSTEMS, SUBSYSTEMS, AND EQUIPMENT

- A. HVAC Instrumentation and Control System Testing: Contractor shall fully test operation of controls system prior to requesting Functional Testing with CxA. Point-to-point check out sheets and as-built control diagrams shall be provided to CxA so he may develop testing procedures.
- B. Mechanical Subcontractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan for piping systems. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA.
- C. HVAC Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air distribution systems; special exhaust; and other distribution systems, including HVAC terminal equipment and unitary equipment.

3.8 FUNCTIONAL TEST PROCEDURES FOR SYSTEMS TO BE COMMISSIONED

- A. General
 - 1. The following paragraphs outline the functional test procedures for the various Div. 23 items to be commissioned. Functional testing will take place only after pre-functional checklists have been completed, equipment has been started-up, TAB has been verified, and Contractor has certified that systems are ready for functional testing.
 - 2. All systems controlled via the Building Automation System shall have all control points and sequences tested by Controls Contractor prior to requesting testing by Commissioning Authority.
 - 3. Functional testing of HVAC systems shall include testing of the Building Automation System. Refer to Section 23 09 26c Commissioning of Building Automation System.
- B. All Equipment:

1. Verify nameplate information (serial numbers, model numbers, etc.); verify that equipment capacity is in accordance with requirements of construction documents.
2. Verify unit runs smoothly and quietly.
3. Verify operation of safeties.
4. Verify electrical wiring and grounding is correct.
5. Verify maintenance and NEC clearances are maintained.
6. Verify Pre-Functional Checklists have completed.

C. Cooling Towers:

1. Record outside air temperature during test.
2. Record programmed setpoints (condenser water temp, OA reset temps, heater temp, freeze control temp, low-limit temp.)
3. Record programmed schedules
4. Verify fans run smoothly and quietly.
5. Verify voltages and amperages are within tolerance.
6. Verify correct fan rotation (in VFD Auto, Hand, Manual, and Bypass positions).
7. Verify tower data in TA&B report versus design
8. Verify fan modulation to maintain temperature setpoint.
9. Verify condenser water bypass valve operation
10. Verify all alarms and safeties.
11. Verify all interlocks.
12. Verify all sequences.

D. Chillers:

1. Record outside air temperature during test.
2. Record programmed setpoints (supply chilled water setpoint, minimal temperature differentials, minimal flow, safeties)
3. Verify chillers run smoothly and quietly under varying loads.
4. Verify voltages and amperages are within tolerance.
5. Verify chiller data in TA&B report versus design (condenser and evaporator side)
6. Verify compressor modulation to control supply chilled water temperature.
7. Verify low-flow (condenser and evaporator) shutdown and restart.
8. Verify high-condenser water alarm and shutdown
9. Verify loss of power restart
10. Verify all alarms and safeties.
11. Verify all interlocks
12. Verify all sequences.

E. HVAC Pumps:

1. Record outside air temperature during test.
2. Record programmed schedules
3. Verify pumps run smoothly and quietly.
4. Verify voltages and amperages are within tolerance.
5. Verify correct fan rotation (in VFD Auto, Hand, Manual, and Bypass positions).
6. Verify pump data in TA&B report versus design
7. Verify all alarms and safeties.
8. Verify all interlocks.
9. Verify all sequences.

F. VAV Boxes:

1. Record outside air temperature during test.
2. Record space temperature during test.
3. Record programmed setpoints (occ/unocc heating and cooling temps, max and min airflows, discharge air temp, safeties)
4. Record programmed schedules
5. Verify voltages and amperages are within tolerance.
6. Verify VAV data in TA&B report versus design
7. Verify fan operation.
8. Verify hot water control valve operation.
9. Verify damper operation
10. Verify all alarms and safeties.
11. Verify all interlocks.
12. Verify all sequences.

G. Boilers:

1. Record outside air temperature during test.
2. Record programmed schedules.
3. Record programmed setpoints (hot water supply, safeties).
4. Verify boiler fan runs smoothly and quietly.
5. Verify voltages and amperages are within tolerance.
6. Verify gas pressure is within tolerance.
7. Verify burner modulation/staging at varying loads
8. Verify flow data in TA&B report versus design
9. Verify all alarms and safeties.
10. Verify all interlocks.
11. Verify all sequences.

H. Air Handling Units:

1. Record outside air temperature during test.
2. Record programmed setpoints (occ/unocc heating and cooling temps, coil discharge air temps, static pressure, economizer temp, CO2 setpoint, safeties and alarms)
3. Record programmed schedules
4. Verify fans run smoothly and quietly.
5. Verify voltages and amperages are within tolerance.
6. Verify correct fan rotation (in VFD Auto, Hand, Manual, and Bypass positions).
7. Verify AHU data in TA&B report versus design.
8. Verify chilled water control valve modulation to control supply air temperature.
9. Verify hot water control valve modulation to control discharge air temperature
10. Verify fan modulation to maintain duct static pressure setpoint.
11. Verify damper operation (Return, Outside and relief).
12. Verify Smoke detector operation.
13. Verify all alarms and safeties.
14. Verify all sequences.

I. Exhaust Fans

1. Record outside air temperature during test.
2. Record programmed schedules and interlocks
3. Verify fans run smoothly and quietly.
4. Verify voltages and amperages are within tolerance.

5. Verify fan data in TA&B report versus design
6. Verify backdraft damper operation
7. Verify all alarms and safeties.
8. Verify all sequences.

J. Dx Single-Zone Units:

1. Record outside air temperature during test.
2. Record space temperature during test.
3. Record programmed setpoints (occ/unocc heating and cooling temps, runtime, safeties and alarms)
4. Record programmed schedules and interlocks
5. Verify fans run smoothly and quietly.
6. Verify voltages and amperages are within tolerance.
7. Verify unit data in TA&B report versus design.
8. Verify compressor cycling to control space temperature.
9. Verify Smoke detector operation.
10. Verify all alarms and safeties.
11. Verify all sequences.

K. Testing Adjusting and Balancing (TAB).

1. Review TAB report for accuracy and completeness.
2. Take random sample of air flow from supply air diffusers and compare to TAB report / design drawings.
3. Take pressure readings at inlets and outlets of hydronic pumps and compare to TAB report and pump curves.

L. Building Automation System –Refer to Section 23 09 26c

3.9 TRAINING

- A. Refer to section 019113- GENERAL COMMISSIONING REQUIREMENTS.

3.10 O&M MANUALS

- A. Refer to section 019113 - GENERAL COMMISSIONING REQUIREMENTS and section 017800 CLOSEOUT SUBMITTALS.

END OF SECTION 23 01 00

SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes single- and three-phase motors for application on equipment provided under other sections [and for motors furnished loose to Project].
- B. Related Sections:
 - 1. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
 - 2. Section 26 05 53 – Identification for Electrical Systems.
 - 3. Section 26 29 13 – Enclosed Controllers and Section 26 29 23 – Enclosed Circuit Breakers.

1.02 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
- B. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 – Motors and Generators.
- C. International Electrical Testing Association:
 - 1. NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.03 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.
- B. Testing Agency: Company specializing in testing products specified in this section with minimum ten years documented experience.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 – Product Requirements: Product storage and handling requirements.

- B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.
- C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.
- D. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS FOR MOTORS

- A. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
 - 1. Voltage: As indicated on Drawings.
 - 2. Service Factor: 1.15
 - 3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
 - 4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 5. Insulation System: NEMA Class B or better.
 - 6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
 - 7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
 - 8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
 - 9. Sound Power Levels: Conform to NEMA MG 1.
- B. Single Phase Motors:
 - 1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
 - 2. Voltage: As indicated on Drawings.
- C. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities,

sizes, and materials indicated.

2.02 SOURCE QUALITY CONTROL

- A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 EXECUTION

3.01 EXISTING WORK

- A. Disconnect and remove abandoned motors.
- B. Maintain access to existing motors and other installations remaining active and requiring access. Modify installation or provide access panel.
- C. Clean and repair existing motors to remain or are to be reinstalled.

3.02 INSTALLATION

- A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- B. Install in accordance with manufacturer's instructions.
- C. Ground and bond motors in accordance with Section 26 05 26.

3.03 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Quality Requirements, 01 70 00 – Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION

SECTION 23 05 29 – HANGERS AND SUPPORTS FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Hangers and supports.
2. Hanger rods.
3. Flashing.
4. Equipment curbs.
5. Sleeves.
6. Equipment bases and supports.
7. Rooftop non-penetrating pipe supports
8. Rooftop pipe chase housing

B. Related Sections:

1. Section 03 10 00 – Concrete Forming and Accessories: Execution requirements for placement of inserts or sleeves in concrete forms specified by this section.
2. Section 03 30 00 – Cast-In-Place Concrete: Execution requirements for placement of concrete housekeeping pads specified by this section.
3. Section 07 84 00 – Firestopping: Product requirements for firestopping for placement by this section.
4. Section 07 62 00 – Sheet Metal Flashing and Trim: Product and execution requirements for sheet metal flashing and trim for placement by this section.
5. Section 07 90 00 – Joint Protection: Product requirements for sealant materials for placement by this section.
6. Section 09 90 00 – Painting and Coating: Product and execution requirements for painting specified by this section.
7. Section 23 05 48 – Vibration for HVAC Piping and Equipment: Product and execution requirements for vibration isolators.
8. Section 23 21 13 – Hydronic Piping: Execution requirements for placement of hangers and supports specified by this section.
9. Section 23 22 13 – Steam and Condensate Heating Piping: Execution requirements for placement of hangers and supports specified by this section.

1.02 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B31.5 – Refrigeration Piping.
 - 2. ASME B31.9 – Building Services Piping.
- B. American Welding Society:
 - 1. AWS D1.1 – Structural Welding Code – Steel.
- C. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 58 – Pipe Hangers and Supports – Materials, Design and Manufacturer.
 - 2. MSS SP 69 – Pipe Hangers and Supports – Selection and Application.
 - 3. MSS SP 89 – Pipe Hangers and Supports – Fabrication and Installation Practices.

1.03 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures: Submittal procedures.
- B. Product Data:
 - 1. Hangers and Supports: Submit manufacturer's catalog data including load capacity.
- C. Design Data: Indicate when requested, load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- D. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years of documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum 3 years of documented experience.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 – Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

- C. Protect from weather and construction traffic, dirt, water, chemical and damage, by storing in original packaging.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 – Product Requirements: Environmental conditions affecting products on site.

1.07 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.08 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.01 HANGERS AND SUPPORTS

- A. General:
 - 1. Refer to individual system and equipment Specification Sections for additional support requirements. Comply with MSS SP-69 for support selections and applications that are not addressed within these Specifications.
 - 2. Utilize hangers and supports to support systems under all conditions of operation, allowing free expansion and contraction, and to prevent excessive stresses from being introduced into the structure, piping or connected equipment.
 - 3. All pipe supports shall be of the type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.
 - 4. Design hangers to impede disengagement by movement of supported pipe.
 - 5. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping.
 - 6. Wire or perforated strap iron will not be acceptable as hanger material.
 - 7. Field fabricated supports shall be constructed from ASTM A36/A36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

8. Finishes: All ferrous hangers, rods, inserts, clamps, stanchions, and brackets on piping within interior non-corrosive environments, shall be dipped in Zinc Chromate Primer before installation. Rods may be galvanized or cadmium plated after threading, in lieu of dipping zinc chromate. All hangers and supports exposed to the weather, including roofs and building crawl space areas, shall be galvanized or manufactured from materials that will not rust or corrode due to moisture. All hangers and supports located within corrosive environments shall be constructed from or coated with materials manufactured for installation within the particular environment.
- B. Refrigerant Piping and Condensate Drain Piping:
1. Conform to ASME B31.5, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
 3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods. At un-insulated piping provide clamp with a thermoplastic elastomer cushion insert similar to Unistrut's Cush-A-Clamp or equal.
 5. Wall Support: Steel channels with electro-galvanized clamps. At un-insulated piping provide clamp with a thermoplastic elastomer cushion insert similar to Unistrut's Cush-A-Clamp or equal.
 6. Vertical Support: Steel riser clamp.
 7. Floor Support: Steel channels with electro-galvanized clamps. At un-insulated piping provide clamp with a thermoplastic elastomer cushion insert similar to Unistrut's Cush-A-Clamp or equal.
 8. Copper Pipe Support: Copper-plated carbon-steel ring.
- C. Flexible Plastic Tubing (HDPE) for Geothermal Heat Pump Systems:
1. V-bottom clevis hanger with galvanized 18 gauge continuous support channel to form a continuous support system for flexible plastic tubing.
- D. Ductwork:
1. All ductwork shall be supported in accordance with SMACNA recommendations for the service involved. Horizontal ducts supported using galvanized steel bands shall extend up both sides and onto the construction above, where they shall turn over and be secured with bolts and nuts fitted in inserts set in the concrete, bolted to angles secured to the construction above, or secured in another approved manner.

2.02 ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded with adjusting and lock nuts.

2.03 FLASHING

- A. Metal Flashing: 24 gauge thick galvanized steel.
- B. Metal Counterflashing: 24 gauge thick galvanized steel.
- C. Lead Flashing:
 - 1. Waterproofing: 5 lb./sq. ft. sheet lead.
 - 2. Soundproofing: 1 lb./sq. ft. sheet lead.
- D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
- E. Caps: Steel, 22 gauge minimum; 16 gauge at fire-resistant elements.

2.04 EQUIPMENT CURBS

- A. Rooftop equipment.
 - 1. Furnished with rooftop equipment.
 - 2. Factory insulated with 1-1/2 inches, 3 lb. density rigid insulation.
 - 3. Constructed for the roof slope so that equipment is level.
 - 4. 24-inch-high, galvanized steel construction with sufficient structural capacity to accommodate the imposed load.
 - 5. Factory-installed 2" by 2" wood nailer.
 - 6. Provide rubber curb seal between unit and roof curb.
 - 7. Roof curb shall be compatible with the roof type. Where installed on a metal roof the curb shall match the metal roof profile.
- B. Condensing Units, roof mounted:
 - 1. Curbs shall be as specified in Section 07 72 10. Where curbs are not specified in Section 07 72 10, furnish curbs equal to ThyCurb Model TEMS-3, 24 inches high. Each unit to be supported by a minimum of two equipment curbs.
 - 2. Secure units to curb with galvanized steel or stainless steel fasteners. Utilize galvanized steel or stainless steel ell brackets as required to allow for the fasteners to penetrate at the side of the curb and not the top.

2.05 SLEEVES

- A. Sleeves for Pipes Through Non-Fire-Rated Floors: 18-gauge thick galvanized steel.
- B. Sleeves for Pipes Through Non-Fire-Rated Beams, Walls, Footings and Potentially Wet Floors: Steel pipe or 18-gauge thick galvanized steel.
- C. Sealant: Refer to Section 07 90 00.

2.06 ROOFTOP NON-PENETRATING PIPE SUPPORTS

- A. Adjustable height, single pipe support for pipe sizes 3" and smaller: UV resistant, high density polypropylene, polycarbonate or fiberglass reinforced nylon base with support strut channel, threaded rod, nuts, washers and pipe clamp. All metal components to be hot dipped galvanized or stainless steel.
1. PHP model PP10
 2. Miro Industries, Inc. model 2.5-SB-HCS
 3. Mapa model MS-12SA10
 4. Substitutions: Under provisions of Section 01 60 00.
- B. Adjustable height, single pipe support for pipe sizes 4" and larger: Two base type support system with UV resistant high density polypropylene, UV resistant polycarbonate or stainless steel bases. Provide with support hangers appropriate for the type of pipe as specified in this section. Provide with threaded rod, nuts and washers. All metal components, unless indicated otherwise, to be hot dipped galvanized or stainless steel.
1. PHP model PS-1-2
 2. Miro Industries, Inc. models 6-H, 8-H or 16-H as appropriate
 3. Mapa model MB series
 4. Substitutions: Under provisions of Section 01 60 00.
- C. Adjustable height, multiple pipe support: Two base type support system with UV resistant high density polypropylene, UV resistant polycarbonate or stainless steel bases. Provide with support hangers appropriate for the type of pipe as specified in this section. Provide with threaded rod, nuts and washers. All metal components, unless indicated otherwise, to be hot dipped galvanized or stainless steel.
1. PHP model PSE series
 2. Miro Industries, Inc. models 6-H, 8-H or 16-H as appropriate
 3. Mapa model MB series
 4. Substitutions: Under provisions of Section 01 60 00.

2.07 ROOFTOP PIPE CHASE HOUSING

- A. Manufacturers:
1. Roof Penetration Housing, LLC: The Vault
 2. Substitutions: Under provisions of Section 01 60 00.
- B. Rooftop Pipe Chase Housing:

1. Constructed of heavy gage powder coated welded aluminum with stainless steel hardware consisting of three pieces, a removable vandal resistant lid, a middle housing and a wide flanged 14 inch high curb.
 2. Size, unless noted otherwise on drawings:
 - a. Length: 20 ½ inches.
 - b. Width: 14 ½ inches.
 - c. Height: 12 inches.
 3. Exit seals to be of aluminum or stainless steel using SilX14 gasket seal. Each seal shall accommodate the specified size of the pipe, cable or conduit ranging in size from .25 inches up to 7.09 inches OD.
 - a. Where noted on the drawings, provide pipe chase housing prepped with a hole and cover plate for a GFCI outlet to be installed by the electrician.
 4. ICC-500 and FEMA 320/361 wind rated and rain tight.
 5. Furnish each unit with factory installed one inch thick insulation in the curb, housing and lid. Insulation to have a minimum R value of 4.3.
- C. Warranty:
1. The rooftop pipe chase housing shall carry an insured 20 year warranty accommodating multiple penetrations including piping and conduits.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.

3.02 PREPARATION

- A. Do not drill or cut structural members.

3.03 INSTALLATION – GENERAL

- A. Application, sizing and installation of piping, supports, anchors and sleeves shall be in accordance with manufacturer's printed installation instructions.
- B. Install hanger so that rod is vertical under operating conditions.
- C. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including any concrete that holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required. Contractor shall be responsible for engaging a structural engineer as required for design and review at support systems.

- D. Do not hang pipe, duct or any mechanical/plumbing item directly from a metal deck or locate on the bottom chord of any truss or joist unless approved by the Structural Engineer of Record.
- E. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc.
- F. All piping and ductwork supports shall be designed and installed to allow the insulation to be continuous through the hangers.
- G. All hanger rods shall be trimmed neatly so that 1 inch of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the Contractor shall take appropriate measures to protect the pipe or other materials from damage.
- H. Install hangers to provide minimum ½ inch space between finished covering and adjacent structures, materials, etc.

3.04 INSTALLATION – PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1, ASME B31.5, ASME 31.9, ASTM F708, MSS SP 58, MSS SP 69 and MSS SP 89.
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment.
- F. Support vertical piping at every floor.
- G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide copper plated hangers and supports for copper piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- L. Provide clearance in hangers and from structure and other equipment for installation of insulation.
- M. Install rooftop non-penetrating pipe supports per manufacturer's recommendations. Spacing shall be same as pipe hanger spacing schedule.

3.05 INSTALLATION – HANGER RODS

- A. Trim any excess at all hanger rods to within 1 inch of the fastener nut.

3.06 INSTALLATION – EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed.

3.07 INSTALLATION – FLASHING

- A. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.
- C. Provide curbs for roof installations. Flash and counter-flash with sheet metal; seal watertight. Attach Counterflashing to equipment and lap base flashing on roof curbs. Flatten and solder joints. Provide continuous shims under curbs as required to install equipment level.
- D. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.08 INSTALLATION – ROOFTOP PIPE CHASE HOUSINGS

- A. Install in accordance with manufacturer's recommendations.
 - 1. Coordinate size of the exit seals with HVAC, plumbing, electrical and telecommunications contractor.
 - 2. All penetrations shall use the appropriate exit seal furnished by the manufacturer. All penetrations shall only pass through the housing portion of the assembly. Support each penetration within 12 inches of exiting the unit.

3.09 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Quality Requirements and 01 70 00 – Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

- A. Section 01 70 00 – Execution and Closeout Requirements: Requirements for cleaning.

- B. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 – Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

3.12 SCHEDULES

- A. Copper and Steel Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	COPPER TUBING HANGER ROD DIAMETER Inches	STEEL PIPE HANGER ROD DIAMETER Inches
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8
5	13	16	1/2	5/8
6	14	17	5/8	3/4
8	16	19	3/4	3/4
10	18	22	3/4	7/8
12	19	23	3/4	7/8
14	22	25	7/8	1
16	23	27	7/8	1
18	25	28	1	1
20	27	30	1	1-1/4
24	28	32	1-1/4	1-1/4

Note 1: Refer to manufacturer's recommendations for grooved end piping systems.

- B. Plastic Pipe Hanger Spacing:

PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
PVC (All Sizes)	4	3/8

- C. Flexible Plastic Tubing (HDPE) with Continuous Galv. Steel Channel Support Spacing:

PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches

HDPE ½" to 2"	8	3/8
HDPE 2-½" to 4"	10	1/2

END OF SECTION

SECTION 23 05 48 – VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Inertia bases.
2. Vibration isolators.

B. Related Sections:

1. Section 03 30 00 - Cast-In-Place Concrete: [Execution requirements for placement of isolators in floating floor slabs specified by this section and] product requirements for concrete for placement by this section.
2. Section 07 90 00 - Joint Protection: Product requirements for joint sealers specified for placement by this section.
3. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports.
4. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC: Requirements for sound and vibration measurements performed independent of this section.
5. Section 23 33 00 - Air Duct Accessories: Product requirements for both solid and flexible duct connectors for duct silencers specified for placement by this section.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

B. American National Standards Institute:

1. ANSI S1.4 - Sound Level Meters.
2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
3. ANSI S1.13 - Methods for the Measurement of Sound Pressure Levels in Air.
4. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.

C. Air-Conditioning and Refrigeration Institute:

1. AHRI 575 - Method of Measuring Machinery Sound within Equipment Space.

D. American Society of Heating, Refrigerating and Air Conditioning:

1. ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.
 2. ASHRAE Handbook - HVAC Applications.
- E. ASTM International:
1. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 2. ASTM E477 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
 3. ASTM E596 - Standard Test Method for Laboratory Measurement of the Noise Reduction of Sound-Isolating Enclosures.
- F. Sheet Metal and Air Conditioning Contractors' National Association:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Indicate assembly, materials, thickness, dimensional data, pressure losses, acoustical performance, layout, and connection details for sound attenuation products fabricated for this project.
- C. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.
- D. Design Data: Submit calculations indicating maximum room sound levels are not exceeded.
- E. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.
- F. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of hangers including attachment points.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with AMCA 300, ANSI S1.13, AHRI 575, ANSI S12.36, standards and recommendations of ASHRAE 68.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.07 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.08 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.01 INERTIA BASES

- A. Structural Bases - Type 1:
 - 1. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
 - 2. Construction: Welded structural steel with gusset brackets, supporting equipment and motor with motor slide rails.
- B. Concrete Inertia Bases - Type 2:
 - 1. Mass: Minimum of 1.5 times weight of isolated equipment.
 - 2. Construction: Structured steel channel perimeter frame, with gusset brackets and anchor bolts, adequately reinforced, concrete filled.
 - 3. Connecting Point: Reinforced to connect isolators and snubbers to base.
 - 4. Concrete: Reinforced 3,000 psi concrete.

2.02 VIBRATION ISOLATORS

- A. Open Spring Isolators - Type A:
 - 1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 - 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
 4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
- B. Restrained Spring Isolators - Type B:
1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
 4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
 5. Restraint: Furnish mounting frame and limit stops.
- C. Closed Spring Isolators - Type C:
1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.
- D. Restrained Closed Spring Isolators - Type D:
1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.

3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.
- E. Spring Hanger - Type E:
1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
 4. Misalignment: Capable of 20 degree hanger rod misalignment.
- F. Neoprene Pad Isolators - Type F:
1. Rubber or neoprene-waffle pads.
 - a. 30 durometer.
 - b. Minimum 1/2 inch thick.
 - c. Maximum loading 40 psi.
 - d. Height of ribs: not to exceed 0.7 times width.
 2. Configuration: 1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.
- G. Rubber Mount or Hanger - Type G:
1. Molded rubber designed for 0.5 inches deflection with threaded insert.
- H. Glass Fiber Pads – Type H:
1. Neoprene jacketed pre-compressed molded glass fiber.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.
- B. Verify equipment, ductwork and piping is installed before work in this section is started.

3.02 EXISTING WORK

- A. Provide access to existing piping and ductwork and other installations remaining active and requiring access.
- B. Extend existing piping and ductwork installations using materials and methods compatible with existing installations.

3.03 INSTALLATION

- A. Install isolation for motor driven equipment.
- B. Bases:
 - 1. Set steel bases for 1 inch clearance between housekeeping pad and base.
 - 2. Set concrete inertia bases for 2 inch clearance between housekeeping pad and base.
- C. Adjust equipment level.
- D. Install spring hangers without binding.
- E. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- F. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- G. Provide pairs of horizontal limit springs on fans with more than 6 inch static pressure, and on hanger supported, horizontally mounted axial fans.
- I. Support piping connections to isolated equipment resiliently to nearest flexible pipe connector.
- J. Connect wiring to isolated equipment with flexible hanging loop.
- K. Pipe Isolation:
 - 1. Provide isolators for supports of all piping connected to isolated equipment for distance indicated on Pipe Isolation Schedule.
 - 2. Isolator deflection shall have 1/2 the static deflection capabilities of the isolation system of the equipment to which it is connected.
 - 3. Suspended piping: Type E spring hangers.

3.04 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Quality Requirements, 01 70 00 – Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect isolated equipment after installation and submit report. Include static deflections.

3.05 SCHEDULES

A. Pipe Isolation Schedule: (Type E, Spring Hangers)

Pipe Size (Inch)	Isolated Distance from Equipment (Feet)
1	10
2	15
3	20
4	25
6	30
8	35
10	35
12	35

B. Equipment Isolation Schedule:

Isolated Equipment	Base		Isolator	
	Type	Thickness	Type	Min. Deflection
Horizontal Air Handling Units	None	-	E	0.5 in.
Air Cooled Condensing Units	None	-	F	0.25 in.
Ceiling Cabinet Fans	None	-	G	0.5 in.

END OF SECTION

SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Equipment markers.
2. Pipe markers.
3. Duct markers.
4. Ceiling tacks.
5. Signs.

B. Related Sections:

1. Section 09 90 00 - Painting and Coating: Execution requirements for painting specified by this section.

1.02 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A13.1 – Scheme for the Identification of Piping Systems.

B. American National Standards Institute:

1. ANSI Z535.1 – Safety Color Standard.
2. ANSI Z535.2 – Environmental and Facility Safety Signs.

1.03 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit manufacturer's catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification. Submit a valve chart and schedule, including valve tag number, location, function and valve manufacturer's name and model number.

D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.04 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag

numbers.

1.05 QUALITY ASSURANCE

- A. Conform to ASME A13.1 and ANSI Z535.1 for color scheme for identification of piping systems and accessories.
- B. Conform to ASME A13.1 for length of field and letter height for pipe markers.
- C. Conform to ANSI Z535.1 and ANSI Z535.2 for emergency operating, information and warning signs.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years of experience.

PART 2 PRODUCTS

2.01 PIPE MARKERS

- A. General: Conform to ASME A13.1 for background and letter colors, length of color field and letter height.
- B. Self-Adhesive Pipe Markers: Flexible, indoor/outdoor grade vinyl with factory-applied pressure-sensitive adhesive. Provide with minimum 1-1/2 inch wide banding tape.
- C. Mechanically Applied Pipe Markers:
 - 1. For pipes with an overall diameter up to 6 inches, including insulation, provide semi-rigid plastic wrap around pipe marker that extends 360 degrees around the pipe at each marker location. The semi-rigid marker should include the legend and a directional flow arrow. The marker shall be supplied as a pre-tensioned device and be equipped with a 1/2 inch strip of adhesive on the inside to further secure the marker in a permanent position on vertical locations.
 - 2. For pipes with an overall diameter greater than 6 inches, including insulation, provide a semi-rigid plastic strap-on pipe marker with a height no less than 3 times the letter height. The marker shall include a legend and a directional flow arrow. Markers to be installed indoors shall be supplied with no less than two nylon straps to secure the marker in place. Markers to be installed outdoors shall be supplied with stainless steel or aluminum strapping.

2.02 DIRECTIONAL ARROWS

- A. Flow Direction: Provide flow directional arrows either as part of pipe markers, banding tape or separately, attached to pipes.
 - 1. Conform to requirements for markers.

2. Size to conform to ANSI A13.1 (1 inch wide minimum).

2.03 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
 1. Green: Plumbing valves.
 2. Blue: Heating/cooling valves.

2.04 PLASTIC EQUIPMENT MARKERS

- A. General: Provide laminated plastic equipment markers for all scheduled items of mechanical equipment installed indoors.
- B. Size: Size laminated plastic markers not less than one inch in height and three inches in length with engraved lettering white on black not less than 1/4 inch in height. For larger pieces of equipment, size markers 1-1/2 inch in height by 4-1/2 inches long, of 3/32 inch laminated plastic melamine with white on black lettering engraved not less than 1/16 inch deep and 1/2 inch high.
- C. Attachment: Attach nameplates with rivets, stainless steel screws or bolts. On equipment such as tanks and pumps which cannot be drilled or pierced, attach nameplates with brass chains and "S" hooks.
- D. For HVAC equipment installed above ceiling, provide 3/4 inch by 2-1/2 inches laminate tags attached with adhesive to the ceiling grid below. All smoke dampers, fire dampers, VAV boxes, humidifiers, etc. shall be tagged.

2.05 ALUMINUM EQUIPMENT MARKERS

- A. General: Provide engraved anodized aluminum equipment markers for all scheduled items of mechanical equipment installed outdoors.
- B. Size: Size engraved aluminum markers not less than 1 inch in height and 3 inches in length with engraved lettering white on black background not less than 5/8 inch in height. For larger pieces of equipment, size markers 3 inches in height by 6 inches long, with lettering not less than 1 inch in height.
- C. Attachment: Attach nameplates with rivets, stainless steel screws or bolts. On equipment such as tanks and pumps which cannot be drilled or pierced, attach nameplates with stainless steel chains and "S" hooks.

2.06 ENGRAVED PLASTIC LAMINATE SIGNS

- A. General: Where indicated in other sections of the specifications, provide engraved instruction signs, warning signs, operational instructions or other signs designated.
- B. Emergency Operating Signs: For emergency instructions on air handler/fan start-stop or other emergency operating instructions, provide engraved, laminate, melamine plastic, white on red, not less than 1/8 inch thick.

1. Provide concise written instructions on the emergency operation of the device.
 2. Letters shall be not less than 5/16 inch in height, engraved 1/16 inch deep in block capital letters.
- C. Information and Warning Signs: Provide general information and warning signs of laminated, melamine plastic, not less than 1/8 inch thick, with white engraved lettering on black, with letters not less than 1/4 inch in height, block capitals.
- D. Attachment: Attach signs directly to the equipment with rivets, bolts or screws, if possible. Otherwise, attach signs with angle brackets, U-bolts, or metal plates held in place to piping with stainless steel draw-bands.
1. Attachment with adhesives will not be permitted.
 2. Locate signs not less than 4 feet nor more than 6 feet above the operating floor, directly visible from an operating aisle.
 3. Locate signs to preclude damage during maintenance and repair or by operating traffic.

2.07 DUCT MARKERS

- A. Provide plastic adhesive duct access door markers indicating item and associated equipment accessed, and appropriate safety and procedural information. (e.g. Fire Damper AHU-1).

PART 3 EXECUTION

3.01 GENERAL

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Install identifying devices after completion of coverings and painting.
- C. Install labels with sufficient adhesive for permanent adhesion. For unfinished canvas covering, apply paint primer before applying labels.
- D. Identify control panels and major control components outside panels with plastic nameplates.

3.02 CONCEALED EQUIPMENT

- A. Equipment Above Ceilings: Provide identification to equipment located above ceilings, such as traps and other items before the ceilings are installed.
- B. Finished Surfaces: Where identification is to be provided on surfaces which require insulation, painting and finishing, install identification after covering and painting is complete.
- C. Provide ceiling tacks to locate equipment or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

3.03 PIPING SYSTEM IDENTIFICATION

- A. Install pipe markers on all piping systems and include arrows to show the normal direction of flow. Where flow can be in both directions, arrows in both directions shall be displayed.
- B. Identify piping exposed to view and concealed by accessible ceilings, including hard ceilings provided with access panels. Identify piping outdoors, in crawlspaces, on roof, above grade and within parking structures. Only piping located within walls or inaccessible areas need not be identified.
- C. Locate pipe markers as follows:
 - 1. Every 15 feet on straight runs.
 - 2. At each valve and control device.
 - 3. At each branch or take-off. Provide flow arrows on the branch pipe as well as on the main on both sides of the branch.
 - 4. At any change in piping direction.
 - 5. Above and below every floor or roof penetration.
 - 6. On either side of every wall or partition. Ensure there is a minimum of one marker per pipe in every room.
 - 7. On either side of large obstructions, ductwork or equipment that piping passes above.
 - 8. At 5-foot intervals where piping is obscured by close proximity to walls or other pipes.
 - 9. Provide only one label per unit drain connection for condensate drain piping on roof.
- C. Install pipe markers so they are visible and legible from a normal standing position.
- D. Secure each end of self-adhesive pipe markers with a full wrap of banding tape of the same background color. Banding tape shall overlap itself a minimum of 3 inches.
- E. Provide mechanically applied pipe markers for all piping in mechanical rooms and outdoors.

3.04 MECHANICAL EQUIPMENT IDENTIFICATION

- A. General: Install equipment markers on or near each major item of mechanical equipment. Provide signs for the following general categories of equipment and operational devices:
 - 1. Condensing units.
 - 2. Air handling and fan-coil units.
 - 3. Fans, blowers.

4. Motorized control dampers and primary balancing dampers.
 5. Packaged HVAC units.
 6. Filters.
- B. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.05 DUCTWORK IDENTIFICATION

- A. Identify fire damper, smoke damper, fire/smoke damper, and duct access doors with duct access door markers.

3.06 COLOR AND IDENTIFICATION SCHEDULE

- A. Provide final coat of paint, label surface, or lettering of color listed below:

<u>FLUID SERVICE TYPE</u>	<u>PIPE MARKER LEGEND</u>	<u>PIPE MARKER BACKGROUND / LETTERING COLOR</u>	<u>VALVE TAG LETTERING</u>
Condensate Drain	CONDENSATE DRAIN	Green/White	CD
Refrigerant Liquid	REFRIGERANT LIQUID	Yellow/Black	
Refrigerant Suction	REFRIGERANT SUCTION	Yellow/Black	
Refrigerant Relief Vent	VENT	Yellow/Black	
Natural Gas	NATURAL GAS	Yellow/Black	GAS
Miscellaneous Drain Piping	DRAIN	Green/White	
Miscellaneous Vent Piping	VENT	Green/White	

END OF SECTION

SECTION 23 05 93 – TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Testing, adjusting and balancing of air systems.
2. Measurement of final operating condition of HVAC systems.
3. Sound measurement of equipment operating conditions.
4. Vibration measurement of equipment operating conditions.

B. Related Sections:

1. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment
2. Section 23 09 23 - Direct-Digital Control System for HVAC: Requirements for coordination between DDC system and testing, adjusting and balancing work
3. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for HVAC equipment
4. Section 23 34 00 - HVAC Fans
5. Section 23 37 00 -Air Outlets and Inlets
6. Section 23 40 00 - HVAC Air Cleaning Devices
7. Section 23 81 03 - Packaged Rooftop Air Conditioning Units - Small Capacity
8. Section 23 81 26 - Split-System Air-Conditioners and Heat Pumps

1.02 REFERENCES

A. Associated Air Balance Council:

1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

C. Natural Environmental Balancing Bureau:

1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Prior to commencing Work, submit proof of latest calibration date of each instrument.
- C. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms or forms prepared following ASHRAE 111 or NEBB Report forms.
- D. Field Reports: Indicate deficiencies preventing proper testing, adjusting and balancing of systems and equipment to achieve specified performance.
- E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing and equipment data required. Include detailed procedures, agenda, sample report forms and Copy of NEBB Certificate of Conformance Certification.
- F. Submit draft copies of report for review prior to final acceptance of Project.
- G. Furnish reports in soft cover, letter size, three-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified in color to correspond with data sheets, and indicating thermostat locations.
- H. Submit name of adjusting and balancing agency for approval within 60 days after award of contract.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flow measuring stations, balancing valves and rough setting.
- C. Operation and Maintenance Data: Furnish final copy of testing, adjusting and balancing report inclusion in operating and maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance, ASHRAE 111, NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.06 QUALIFICATIONS

- A. Agency: Company specializing in testing, adjusting and balancing of systems specified in this section with minimum three years of documented experience certified by AABC or Certified by NEBB.
- B. Perform Work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor or registered professional engineer experienced in performance of this Work and licensed in State of Texas.

1.07 SEQUENCING

- A. Section 01 10 00 – Summary of Work: Work sequence.
- B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.08 SCHEDULING

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Schedule and provide assistance in final adjustment and test of life safety system with Fire Authority.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify systems are complete and operable before commencing work. Verify the following:
 - 1. Systems are started and operating in safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
- C. Report any defects or deficiencies noted during performance of services to Architect/Engineer.
- D. Promptly report abnormal conditions in mechanical systems or conditions which prevent

system balance.

- E. If, for design reasons, system cannot be properly balanced, report as soon as observed.
- F. Beginning of work means acceptance of existing conditions.

3.02 PREPARATION

- A. Furnish instruments required for testing, adjusting and balancing operations.
- B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.03 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.04 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting and balancing.
- B. Verify recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of dampers and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- E. Report defects and deficiencies noted during performance of services, preventing system balance.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.
- H. Check and adjust systems approximately six months after final acceptance and submit report.

3.05 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.

- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.
- L. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
- M. For fans or fan arrays with VFDs, operate at each Hz band from minimum speed to maximum speed to visually and aurally check for resonance frequency vibration; at each Hz band where resonance frequency operation is observed, lock out the band in the VFD.
- N. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.

3.06 VIBRATION TESTING

- A. After all systems have been tested, adjusted and balanced to meet specifications, perform vibration measurements of rotating equipment in accordance with AABC procedures.
- B. Vibration measurements shall be evaluated in accordance with Chapter 57 of the ASHRAE 1987 HVAC Systems and Application Handbook.
- C. Vibration measurements shall be compared to the following acceptable criteria:

Equipment	Maximum Allowable Vibration Peak to Peak Displacement (MIL)
Fans (Centrifugal and Axial)	
< 600 RPM	4
600 - 1000 RPM	3
1000 – 2000 RPM	2
> 2000 RPM	1

- D. Vibration amplitude shall not exceed the values listed at the final balanced rotating speed of the machine. Predominant vibration at frequencies other than rotational speed is not acceptable.
- E. The amplitude of axial vibration at the bearings shall not exceed radial vibration.
- F. Test and report the vibration isolation system efficiency for all isolated equipment.

3.07 SCHEDULES

A. Equipment Requiring Testing, Adjusting and Balancing:

- 1. Air Cooled Refrigerant Condensing Units.
- 2. Packaged Roof Top Heating/Cooling Units.
- 3. Fan Coil Units.
- 4. Air Handling Units.
- 5. Fans.
- 6. Air Filters.
- 7. Air Inlets and Outlets.

B. Report Forms

- 1. Title Page:
 - a. Name of testing, adjusting and balancing agency
 - b. Address of testing, adjusting and balancing agency
 - c. Telephone and facsimile numbers of testing, adjusting and balancing agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date

2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions

3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date

4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore

5. V-Belt Drive:
 - a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave diameter and RPM
 - f. Center to center distance, maximum, minimum and actual

6. Combustion Test:
 - a. Manufacturer
 - b. Model number
 - c. Serial number
 - d. Firing rate
 - e. Overfire draft
 - f. Gas meter timing dial size
 - g. Gas meter time per revolution
 - h. Gas pressure at meter outlet
 - i. Gas flow rate
 - j. Heat input

- k. Burner manifold gas pressure
 - l. Percent carbon monoxide (CO)
 - m. Percent carbon dioxide (CO₂)
 - n. Percent oxygen (O₂)
 - o. Percent excess air
 - p. Flue gas temperature at outlet
 - q. Ambient temperature
 - r. Net stack temperature
 - s. Percent stack loss
 - t. Percent combustion efficiency
 - u. Heat output
7. Air Cooled Condenser:
- a. Identification/number
 - b. Location
 - c. Manufacturer
 - d. Model number
 - e. Serial number
 - f. Entering DB air temperature, design and actual
 - g. Leaving DB air temperature, design and actual
 - h. Number of compressors
8. Cooling Coil Data:
- a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air DB temperature, design and actual
 - g. Entering air WB temperature, design and actual
 - h. Leaving air DB temperature, design and actual
 - i. Leaving air WB temperature, design and actual
 - j. Saturated suction temperature, design and actual
 - k. Air pressure drop, design and actual
9. Electric Duct Heater:
- a. Manufacturer
 - b. Identification/number
 - c. Location
 - d. Model number
 - e. Design kW
 - f. Number of stages
 - g. Phase, voltage, amperage
 - h. Test voltage (each phase)
 - i. Test amperage (each phase)
 - j. Air flow, specified and actual
 - k. Temperature rise, specified and actual
10. Air Moving Equipment:

- a. Location
- b. Manufacturer
- c. Model number
- d. Serial number
- e. Arrangement/Class/Discharge
- f. Air flow, specified and actual
- g. Return air flow, specified and actual
- h. Outside air flow, specified and actual
- i. Total static pressure (total external), specified and actual
- j. Inlet pressure
- k. Discharge pressure
- l. Sheave Make/Size/Bore
- m. Number of Belts/Make/Size
- n. Fan RPM

11. Return Air/Outside Air Data:

- a. Identification/location
- b. Design air flow
- c. Actual air flow
- d. Design return air flow
- e. Actual return air flow
- f. Design outside air flow
- g. Actual outside air flow
- h. Return air temperature
- i. Outside air temperature
- j. Required mixed air temperature
- k. Actual mixed air temperature
- l. Design outside/return air ratio
- m. Actual outside/return air ratio

12. Exhaust Fan Data:

- a. Location
- b. Manufacturer
- c. Model number
- d. Serial number
- e. Air flow, specified and actual
- f. Total static pressure (total external), specified and actual
- g. Inlet pressure
- h. Discharge pressure
- i. Sheave Make/Size/Bore
- j. Number of Belts/Make/Size
- k. Fan RPM

13. Duct Traverse:

- a. System zone/branch
- b. Duct size
- c. Area
- d. Design velocity
- e. Design air flow
- f. Test velocity
- g. Test air flow

- h. Duct static pressure
- i. Air temperature
- j. Air correction factor

14. Duct Leak Test:

- a. Description of ductwork under test
- b. Duct design operating pressure
- c. Duct design test static pressure
- d. Duct capacity, air flow
- e. Maximum allowable leakage duct capacity times leak factor
- f. Test apparatus
 - 1) Blower
 - 2) Orifice, tube size
 - 3) Orifice size
 - 4) Calibrated
- g. Test static pressure
- h. Test orifice differential pressure
- i. Leakage

15. Air Distribution Test Sheet:

- a. Air terminal number
- b. Room number/location
- c. Terminal type
- d. Terminal size
- e. Area factor
- f. Design velocity
- g. Design air flow
- h. Test (final) velocity
- i. Test (final) air flow
- j. Percent of design air flow

16. Sound Level Report:

- a. Location
- b. Octave bands - equipment off
- c. Octave bands - equipment on
- d. RC level - equipment on

17. Vibration Test:

- a. Location of points:
 - 1) Fan bearing, drive end
 - 2) Fan bearing, opposite end
 - 3) Motor bearing, center (when applicable)
 - 4) Motor bearing, drive end
 - 5) Motor bearing, opposite end
 - 6) Casing (bottom or top)
 - 7) Casing (side)

- 8) Duct after flexible connection (discharge)
- 9) Duct after flexible connection (suction)

- b. Test readings:
 - 1) Horizontal, velocity and displacement
 - 2) Vertical, velocity and displacement
 - 3) Axial, velocity and displacement

- c. Normally acceptable readings, velocity and acceleration
- d. Unusual conditions at time of test
- e. Vibration source (when non-complying)

END OF SECTION

SECTION 23 07 00 – HVAC INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Piping and Equipment - Cellular Foam.
2. Piping – Jackets.
3. Equipment Jackets.

B. Related Sections:

1. Section 07 84 00 – Firestopping: Product requirements for firestopping for placement by this section.
2. Section 09 90 00 – Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.
3. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment: Product and Execution requirements for inserts at hanger locations.
4. Section 23 05 53 – Identification for HVAC Piping and Equipment: Product requirements for HVAC piping and equipment identification.
5. Section 23 31 00 _ HVAC Ducts and Casings.

1.02 REFERENCES

A. ASTM International:

1. ASTM A167 – Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
3. ASTM C177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
4. ASTM C195 – Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C449/C449M – Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C518 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter

Apparatus.

7. ASTM C533 – Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
8. ASTM C534 – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
9. ASTM C547 – Standard Specification for Mineral Fiber Pipe Insulation.
10. ASTM C552 – Standard Specification for Cellular Glass Thermal Insulation.
11. ASTM C553 – Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
12. ASTM C591 – Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
13. ASTM C592 – Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
14. ASTM C610 – Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.
15. ASTM C612 – Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
16. ASTM C795 – Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
17. ASTM C921 – Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
18. ASTM C1071 – Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
19. ASTM C1126 – Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
20. ASTM C1136 – Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
21. ASTM C1290 – Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
22. ASTM D1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
23. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
24. ASTM E90-09 – Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

25. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials.
 26. ASTM E2336 – Standard Test Methods for Fire Resistant Grease Duct Enclosure Systems Acceptance Criteria for Grease Duct Enclosures.
 27. ASTM E162 – Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
 28. ASTM E1222-90 - Standard Test Method for Laboratory Measurement of the Insertion Loss of Pipe Lagging Systems
 29. ASTM F1249 -- Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor
 30. ASTM G21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 31. ASTM D5590 -- Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay.
- B. Sheet Metal and Air Conditioning Contractors':
1. SMACNA – HVAC Duct Construction Standard – Metal and Flexible.
- C. Greenguard Environmental Institute:
1. GEI - Greenguard Certification Standards for Low-Emitting Products.
- D. South Coast Air Quality Management District:
1. SCAQMD Rule 1168 – Adhesive and Sealant Applications, amended January 7, 2005.
 - a. PVC welding: Maximum VOC content 510 g/L.
 - b. Adhesive primer for plastic: Maximum VOC content 550 g/L.
 - c. Contact adhesive: Maximum VOC content 80 g/L.
 - d. Fiberglass adhesive: Maximum VOC content 80 g/L.
 - e. Insulation joint sealant: Maximum VOC content 420 g/L.
 - f. Other: Maximum VOC content 420 g/L.
- E. Green Seal Standard GS-11
1. GS-11 – Paints and Coatings (flat insulation coatings); amended May 20, 1993
 - a. Vapor Barrier Coatings: Maximum VOC content 50 g/L.
 - b. Weather Barrier Mastics: Maximum VOC content 50 g/L.
 - c. Lagging Adhesive/Coating: Maximum VOC content 50 g/L.

1.03 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures: Submittal procedures.
- B. Product Data: Submit product description, thermal characteristics, performance

characteristics and list of materials and thickness for each service, and location.

- C. Samples: Submit one sample of representative size illustrating each insulation type.
- D. Manufacturer's Installation Instructions: Submit manufacturer's published literature indicating proper installation procedures.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years of experience.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 – Product Requirements: Requirements for transporting, handling, storing and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical and damage, by storing in original wrapping.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 – Product Requirements: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- C. Maintain temperature during and after installation for minimum period of 24 hours.

1.07 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.01 PIPING AND EQUIPMENT - CELLULAR FOAM

- A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
 - 1. 'K' Value: ASTM C177 or C518; 0.27 at 75 degrees F.
 - 2. Minimum Service Temperature: -40 degrees F.
 - 3. Maximum Service Temperature: 220 degrees F.
 - 4. Maximum Moisture Absorption: ASTM D1056; 1.0 by volume.

5. Moisture Vapor Transmission: ASTM E96; 0.20 perm inches.
6. Maximum Flame Spread: ASTM E84; 25.
7. Maximum Smoke Developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.
9. GEI Greenguard indoor air quality certified for low chemical and particle emission.

B. Elastomeric Foam Adhesive

1. Air dried, contact adhesive, compatible with insulation.
 - a. Foster 85-75.
 - b. Childers CP-82.
 - c. Armacell 520.

2.02 PIPING - JACKETS

A. PVC Plastic

1. Jacket: ASTM C921, One piece molded type fitting covers and sheet material, off white color.
 - a. Minimum Service Temperature: -40 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
 - d. Maximum Flame Spread: ASTM E84; 25.
 - e. Maximum Smoke Developed: ASTM E84; 50.
 - f. Thickness: 20 mil.
 - g. Connections: Brush on welding adhesive.
2. Vapor Barrier Coating (Indoors) and Weather Barrier Breather Mastic:
 - a. Mold resistant, compatible with below ambient piping insulation with a white color finish. Permeability shall be a maximum of 0.08 perms or less at 37 mils dry tested at 100 degrees F (38 degrees C) and 90 percent RH per ASTM F1249. Coating shall meet ASTM D 5590 with 0 growth rating.
 - 1) Foster 30-80 AF.
 - b. Compatible with above ambient insulation: Weather barrier mastic-fire-resistive mastic for indoor/outdoor use.
 - 1) Foster 46-50.
 - 2) Childers CP-10/CP-11

B. Aluminum Jacket: ASTM B209.

1. Thickness: 0.016 inch.

2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: 0.016 mm thick die-shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
6. Metal Jacketing/Flashing Sealant: Sealing of seams to prevent water entry.
 - a. Foster 95-44.
 - b. Childers CP-76.

2.03 EQUIPMENT JACKETS

- A. Lattice Fiberglass cloth: 4 - 8.5 oz/ sq. yd
 1. GLT Products 84215/9383
 2. Childers Chil Glas #5
- B. Indoor Mold Resistant Lagging Adhesive: Coating shall meet ASTM D5590 with 0 growth rating. UL listed; Fire retardant lagging adhesive. Composite of insulation, jacket and lagging adhesive having flame spread index not greater than 25 and smoke developed index not greater than 50 when tested to ASTM E84.
 1. Foster 30-36 AF.
 2. Childers CP-137AF.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.
- B. Verify piping, equipment and ductwork has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION – PIPING

- A. Install materials in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- D. Insulated pipes conveying fluids below ambient temperature:

1. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch monel expanding staples and seal staple penetrations and all ASJ seams with vapor barrier coating.
 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier coating or PVC covers.
- E. For hot piping conveying fluids over 180 degrees F, insulate flanges and unions at equipment. If 180 degrees F or under, then bevel and seal ends of insulation with breather mastic.
- F. Insulated pipes conveying fluids above ambient temperature:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch monel expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 2. Insulate fittings, joints and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and weather barrier breather mastic or PVC covers.
- G. Inserts and Shields:
1. Application: All Piping or Equipment, 1 inch diameter or larger.
 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 3. Insert location: Between support shield and piping and under finish jacket.
 4. Insert configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 5. Insert material: Compression resistant insulating material suitable for planned temperature range and service.
- H. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions and interruptions. Refer to Section 07 84 00 for penetrations of assemblies with fire resistance rating greater than one hour.
- I. Exterior Applications: Provide vapor retarder jacket. Insulate fittings, joints and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement
- J. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size the insulation large enough to enclose pipe and heat tracing. Refer to Section 23 21 13 for heat tracing requirements.
- K. PVC or aluminum jacket: Install with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.

3.03 INSTALLATION – EQUIPMENT

- A. Install in accordance with manufacturer's instructions.
- B. Factory Insulated Equipment: Do not insulate.
- C. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires or bands.
- E. Fill joints, cracks, seams and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement. Coat with lagging cloth and lagging adhesive
- F. For all insulated equipment, insulate flanges and unions with removable sections and jackets.
- G. Finish insulation at supports, protrusions and interruptions.
- H. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- I. Equipment Requiring Access for Maintenance, Repair or Cleaning: Install insulation for easy removal and replacement without damage.

3.04 PIPING – CELLULAR FOAM INSULATION SCHEDULE

PIPING SYSTEMS	PIPE SIZE INCH	MIN INSTALLED THICKNESS INCH
A. Condensate Drains	All	1/2"
B. Refrigerant Suction Piping	All	1"
C. Field Applied Jackets:		
1. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor):		Finish with aluminum jacket and fitting covers.
2. Pipe located outdoors:		Finish with aluminum jacket and fitting covers.

END OF SECTION

**DIRECT DIGITAL CONTROLS FOR
LOCAL BUILDING AUTOMATION SYSTEMS
TRIDIUM-BACNET WEB-BASED –SECTION 230926a**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Division 23
 - 1. General Mechanical Requirements
 - 2. Mechanical equipment
 - 3. Piping
 - 4. Variable Frequency Drives (VFDs)
 - 5. Building Automation System Commissioning Requirements
- C. Division 26
 - 1. General Electrical Requirements
 - 2. Raceways
 - 3. Disconnect Switches
 - 4. Wiring
- D. Division 27
 - 1. Telecommunications cabling
- E. Division 28
 - 1. Fire Alarm Systems.
- F. Mechanical and electrical drawings: Specifications and drawings are complementary to each other and binding. What is called for by one shall be binding as if called for by both. Should there be a conflict between drawings and specifications regarding a material shown of work described or detailed then the material of work having the greater value shall be provided.

1.2 SUMMARY

- A. Provide all hardware, software, materials, labor, and programming for the implementation of a complete standalone Local Building Automation System (BAS) for control of HVAC systems and components.
- B. The system shall consist of a network of microprocessor-based, peer-to-peer, networked, distributed devices utilizing the BACnet communication protocol in an open, interoperable system. The system shall include all wiring and control devices, sensors, actuators, valves, dampers, and hardware required for a complete operational system that will achieve the control sequences specified.
- C. Provide all programming to achieve specified operational sequences, and development of graphical screens, setup of schedules, trends, logs, alarms, network management, and operational connection of the Network Control Unit (NCU) to the local area network.

- D. Access to the Building Automation System for configuration and monitoring shall be performed via a Network Control Unit (NCU) connected to the LAN or WAN.
- E. All components of the system shall be BACnet Testing Laboratories (BTL) Certified.
- F. System design shall follow pertinent and applicable BACnet guidelines. Controllers that require a master computer or controller to perform basic functions are not acceptable. In the event of a network communication failure, or the loss of any other controller on the BACnet network, the control system shall continue to independently operate under control of the resident program stored in nonvolatile memory as detailed herein.
- G. The network infrastructure shall conform to the BACnet published guidelines for network wiring and system architecture. Wire type, distance, termination, and use of routers shall strictly conform to the BACnet wiring standards. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.
- H. Mechanical equipment controllers shall include all control points and achieve all control sequences specified while operating under stand-alone control, independently of connection to the network manager.
- I. Provide DDC system shop drawings and submittals, participate in submittal review meetings, and obtain final approval of submittal from Owner and Engineer prior to installation of system.
- J. Fully test system prior to requesting installation inspection and pre-functional testing by Owner, Engineer, and Commissioning Authority.
- K. Schedule competent technical personnel to participate in Commissioning activities.
- L. Provide a Schedule of Values for work of this section, that includes the following:
 - 1. Submittals (5%)
 - 2. Materials (35%)
 - 3. Installation (35%)
 - 4. Installation Verification with Owner's CxA (5%)
 - 5. Programming & Graphics (10%)
 - 6. Point check out and Commissioning with Owner's CxA (5%)
 - 7. Final O&Ms and As-Built Documentation (5%)

1.3 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
 - 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
 - 3. Object Command: Reaction time of less than ten seconds between operator command of a binary object and device reaction.
 - 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within eight to ten seconds.
 - 5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
 - 6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.

7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.

1.4 ACCEPTABLE CONTRACTORS

- A. Pending compliance with this specification, the following firms have been deemed acceptable contractors for the products and services herein specified:
 1. Tempset Controls
 2. Johnson Controls
 3. Trane
 4. Others must request approval from Owner and Engineer, including
 - a. Statement of compliance with every aspect of this specification;
 - b. Preliminary submittal in accordance with Paragraph 1.5 –specific to the particular project being bid.
- B. Contractor responsible for work under this Section shall be a local factory certified office of the manufacturer of control systems located within 75-mile radius from the job site. Experience requirements below apply only to the local factory certified office.
- C. Contractor shall have, as a minimum, five (5) years of documented continuous business experience in the installation of controls, instrumentation and Energy Management Systems.
- D. Contractor's local personnel conducting work of this section shall have a minimum of three (3) years of experience in the installation of BACnet systems. Personnel conducting work shall be:
 1. Tridium Niagara N4 Certified
 2. BACnet Certified Professional

Contractor shall provide evidence of certifications upon request.

- E. The installing office shall provide a list of completed and accepted BACnet job references. The references shall include one job from each of the Three (3) years required.
- F. Each reference shall include the following: the job name, the job size, the owner with address, contact name and phone number, the general contractor, the mechanical contractor, and the contracting company's system programmer name(s).
- G. The Contractor's BACnet Certified personnel shall be directly responsible for all work related to:
 1. System design
 2. Submittals
 3. Programming;
 4. Installation Supervision
 5. Calibration
 6. Checkout
 7. Commissioning.

1.5 SUBMITTALS

- A. Refer to Division-1 Submittals and Division-23 General Mechanical Work for additional submittal requirements.

- B. Scope of Work Summary: Include in submittal package a clear written summary of the scope of control work, including but not limited to the following:
1. Integration with the existing systems (if any) at the facility;
 2. Scope of demolition work (if any)
 3. Systems to be controlled as part of this work, clearly stating which systems will receive full DDC systems, and which (if any) will receive only timeclock control.
 4. Evidence of coordination with manufacturers of equipment provided under the mechanical and electrical scope of work to verify that all required control points and sequences will be implemented, regardless of whether the DDC controls reside in a controller provided by the equipment manufacturer or the controls contractor.
- C. Product Data:
1. DDC System Hardware:
 - a. Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 - b. Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 2. Network Control Devices and System Software:
 - a. Include technical data for operating system software, service maintenance agreement and device/point count license details.
 - b. Provide legally licensed copies of all software tools, configuration tools, management tools, and utilities used during system installation and commissioning.
 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
 4. Cabling: Technical data sheets for all cables.
- D. Shop Drawings:
1. Include AISD Project Number on Cover Page.
 2. Include specification section and revision on Cover Page.
 3. Single-line schematic diagram, top-level subsystem, depicting the network architecture. The top-level subsystem shall illustrate the network media, channel transceiver types, subsystems, network interfaces, Human Machine Interfaces (HMI), repeaters, and terminators if utilized.
 4. Floor plan diagrams of the building shall indicate unit and unit controller locations, room numbers or area names and space sensor locations and a diagram of how the BACnet Network wiring is routed from the Building Controller to all of the BACnet controllers.
 5. System diagrams for each system and subsystem, including power supply through starters and motors; motor starting and interlock wiring; pushbuttons; all control wiring; interior electrical circuits of control instruments with terminal designations; control motors; colors of wires; wire tags and tag numbers, location of router, controllers, instruments and remote elements; horsepower of motors; normal position of valves, dampers, and relays. A detailed description of the operation of the control system,

including control device designation, shall accompany the drawings. The drawings shall include a floor plan and riser diagram of the school indicating unit locations, sensor locations, areas served by each piece of equipment and BACnet Network and Sub-network wiring details with routing of all communication cables.

6. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 7. Details of control panel faces, including controls, instruments, and labeling.
 8. Schedule of dampers including size, leakage, and flow characteristics.
 9. Schedule of valves including flow characteristics.
 10. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
 11. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram. In the event the sequences proposed by Engineer are unclear, incomplete, or known to be non-compliant with Owner's requirements, Contractor shall issue a Request For Information (RFI) document prior to preparing submittals.
 - d. Points list: Provide a complete list of all input and output points, alarms, setpoints and schedules that will be transmitted to and from the Web Server. This point list shall include points to be obtained from BACnet Controllers provided by equipment manufacturers.
- E. Preliminary Submittal (Shop Drawings and Product Data)
1. Prepare a Preliminary Submittal for review by Owner, Engineer, and Commissioning Authority.
 2. Make arrangements with General and Mechanical Contractors to transmit Preliminary Submittal electronically to all recipients simultaneously, with no paper copy to follow.
 3. Shop Drawings and Product Data shall be submitted at the same time but as separate files.
 4. Request a Preliminary Submittal Review meeting with General Contractor, Mechanical Contractor, Owner, Engineer, and Commissioning Authority no less than six (6) days after transmittal. This time is required for review by all parties.
 5. Contractor shall lead the Preliminary Submittal Review Meeting to address at least the following:
 - a. Owner, Engineer, and Commissioning Authority comments;
 - b. Resolution to any pending RFI's related to control work;
 - c. Final coordination of any controls provided by equipment manufacturers (in which case manufacturers should be asked to attend meeting as well)
 - d. Review Submittal Checklist
 - e. Timeline for final submittal.
- F. Final Submittal (Shop Drawings and Product Data)
1. Prepare Final Submittal after addressing all issues discussed during Preliminary Submittal Review Meeting.

2. Allow six (6) days for review by Owner, Engineer and Commissioning Authority.
3. Do not proceed with installation prior to receiving notification of submittal approval.

1.6 OPERATION AND MAINTENANCE DATA

- A. At the time of Functional Testing, update submittal data to reflect condition of systems as installed and programmed.
- B. Make any final revisions made during Functional Testing with Owner and Commissioning Authority.
- C. Submit ALL requirements listed under Paragraph 1.6 Submittals, as part of the Operation and Maintenance Manual. Include warranty start date.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Refer to Paragraph 1.5.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Installation in accordance with all codes and local ordinances. Refer to Part 3 of this specification for additional installation requirements.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

- A. Prior to preparing submittals, coordinate location of control devices and routing of wiring with plans and room and equipment details. For retrofit applications, conduct a detailed inspection of the site and equipment to receive controls in order to identify optimal locations for devices, mounting of controllers, and routing of wiring.
- B. It is the intent of this specification that the Section 230926 Contractor shall be responsible for all power and control wiring and raceways associated with the turnkey operational installation of the DDC system. Prior to submittals, coordinate with any additional power requirements that require the involvement of the Division 26 Contractor.
- C. Coordinate with other Division 23 Contractors and equipment suppliers for control of mechanical equipment. It is the intent of this specification that the Section 230926 Contractor shall assume responsibility for a turnkey fully operational control system that includes interfacing with controls integral to equipment –whether via conventional electro-mechanical control or BACnet interfaces.
- D. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
- E. Coordinate equipment with Division 26 Section "Motor-Control Centers" and "Variable Frequency Controllers" to achieve compatibility with motor starters and annunciation devices.

1.10 WARRANTY

- A. The entire BACnet network controls system including wiring, controllers, controlling devices, sensing devices, integral components, service and labor will be warranted for one (1) year from date of system acceptance date unless the manufactures warranty extends beyond the one (1) year warranty. The warranty will then be as indicated by the manufacture of the product.
- B. System acceptance date starts upon successful completion of Functional Testing, as determined by Commissioning Authority.
- C. If corrective software and/or hardware modifications are made during the warranty period, the BAS controls contractor shall update all user documentation, user and manufacturer archived CD ROM and software disks.

1.11 TRAINING

- A. Provide a minimum of **16 hours** of training to AISD personnel. The number of individuals selected for training shall be at the sole discretion of AISD.
- B. Training shall cover all aspects of the specified controls system from system overview and operation to basic trouble-shooting. Training shall include a mix of classroom and actual hands on instruction to include but not limited to training during commissioning of BACnet nodes on site and application specific at the BAS system contractor's local office. Training shall include a minimum of eight (8) hours of classroom and eight (8) hours of field training on the newly installed control system. At AISD's discretion, the training may be mixed to allow for more or less time in the classroom or field training areas.
- C. The BAS System Contractor shall create an agenda for the training class and submit it for approval by AISD Energy Management Department before training classes are scheduled.
- D. Provide all training manuals, materials, and operator and maintenance manuals as required.

1.12 CODES AND STANDARDS

- A. The completed and operational BAS shall be in compliance with and meet the requirements of all governing bodies, Authorities Having Jurisdiction (AHJ), applicable local or national standards and codes, except where more stringent or detailed requirements are indicated by the Contract Documents, including the requirements set forth in this Specification and the following:
 - 1. ASHRAE 135-2016: BACnet -Building and Air Conditioning Engineers (ASHRAE)
 - 2. Underwriters Laboratories UL-916: Energy Management Systems (EMS)
 - 3. NIST IR 6392 Annex B: Profiles of Standard BACnet Devices
 - 4. EIA-485: Standard for Electrical Characteristics of Generator and Receivers for Use in Balanced Digital Multi-Point System.

PART 2 - PRODUCTS**2.1 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES**

- A. The intent of this specification is to provide a peer-to-peer networked, distributed control system using ANSI/ASHRAE Standard 135-2016, BACnet technology communication protocols, in an open, interoperable system. The direct digital control (DDC) system shall consist of BACnet based microprocessor-based controllers, plus instrumentation, control valves, dampers, operators, control devices, interface equipment, network manager, BACnet communication interfaces, and other apparatus required to operate systems and perform functions specified. The DDC system shall be capable of providing total integration of the facility infrastructure systems with user access to all system data via Human Machine Interface (HMI) using a Web Browser such as Internet Explorer™, Mozilla Firefox™ or Google Chrome™ connected to the system network using the LAN or WAN.

2.2 NETWORKS

- A. The system architecture shall support the following levels.
 - 1. Master Slave/Token Passing (MS/TP)
 - 2. BACnet IP (B/IP)
- B. Local area network minimum physical and media access requirements:
 - 1. Ethernet; IEEE standard 802.3u
 - 2. Cable; 100 Base-T, UTP-8 wire, Category 5e
 - 3. Minimum throughput; 100 Mbps

2.3 GRAPHICAL USER INTERFACE (GUI) SOFTWARE

- A. Graphical User Interface: Provide a software tool that allows for the development and management of the end users' Graphical User Interface (GUI) and as the primary point of access to the BAS for the end user.
- B. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, log-off button and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.
- C. Real Time Displays: The GUI shall at a minimum support the following features and functions:
 - 1. Graphic screens shall be developed using any drawing package capable of generating or assembling objects from a GIF, JPG, PNG or ICO file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
 - 2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.

3. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 4. Schedule and holiday times shall be adjusted using a graphical calendar.
 5. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu.
 6. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value.
- D. System Configuration: At a minimum the GUI shall permit the operator to perform the following tasks with proper password access:
1. Create, delete or modify control strategies
 2. Add/delete objects to the system
 3. Tune control loops through the adjustment of control parameters
 4. Enable or disable control strategies
 5. Override inputs and outputs (permanent and timed)
 6. Generate hard copy records or control strategies on a printer
 7. Select point to be trended over a period of time and initiate the recording of values automatically.
- E. On-Line Help: 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 applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.
- F. Security: Each operator shall be required to log on to that 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 administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' 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 log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.
- G. 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.
- H. Alarm Console:
1. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
 2. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2.4 WEB BROWSER CLIENTS

- A. A web browser shall be the primary means of access to the BAS for day to day operation from any PC connected to the LAN and remote via internet without the need for any proprietary software.
- B. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™, Mozilla Firefox™ or Google Chrome™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
- C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
- D. The Web browser client shall support at a minimum, the following functions:
 - 1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - 2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 - 3. HTML programming shall not be required to display system graphics or data on a Web page.
 - 4. Storage of the graphical screens shall be in the Network Control Unit (NCU), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - 5. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
 - 6. User shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - b. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - c. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 - d. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 - e. View logs and charts.
 - f. View and acknowledge alarms.
 - g. The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
 - h. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.5 NETWORK CONTROL UNITS

- A. The Network Control Unit (NCU) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NCU.
- B. The NCU shall be capable of executing application control programs to provide:
 - 1. Calendar functions
 - 2. Scheduling
 - 3. Trending
 - 4. Alarm monitoring and routing
 - 5. Time synchronization
 - 6. Integration of BACnet controller data
 - 7. Network management functions for all BACnet based devices.
- C. The NCU must provide the following hardware features as a minimum:
 - 1. 1000Mhz Processor
 - 2. 1GB DDR-3 SDRAM
 - 3. 4GB Flash Memory
 - 4. Wi-Fi Connectivity IEEE802.11a/b/g/n
 - 5. Two 10/100MB Ethernet Ports
 - 6. Two Isolated RS-485 Ports
 - 7. One USB Type A Connector
 - 8. Real Time Clock
 - 9. Support of up to Four IO/Communication Expansion Modules
- D. The NCU shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NCU shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
- E. The Network Control Unit will provide all scheduling, alarming, trending, and network management for the all BACnet devices.
- F. Provide multiple Network Control Units as necessary. The NCU shall support a minimum of 128 BACnet controllers. In order to maintain peak performance of the network, no more than 110 BACnet controllers may be connected to a single NCU and no more than 64 BACnet controllers per NCU Communication Trunk. In any event, no more than 70% of the available resources of the NCU (as indicated by the resource meter of the programming tools for the NCU) shall be committed. In the event that the available resources are less than 30%, the number of nodes connected to the NCU shall be reduced in order to maintain a 30% or greater buffer of resources within the NCU.
- G. The NCU shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 5 simultaneous users.
- H. Event Alarm Notification and actions - The NCU shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers. The NCU shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.
 - 1. Alarm generation shall be selectable for annunciation type and acknowledgement; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers. The NCU shall be able to route any

alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.

- a. To Alarm
 - b. Return to normal
 - c. To fault
2. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
 3. Provide timed (schedule) routing of alarms by class, object, group, or node.
 4. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control. Control equipment and network failures shall be treated as alarms and annunciated.
 5. Alarms shall be annunciated in any of the following manners as defined by the user, but implemented by this contractor:
 - a. Screen message on screen
 - b. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
 - 1) Day of week
 - 2) Time of day
 - 3) Recipient
 - c. Pagers via paging services that initiate a page on receipt of email message.
 - d. Graphic with flashing alarm object(s).
 - e. Printed message, routed directly to a dedicated alarm printer.
 6. The following shall be recorded by the NCU for each alarm (at a minimum):
 - a. Time and date
 - b. Equipment (Air handler #, pump, etc)
 - c. Acknowledge time, date and user who acknowledged
 - d. Number of occurrences since last acknowledgement
 7. Alarm actions may be initiated by user defined programmable objects created for that purpose.
 8. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
 9. A log of all alarms shall be maintained by the NCU and/or a server (if configured in the system) and shall be available for review by the user.
 10. Provide a “query” feature to allow review of specific alarms by user defined parameters.
 11. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
 12. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.
- I. Acceptable Products:
1. JACE-8000:
 - a. Niagara N4 Version 4.2
 - b. Open License NiCS (Vendor Neutral, No Vendor Locking)
 - c. Embedded Workbench
 - d. 40% Minimum Spare Capacity (Devices & Points)
 - e. 5-Year SMA (Software Maintenance Agreement)
- J. Data Collection and Storage

1. The NCU shall have the ability to collect data for any property of any object and store this data for future use.
 2. The data collection shall be performed by log objects, resident in the NCU that shall have, at a minimum, the following configurable properties:
 - a. Designating the log as interval or deviation.
 - b. For interval logs, the object shall be configured for time of day, day of weeks and the sample collection interval.
 - c. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - d. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 - e. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
 3. All log data shall be stored in a relational database in the NCU and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements. All log data shall be available to the user in the following data formats:
 - a. HTML
 - b. XML
 - c. Plain Text
 - d. Comma or tab separated value
 4. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
 5. The NCU shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NCU on the network. Provide the ability to configure the following archiving properties, at a minimum:
 - a. Archive when the log has reached its user-defined capacity of data stores
 - b. Archive on time of day
 - c. Archive on user-defined number of data stores in the log (buffer size)
 - d. Provide ability to clear logs once archived
 6. Provide and maintain an Audit Log that tracks all activities performed on the NCU. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NCU), to another NCU on the network, or to a server. For each log entry, provide the following data:
 - a. Time and date
 - b. User ID
 - c. Change or activity; i.e. change setpoint, add or delete objects, commands, etc.
- K. Database Backup and Storage
1. The NCU as provided shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval. Copies of the current database and, at the most recently saved database shall be stored in the NCU. The age of the most recently saved database is dependent on the user-defined database save interval. The NCU database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2. Provide all tools necessary for the development, maintenance, expansion and use of the BAS described within these specifications. All software tools shall be compatible with the network management tool (workbench) that is provided as part of this project. For the purpose of this specification software tools shall be divided into the following categories and meet these specified requirements.
- L. NCU Programming Wizards for LCU/TCU Controllers
1. Provide Wizards or objects that facilitate the programming and configuration of the local Control Unit (LCU) and terminal Control Unit (TCU) Controllers sequence of operation through a menu driven wizard. All software tools (including Wizards) shall be compatible with the network management tool (workbench) that is provided as part of this project. The programming and configuration tools shall perform the following functions:
 - a. LCU Controllers programming shall be accomplished by Graphical programming language (GPL) where objects are used to define different portions of the control sequence. All control sequences programmed into the controller shall be stored in non-volatile memory. Systems that only allow selection of sequences from a library or table are not acceptable. All code must be exportable to a library for future use.
 - b. TCU Controllers – Provide for the programming of the required sequence of operation through an intuitive menu driven selection process. The configuration tools menu shall define items such as I/O configurations, set point, delays, PID loops, optimum start stops, and network variables settings. The configuration tool must indicate the device status and allows system override. Or, provide for the programming of the required sequence of operation through Graphical programming language (GPL) where objects are used to define different portions of the control sequence. All control sequences programmed into the controller shall be stored in non-volatile memory. Systems that only allow selection of sequences from a library or table are not acceptable. All code must be exportable to a library for future use.
- M. NCU Network Management Software Tools
1. Provide a complete set of Network Management tools that provides for the development and management of BACnet networks.
 2. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.
 3. The network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.
 4. These tools shall provide the ability to “discover” existing BACnet networks, regardless of what network management tool(s) were used to install the existing network, so that existing BACnet devices and newly added devices are part of a single network management database.
 5. The network management database shall be resident in the NCU and with proper authorization, shall allow access to the network management database. Systems employing network management databases that are not resident in the NCU, shall not be accepted.
 6. System shall allow access to all of the Network Management tool functions including controller programming from a Web Browser.
- N. NCU Programming Software

1. Provide programming software for the Network Control Unit that allows for the development of the NCU control logic, point management, global properties such as alarm, trend and scheduling.
 2. All library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Access to these functions shall be provided through Graphical User Interface software (GUI). Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide “real-time” data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.
 3. Programming Methods – Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user’s application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.
 - a. Configuration of each object will be done through the object’s property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
 - b. The software shall provide the ability to view the logic in an off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
 - c. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
 - d. The system shall support object duplication within a customer’s database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.
- O. NCU Object Library
1. A standard library of software objects that represent functions and applications for the development and setup of application logic, user interface displays, system services, and communication networks.
 2. The objects in this library shall be capable of being copied and pasted into the user’s database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
 3. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.

2.6 LOCAL CONTROL UNITS, TERMINAL CONTROL UNITS, INTEGRATED SPACE SENSORS

A. General

1. All controllers provided as part of this system and used for indoor applications shall operate under ambient environmental conditions of 32 degF (0 degC) to 122 degF (50 degC) dry bulb and 5% to 90% relative humidity, non-condensing as a minimum.
2. All controllers provided as part of this system and used for outdoor applications shall operate under ambient environmental conditions of -40 degF (-40 degC) to 158 degF (70 degC) dry bulb and 5% to 90% relative humidity, non-condensing as a minimum.

B. System Design

1. Local Control Units (LCU) shall be utilized for primary mechanical and electrical systems such as Air handling equipment, Make-up Air Unit, Boiler System Control, and Chiller System Control type of applications.
2. Terminal Control Units (TCU) shall be utilized for terminal equipment, such as Variable Air Volume, Fan Coil, Heat Pump, Roof Top applications.
3. Each LCU and TCU controller shall have a minimum of 10% spare capacity of each point type for future points. As a minimum, each controller shall have one spare of each point type available on the controller.
4. The LCU and TCU controller programming or configuration tools shall be fully accessible through the Operator Workstation and Web Browser Client through the use of Wizards. Provide Wizards or objects as specified in NCU paragraph that facilitate the programming and configuration of the LCU and TCU through a menu driven wizard.

C. Controller Local Area Network (BAS sub LAN)

1. Provide a network of stand-alone, distributed direct digital controller that operate on ANSI/ASHRAE Standard 135-2016 BACnet communication protocol.
2. Provide BAS Controllers that utilize BACnet technology and are BTL certified. Controllers using proprietary protocols are unacceptable.
3. The design of the BAS sub-LAN shall network Local Control Unit (LCU) and Terminal Control Unit (TCU) to a Network Control Unit (NCU).
4. This level of communication shall support a family of application specific controllers and shall communicate bi-directionally with the network through DDC Controllers for transmission of global data.
5. Terminal Control Unit (TCU) shall be arranged on the BAS sub-LAN's in a functional relationship manner with Local Control Unit (LCU). Ensure that a Variable Air Volume (VAV) Terminal Control Unit (TCU) is logically on the same LAN or segment as the Local Control Unit (LCU) that is controlling its corresponding Air Handling Unit (AHU).

D. Local Control Units (LCU)

1. The Local Control Units (LCU) shall be 32 bits microprocessor-based. They shall also be multi-tasking, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the project point list.
2. Each LCU shall have sufficient memory, to support its own operating system and databases, including:
 - a. Control processes

- b. Energy management applications
 - c. Alarm management applications
 - d. Historical/trend data for points specified
 - e. Maintenance support applications
 - f. Custom processes
 - g. Manual override monitoring
3. Each LCU shall support:
- a. Analog inputs of 4-20 mA, 0-10 Vdc, 10,000 ohm thermistor or 1000 ohm RTD.
 - b. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - c. Each LCU shall be capable of providing the following control outputs without the addition of equipment outside the DDC controller cabinet:
 - 1) Digital outputs (contact closure for motor starters up to size 4)
 - 2) Analog outputs of 4-20 mA or 0-10 VDC
 - d. The LCU analog or universal input shall use a 16 bit A/D converter.
 - e. The LCU analog or universal output shall use a 10 bit D/A converter.
 - f. Each output shall have supervised manual override switch and a potentiometer or integrated LCD operator interface (preferred).
 - g. Each LCU shall have a minimum of 10% spare capacity for each point type for future point connection. Provide all processors, power supplies and communication controllers complete so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring. As a minimum, provide one of each type of point available on the controller.
 - h. Provide sufficient internal memory for the specified control sequences and have at least 25% of the memory available for future use.
 - i. Each controller shall perform its primary control function independent of other NCU controller LAN communication, or if LAN communication is interrupted. Reversion to a fail-safe mode of operation during LAN interruption is not acceptable. The controller shall receive its real-time data from the NCU controller time clock to insure LAN continuity. Each controller shall include algorithms incorporating proportional, integral, and derivative (PID) gains for all applications. All programmed PID gains and biases shall be available for adjustment via the NCU field-adjustable by the user via terminals as specified herein.
 - j. The LCU shall provide local status indication for each output for constant, up-to-date verification of all point conditions via dedicated LEDs or built-in LCD operator interface without the need for an operator handheld device.
 - k. The LCU shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
 - l. Should the LCU memory be lost for any reason, the user shall have the capability of reloading the controller software via the NCU Controller. Direct connection to LCU controller for reloading controller software is not acceptable.
 - m. Multiplexer boards that convert an analog input into several digital inputs such as the DUIC-5P board are not permitted and shall not be used without explicit authorization from the AISD Energy Management Department.

E. LCU Programming Software

1. Provide programming software for the Local Control Unit (LCU) that allows for the development of the LCU control logic and point management.
2. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Access to these functions shall be provided through Graphical User Interface software (GUI). Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide “real-time” data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.
3. Programming Methods –Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user’s application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification.
 - a. Configuration of each object will be done through the object’s property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
 - b. The software shall provide the ability to view the logic with value being inputted/outputted of the graphical blocks (debug mode).
 - c. The system shall support object duplication within a customer’s database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.
4. Provide function to compare and calculate from multiple values from networked controllers (NCU, TCU and/or LCU). As a minimum, the function shall calculate and compare the values and return the average, sum, highest, lowest, 3 highest and 3 lowest values.

F. Terminal Control Units (TCU)

1. Provide Terminal Control Units (TCU) for control of each piece of terminal equipment.
2. The Terminal Control Units (TCU) shall be 32 bit microprocessor-based. They shall also be multi-tasking, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the project point list.
3. Each TCU shall have sufficient memory, to support its own operating system and databases, including:
 - a. Control processes
 - b. Maintenance support applications
 - c. Custom processes
 - d. Manual override monitoring

4. Each TCU shall support:
 - a. Analog inputs of 4-20 mA, 0-10 Vdc, 10,000 ohm thermistor or 1000 ohm RTD
 - b. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - c. Each TCU shall be capable of providing the following control outputs without the addition of equipment:
 - 1) Digital outputs (contact closure for motor starters up to size 4)
 - 2) Analog outputs of 4-20 mA or 0-10 VDC
5. The TCU analog or universal input shall use a 16 bit A/D converter.
6. The TCU analog or universal output shall use a 10 bit D/A converter.
7. Controllers shall include all point inputs and outputs necessary to perform the specific control sequences. As a minimum, 25% of the point outputs shall be of the universal type; that is, the outputs may be utilized either as modulating or two-state, allowing for additional system flexibility. Analog outputs shall be industry standard signals such as 24V floating control, allowing for interface to a variety of modulating actuators.
8. Each TCU controller performing space temperature control shall be provided with a matching room temperature sensor.
9. Each controller shall perform its primary control function independent of other NCU controller LAN communication, or if LAN communication is interrupted. Reversion to a fail-safe mode of operation during LAN interruption is not acceptable. The controller shall receive its real-time data from the NCU controller time clock to insure LAN continuity. Each controller shall include algorithms incorporating proportional, integral, and derivative (PID) gains for all applications. All programmed PID gains and biases shall be available for adjustment via the NCU field-adjustable by the user via terminals as specified herein.
10. Provide each TCU with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration. Operating programs shall be field selectable for specific applications. In addition, specific applications may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable.
11. VAV Terminal Control Units:
 - a. The VAV box TCU controllers shall be powered from a 24 VAC source and shall function normally under an operating range of 20 to 28 VAC ($\pm 15\%$), allowing for power source fluctuations and voltage drops. The BAS contractor shall provide a dedicated power source and separate isolation transformer for each controller unable to function normally under the specified operating range. The controllers shall also function normally under ambient conditions of 32 degF to 122 degF (0 degC to 50 degC) and 5% to 90% RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
 - b. The Variable Air Volume (VAV) Terminal Control Unit (TCU) shall include a built-in differential pressure transducer that shall connect to the VAV terminal unit manufacturer's standard differential pressure sensor to measure the average and amplify differential pressure in the duct. The controller shall convert this value to actual air flow. Single point differential pressure sensing device is not acceptable. The VAV TCU differential pressure transducer shall have a measurement range of 0 to 1 in. W.C. (0 to 250 Pa) and measurement accuracy

- of "5% at 0.1 to 1 in. W.C. (25 to 250 Pa) and a minimum resolution of 0.0001 in. W.C. (0.025 Pa), insuring primary air flow conditions shall be controlled and maintained to within "5% of setpoint at the specified minimum and maximum air flow parameters. The VAV TCU differential pressure transducer shall have a zero value air flow measurement repeatability of 0.001 in. W.C. (0.25 Pa), VAV TCU differential pressure transducer requiring periodic zero value air flow calibration is not acceptable. The BAS contractor shall verify the type of differential pressure sensors used in the existing boxes, and ensure compatibility with the VAV TCU controllers.
- c. The Variable Air Volume (VAV) Terminal Control Unit (TCU) shall include provision for air flow balancing using a local air flow balancing interface. A portable air flow balancing interface or an Intelligent Space Sensor (ISS) capable of balancing air flow is acceptable. The portable air flow balancing interface shall connect to the VAV TCU or the matching room temperature sensor.
 - d. The Variable Air Volume (VAV) Terminal Control Unit (TCU) shall also provide a web browser based air flow balancing tool. This tool shall allow the air balancer to manually control the action of the actuator including the following function: open VAV damper, close VAV damper, open all VAV dampers, close all VAV dampers.
 - e. The VAV box controller shall interface to a matching room temperature sensor as previously specified. The controller shall function to maintain space temperature to within "1.5 degF (0.9 degC) of setpoint at the room sensor location. Each controller shall also incorporate an algorithm that allows for resetting of the associated air handling unit discharge temperature if required to satisfy space requirements. This algorithm shall function to signal the respective DDC controller to perform the required discharge temperature reset in order to maintain space temperature setpoint.
 - f. It shall be possible to view and reset the space temperature, temperature setpoint, maximum airflow setting, minimum airflow setting, and actual airflow, through the BAS LAN.
12. TCU Thermostat
- a. Provide Terminal Control Unit (TCU) Thermostat controllers designed with unique functions and features particular to a specific type of mechanical equipment or applications that may be less common and or standardized in its use and application.
 - b. TCU Thermostat – A self-contained controller with a built-in user interface that is intended for installation in the occupied space of the building. The TCU Thermostat shall have the following features:
 - 1) The TCU Thermostat shall be a microprocessor-based fully-programmable controller with all of its control logic, inputs and outputs, network communication and user interface provided within the manufacturer provided enclosure specific to the application. The enclosure shall be aesthetically appealing with a modern design that will fit in with the architecture of the building. A sample of the TCU Thermostat shall be provided as part of the submittal process.
 - 2) The TCU Thermostat shall be programmed through the user interface contained within the controller and through a software based configuration tool.

- 3) The user interface display shall be provided with 3 levels of password protection: Level 1 – Lockout with view only and time adjustment; Level 2 - schedule override and mode settings; Level 3 – full access to all parameters. Where required in the sequence of operation provide for within Level 2 access the ability to change the units of measure displayed for temperature from Fahrenheit to Celsius. The display shall be back lighted for easy viewing.
 - 4) If required within the sequence of operation, provide for a control schedule and time clock within the TCU Thermostat. The control schedule shall provide for a separate schedule for each day of the week with 4 events per day. The real time clock will have a six hour power reserve time.
 - 5) The TCU Thermostat shall utilize a PI (proportional and integral) control algorithm. Upon power failure, all programmed schedules and parameters must be retained in non-volatile flash memory.
 - 6) Each TCU Thermostat shall be capable of providing the following control inputs and outputs without the addition of equipment:
 - a) One (1) on-board thermistor
 - b) Four (4) universal inputs (0-10VDC, thermistor, dry-contact)
 - c) Five (5) universal outputs (0-10VDC or dry-contact N.O.)
13. Multiplexer boards that convert an analog input into several digital inputs such as the DUIC-5P board are not permitted and shall not be used without explicit authorization from the AISD Energy Management Department.

G. TCU Programming Software

1. Provide programming software for the Terminal Control Unit (TCU) that allows for the development of the TCU control logic and point management.
2. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Access to these functions shall be provided through Graphical User Interface software (GUI). Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide “real-time” data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.
3. Programming Methods - Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user’s application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification.
4. Configuration of each object will be done through the object’s property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.

5. The software shall provide the ability to view the logic with value being inputted/outputted of the graphical blocks (debug mode).
6. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.
7. Provides function to compare and calculate from multiple values from networked controllers (NCU, TCU and/or LCU). As a minimum, the function shall calculate and compared the values and return the average, sum, highest and lowest values.

H. TCU Configuration Software

1. Configuration of the TCU controller shall be done through the configuration tool using fill-in the blank fields, list boxes, and selection buttons.
2. The configuration tool menu shall define items such as I/O configurations, set point, delays, PID loops, optimum start stops, and network variables/object settings. The configuration tool shall indicate the device status and allows system override.
3. The Configurable Controller shall allow the use of its spare I/O as dumb I/O to be shared over the network to other Controllers such as Programmable Controllers, where a sequence of operation can be applied to the I/O. Such applications shall include but not be limited to exhaust fan control, heaters, lighting control, etc.

I. Acceptable Manufacturers/Products

1. Distech
2. Johnson Controls
3. Trane.

2.7 ELECTRONIC INPUT/OUTPUT DEVICES

A. Sensors and Transmitters

1. Provide sensors and transmitters required as outlined in the input/output summary and sequence of operation, as required to achieve the specified accuracy as specified herein.
2. Temperature transmitters shall be equipped with individual zero and span adjustments. The zero and span adjustments shall be non-interactive to permit calibration without iterative operations. Provide a loop test signal to aid in sensor calibration.
3. Temperature transmitters shall be sized and constructed to be compatible with the medium to be monitored. Transmitters shall be equipped with a linearization circuit to compensate for non-linearity of the sensor and bridge and provide a true linear output signal.
4. Temperature sensors shall be of the resistance type and shall be either three-wire 100 ohm platinum RTD, or two-wire 1000 ohm platinum RTD.
5. Thermistors are acceptable provided the mathematical relationship of a thermistor with respect to resistance and temperature with the thermistor fitting constraints is contained with the Control Unit (CU) operating software and the listed accuracy's can be obtained. Submit proof of the software mathematical equation and thermistor manufacturer fitting constants used in the thermistor mathematical expressions. Thermistors shall be of the negative thermistor coefficient (NTC) type with a minimum of 100-Ohm/°F resistance change versus temperature to insure good

resolution and accuracy. Veris or approved equal. AISD prefers 10K Type II Thermistors.

6. Combination Sensors or “Combo Sensors” such as Temperature and Humidity or CO2 and Humidity are not permitted and shall not be used without prior authorization from AISD Energy Management Department.
7. The following point type accuracies are required and include errors associated with the sensor, lead wire and A to D conversion.

<u>Sensor Type</u>	<u>Range</u>	<u>Min. Accuracy</u>
Duct/AHU Temperature	40 – 130°F	± 0.5 Degree F
Room Temperature	50 – 85°F	± 0.5 Degree F
Outside Air Temperature	-20 – 120°F	± 0.5 Degree F
Chilled Water Temperature	32 – 80°F	± 0.5 Degree F
Hot Water Temperature	80 – 220°F	± 0.5 Degree F
Humidity	0 – 100%	± 3% RH
Duct Static Pressure	0 – 3” w.c.	± 1% full scale per 50°F
Space Static Pressure	- 0.25” – 0.25” w.c.	± 1% full scale per 50°F
Current Sensor	Sized for application	± 1% full scale
Power (kWh)	Sized for application	± 2% full scale (at 1.0 PF)
Air Flow	700 – 4,000fpm	± 2% full scale
Water Flow	Sized for application	± 4% full scale
CO ₂ Sensors	0 – 2,000 PPM	± 3% full scale

8. Sensors shall not drift more than 1% of full scale per year.
9. Sensors used in British Thermal Unit (BTU) or process calculations shall be accurate to ±0.10°F over the process temperature range. Submit a manufacturer's calibration report indicating that the calibration certification is traceable to the National Institute of Standards and Technology (NIST).
10. Thermowells
 - a. When thermowells are required, the sensor and well shall be supplied as a complete assembly.
 - b. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
 - c. Thermowells and sensors shall be mounted in a threadlet or ½” NPT saddle and allow easy access to the sensor for repair or replacement.
 - d. Thermowells shall be constructed of the following materials:
 - 1) Chilled and Hot Water; 316 stainless steel
 - 2) Condenser Water and Steam; 316 stainless steel
 - 3) Brine (salt solutions); marine grade stainless steel
 - 4) Heat transfer grease shall be used on all thermowell applications.
11. Space Temperature Sensors
 - a. Each room sensor shall include the following options:
 - 1) Style: Delta style.
 - 2) Setpoint Adjustment: The setpoint adjustment slider shall allow for modification of the temperature by the occupant. Each Setpoint Slider shall be adjustable for allowable range from the Graphic User Interface. Default [+/-3F].
 - 3) Setpoint Adjustment Slider Graduation: “Cool/Warm”
 - 4) Setpoint Adjust Slider Acting: Direct Acting
 - 5) Temperature Indicator: Do Not Provide.

- 6) Override Switch: Required. In parallel with sensor.
 - 7) Foam-backing: Provide for sensors mounted on exterior walls, CMU walls, structure beams or if sensor reading is being affected by air draft in wall.
12. Outside Air Sensors
 - a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall be provided with a solar shield.
 - b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate surrounding the sensor element.
 - c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
 13. Duct Type Sensors
 - a. Duct mount sensors shall mount using a handy box through a hole in the duct and be position do as to be easily accessible for repair or replacement. A neoprene grommet (seal-tight fitting and mounting plate) shall be used on the sensor assembly to prevent air leaks.
 - b. Duct sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate. Sensor probes shall be constructed using 304-rated stainless steel.
 - c. Duct sensor shall be of the appropriate length and mounted in a location on the duct to obtain the best representation of the actual air temperature.
 - d. For outdoor air duct applications, use a weatherproof box with weatherproof cover and gasket.
 - e. Sensor handy box shall not be used as a pull-box. Installation shall allow the replacement of sensor without the need for disconnecting/removing additional wiring or conduit.
 14. Averaging Duct Type Sensors
 - a. Provide capillary supports at the sides of the duct to support the sensing string. Support the middle of the span to prevent flopping of the capillary tube as required. No metal-to-metal contact shall be allowed.
 - b. Where the capillary enters the equipment, it shall be protected from sharp edges using a poly tube sleeve.
 15. Relative Humidity Sensors/Transmitter
 - a. The sensor shall be a solid state, resistance type relative humidity sensor of the bulk polymer design. The sensor element shall be washable and resist surface contaminations.
 - b. Humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2 wire isolated loop powered, 4-20ma, 0-10 VDC linear proportional output.
 - c. The humidity transmitter shall meet the following overall accuracy including lead loss and A to D conversion.
 - 1) Room Type Sensor $\pm 3\%$ RH
 - 2) Duct Type Sensor $\pm 3\%$ RH
 - d. Outside air relative humidity sensors shall be installed in a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with seal-tight fittings and stainless steel bushings.
 - e. Provide a single point humidity calibrator, if required, for field calibration. Transmitters shall be pre-calibrated from factory.

- f. Duct type sensing probes shall be constructed of 304 stainless steel and be equipped with a neoprene grommet, bushings and a mounting bracket.
16. Differential Pressure Transmitters and Accessories
- a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - b. Pressure transmitters shall provide the option to transmit a 0-5 VDC, 0-10 VDC, or 4-20 mA output signals.
 - c. Pressure transmitters shall be equipped with a LED display indicating the transmitter output signal.
 - d. Differential pressure transmitters used for pressure or flow measurement shall be supplied with shutoff and bleed valves in the high and low sensing pick-up lines (5 valve manifolds).
 - e. Provide, at a minimum, a NEMA-1 housing for the transmitter. Locate transmitters in accessible local control panels wherever possible.
 - f. Duct sensing pressure applications shall utilize a static pressure traverse probes.
17. Low Air Pressure Applications
- a. The pressure transmitter shall be capable of transmitting a linear electronic signal proportional to the differential of the room and reference static pressure input signals with the following minimum performance specifications.
 - 1) Span: No greater than two times the design space differential pressure
 - 2) Accuracy: $\pm 0.5\%$ of full scale
 - 3) Dead Band: Less than 0.3% of output
 - 4) Repeatability: Within 0.2% of output
 - 5) Linearity: $\pm 0.2\%$ of span
 - 6) Response: Less than one second for full span input
 - 7) Temperature Stability: Less than 0.01% output shift per degree change
 - b. The transmitter shall utilize variable capacitance sensor technology and be immune to shock and vibration.
 - c. Measuring of outside air pressure shall be accomplished by using a pressure pickup probe suitable for outdoor pressure sampling that stabilizes and reduces fluctuations from wind gusts.
 - d. Measuring of indoor space pressure shall be accomplished by using a static pressure pickup probe either wall or ceiling mounted.
18. Medium to High Air Pressure Applications
- a. The pressure transmitter shall be similar to the low air pressure transmitter. Provide differential pressure transmitters, which meet the following performance requirements:
 - 1) Zero & Span: (% full scale/degree): 0.041% including linearity, hysteresis and repeatability
 - 2) Accuracy: 1% full scale (best straight line)
 - 3) Static Pressure Effect: 0.5% full scale
 - 4) Thermal Effects: $<\pm 0.03\%$ full scale/degree
19. Low Differential, Water Pressure Applications
- a. The differential pressure transmitter shall be of industrial grade and transmit a linear output signal in response to variation of differential pressure or water pressure sensing points.

- b. The differential pressure transmitter shall meet the following performance specifications:
 - 1) Die-cast NEMA-4 Enclosure with readout LCD display
 - 2) Suitable input differential pressure range
 - 3) Dual sensor design
 - 4) Microprocessor profiled with built-in noise rejection
 - 5) 0-10VDC, 0-5VDC or 4-20mA output
 - 6) Maintain accuracy up to 20 to 1 ratio turndown
 - 7) Reference Accuracy: $\pm 0.2\%$ of full span
 - 8) Push-button auto-zero
 - 9) Provide with bypass/test manifold
 - c. Differential pressure transmitters with wired remote sensors are not to be used without the prior approval from AISD Energy Management Department.
20. Medium to High Differential Water Pressure Applications
- a. The differential pressure transmitter shall meet the low-pressure transmitter specifications except the following:
 - 1) Differential pressure range.
 - 2) Reference Accuracy: $\pm 1\%$ of full span (includes non-linearity, hysteresis, and repeatability)
21. Bypass Valve Assembly Actuators
- a. Electronic actuators shall be direct-coupled type capable of being mounted over the shaft of the damper or valve. They shall be approved by a suitable safety or regulatory agency. Power consumption shall not exceed 8 watts or 15 VA of transformer sizing capacity per high torque actuator nor 2 watts or 4 VA for VAV actuators. Sound level shall not exceed 45 dB for high torque or 35 dB for VAV actuators.
 - b. Electronic overload protection shall protect actuator motor from damage. If the damper jams, the actuator shall not burn out. Internal end switch type actuators are not acceptable. Actuators may be mechanically and electrically paralleled on the same shaft to multiply the available torque. A reversing switch shall be provided to change action from direct to reverse in relation to control signal as operation requires.
 - c. All bypass valves shall provide a position feedback to the control system.
 - d. All 120 VAC powered actuators shall be installed with a locking switch (key operated switch, Leviton 1221-2L) as a disconnection means for servicing within reach of the actuator, but not on the actuator. Verify location with Architect, Engineer, and/or Owner prior to install.
22. Intelligent Space Static Pressure Sensors:
- a. Intelligent space static pressure sensors shall meet but not be limited to the following:
 - 1) Low pressure type differential pressure transmitter
 - 2) Integrated Neuron Chip controller
 - 3) TP/FT-10 network transceiver
 - 4) Integral power supply for transmitter controller and transceiver
- B. Valve and Damper Actuators
- 1. Electronic Valve and Damper Actuators
 - a. Electronic actuators shall be direct-coupled type capable of being mounted over the shaft of the damper or valve. They shall be approved by a suitable safety or

- regulatory agency. Power consumption shall not exceed 8 watts or 15 VA of transformer sizing capacity per high torque actuator nor 2 watts or 4 VA for VAV actuators. Sound level shall not exceed 45 dB for high torque or 35 dB for VAV actuators.
- b. Electronic overload protection shall protect actuator motor from damage. If damper jams actuator shall not burnout. Internal end switch type actuators are not acceptable. Actuators may be mechanically and electrically paralleled on the same shaft to multiply the available torque. A reversing switch shall be provided to change action from direct to reverse in relation to control signal as operation requires.
 - c. All 120 VAC powered actuators shall be installed with a locking switch (key operated switch, Leviton 1221-2L) as a disconnecting means for servicing within reach of the actuator, but not on the actuator. Verify location with Architect, Engineer, and/or Owner prior to install.
2. Control Damper Actuators
 - a. Outside air, return air, and exhaust air actuators shall be spring return type for safety functions. Individual battery backup or capacitor return is not acceptable. With approval, a central battery pack system similar to a uninterruptible power system may be used with a battery checking circuit connected to the DDC automation system. Daily verification of battery performance shall be incorporated in the programming.
 - b. The control circuit shall be fully modulating using 0–10VDC, 2–10VDC, 4 - 20 mA, or pulse width modulation signals. Accuracy and repeatability shall be within $\pm 1/21$ of control signal. A 0–10VDC, 2-10VDC, or 4 - 20 ma signal shall be produced by the actuator which is directly proportional to the shaft clamp position which can be used to control actuators paralleled off a master motor or to provide a feedback signal to the automation system indicating damper position. Accuracy shall be within $\pm 2.5\%$.
 - c. Face and bypass dampers and other control dampers shall be modulating using the same control circuit detailed above but shall not be spring return.
 3. Miscellaneous Damper Actuators
 - a. Outside air combusting and ventilation air intake and exhaust damper actuators shall be 2 position (open/close) spring return, and close if any water piping, coils or other equipment in the space which the damper serves needs to be protected from freezing.
 - b. Provide auxiliary switches on damper shaft or blade switch to prove damper has opened on all air handling equipment handling 100% outside air and greater than 2.5" total static pressure.
 4. Air Terminals
 - a. Air terminal actuators shall be fully modulating floating (drive open, drive closed) 3 wire control or use control circuit as detailed in control dampers depending on the controllers requirements.
 5. Inlet Vanes Actuators
 - a. Inlet vanes and actuators shall not be used for this job. Speed control of the fan motor shall use a variable frequency drive (VFD).
 6. Combination Smoke and Fire Damper Actuators
 - a. Actuators shall be factory mounted and connected to the damper section and conform to suitable safety or regulatory agency approved specifications.

7. Valve Actuators
 - a. Actuators shall have a gear release button on all non-spring return models to allow manual setting. The actuator shall have either an insulating air gap between it and the linkage or a non-conducting thermoplastic linkage. Care shall be taken to maintain the actuator's operating temperatures and humidity within its specifications. Pipes shall be fully insulated and heat shields shall be installed if necessary. Mount actuators so condensation shall not form on actuators and be prevented by a combination of insulation, air gap, or other thermal break.
 - b. The control circuit shall be fully modulating using 0–10VDC, 2-10VDC, 4 - 20 mA, or pulse width modulation signals. Accuracy and repeatability shall be within 1/21 of control signal. A 0-10, 2-10VDC, or 4-20 mA signal shall be produced by the actuator which is directly proportional to the shaft clamp position which can be used to control actuators paralleled off a master motor or to provide a feedback signal to the automation system indicating valve position.
 - c. Valve body and actuators shall be equipped fully assembled and tested at the valve factory.
 - d. All 120 VAC powered actuators shall be installed with a locking switch (key operated switch, Leviton 1221-2L) as a disconnecting means for servicing within reach of the actuator, but not on the actuator. Verify location with Architect, Engineer, and/or Owner prior to install.
 - e. All actuators shall be provided with means to accept a 1/2" conduit fitting.
8. Control Valve Actuators (4 inch and larger)
 - a. The Valve actuator shall consist of a permanent split capacitor, reversible type electric motor that drives a compound epicycle gear. The electric actuator shall have visual mechanical position indication, readable from a distance, and show output shaft and valve position. Unit shall be mounted directly to the valves without brackets and adapters, or readily adapted to suit all other types of quarter-turn valves.
 - b. The actuator shall have an integral terminal strip, which, through conduit entries, will ensure simple wiring to power supplies. Cable entries should be approved by a suitable safety or regulatory agency. Use recommended gland stops within the NPT hole to prevent glands from being screwed in too far and damaging cable.
 - c. The actuator shall be constructed to withstand high shock and vibrations without operations failure. The actuator cover shall have captive bolts to eliminate loss of bolts when removing the cover from the base. One copy of the wiring diagram shall be provided with the actuator.
 - d. The actuator shall have a self-locking gear train that is permanently lubricated at the factory. The gearing shall be run on ball and needle bearings. Actuators with high output torque shall have two adjustable factory calibrated mechanical torque limit single-pole double-throw switch type. The motor shall be fitted with thermal overload protection. The motor rotor shaft shall run in ball bearings at each end of motor.
 - e. The actuator housing shall be hard anodized aluminum for full environmental protection.
 - f. The actuator shall be provided with means for manual override.
 - g. The environmental temperature range of the actuator shall be from –30°C to +60°C (-20°F to +140°F).

- h. For intermittent on/off service, the actuator shall be rated at a 20% duty cycle (i.e., 12 minutes extended duty in every hour, or alternatively; one complete cycle every 2 minutes). For more frequent cycling and modulating service, an actuator shall be rated for continuous duty. The actuator rated for continuous duty shall be capable of operating 100% of the time at an ambient temperature of 40°C.
 - i. The actuator shall have an integral self-locking gear train. Motor brakes shall not be required to maintain desired valve position. Levers or latches shall not be required to engage or disengage the manual override. Mechanical travel stops, adjustable to 15° in each direction of 90° rotation shall be standard, as well as two adjustable travel limit switches with electrically isolated contacts. Additional adjustable switches shall be available as an option.
 - j. Single Phase Motor: The motor shall have Class B insulation capable of withstanding locked-rotor for 25 seconds without overheating. Wiring shall also be Class B insulation. An auto-reset thermal cutout protector shall be embedded in the motor windings to limit heat rise to 80°C in a 40°C ambient. All motors shall be capable of being replaced by simply disconnecting the wires and then removing mounting bolts. Disassembly of gears shall not be required to remove the motor.
 - k. Materials of Construction: The electric actuator shall have a pressure die-cast, hard-anodized aluminum base and cover. The compound gear shall be made of die-cast, hard-anodized aluminum or steel. An alloy steel worm gear shall be provided for manual override and torque limiting. Bearings for gears shall be of the ball and needle type; bronze bearings shall be used on the shafting parts.
 - l. Accessories: Potentiometer for providing continuous feedback of actuator position at the CU (for valves specified position feedback).
 - m. All 120 VAC powered actuators shall be installed with a locking switch (key operated switch, Leviton 1221-2L) as a disconnecting means for servicing within reach of the actuator, but not on the actuator. Verify location with Architect, Engineer, and/or Owner prior to install.
9. Variable Frequency Drives (VFD)
- a. Refer to division 23 and 26 for approved list of VFDs and other requirements.
 - b. The VFD shall communicate utilizing the BACnet protocol via manufacturer card to communicate and receive data through the DDC system. All VFDs shall have separate conduits for hi-voltage input circuits, hi-voltage output circuits and control circuits. In addition to the BACnet communications, each drive shall have two hard-wired points from the BAS system. The two points are as follows:
 - 1) VFD start/stop
 - 2) VFD speed input
 - c. Remote mounted VFDs with service disconnects between the VFD and the load, shall be wired to the service disconnect early-break auxiliary switch for proper VFD shutdown upon disconnect operation.

C. OTHER ACCESSORIES

- 1. Electric Low Limit Thermostat (Freeze Stat)
 - a. Heavy-duty, duct type, fixed differential, vapor-charged sensing element, manual reset, with test/reset button.

- b. Sensing element shall be a capillary tube responding to the lowest temperature sensed along any segment of bulb length. Switch shall be rated for 10 amps at full load DPDT (double-pole double-throw).
 - c. The capillary tube shall be protected from damage at the location that it enters the AHU. Any exposed areas of the capillary tube shall be protected by covering with poly- tubing. Refer to Averaging sensors section above. Provide one 20-foot long bulb thermostat for every 20-sq.ft of coil area.
 - d. Adjustable Range: 15 to 55 degree F.
 - e. AISD prefers Johnson Controls A70 Series Low Limit Thermostats.
2. Water Flow Switches
 - a. Suitable safety or regulatory agency approved device, suitable for all service application conditions. Body minimum working pressure rating shall equal or exceed service pressure. Unit shall have two single-pole double-throw switches. Actuating flow rated shall be field adjustable for the specified and indicated service. Switch location shall preclude exposure to turbulent or pulsating flow conditions. Flow switch shall not cause pressure drop at maximum system flow rate.
 3. Strap-On Aqua stat
 - a. Strap-on aqua stats are not to be used without the prior approval from AISD Energy Management Department.

D. FLOW, PRESSURE AND ELECTRICAL MEASURING APPARATUS

1. Traverse Probe Air Flow Measuring Stations
 - a. Traverse probes shall be a dual manifold, cylindrical, type constructed of 3003 extruded aluminum with an anodized finish to eliminate surface pitting and unnecessary air friction. The multiple total pressure manifold shall have sensors located along the stagnation plane of the approaching airflow and without the physical presence of forward projecting sensors into the air stream. The static pressure manifold shall incorporate dual offset static tips on opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as $\pm 20^\circ$ in the approaching air stream.
 - b. The airflow traverse probe shall not induce a measurable pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presences in the airstreams. Each airflow-measuring probe shall contain multiple total and static pressure sensors placed at equal distances along the probe length. The number of sensors on each probe and the quantity of probes utilized at each installation shall comply with the ASHRAE Standards for duct traversing.
 - c. Traverse probes shall be accurate to $\pm 2.5\%$ of the measured airflow range and be installed in a duct section that meets manufacturer's installation specifications sheet. Allow adequate distance from elbows, junctions or other disturbances.
2. Shielded Static Pressure Sensor
 - a. Provide for each zone where required a shielded static pressure sensor suitable for ceiling surface mounting, complete with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, compression takeoff fittings, all contained in a welded stainless steel casing, with polish finish on the exposed surfaces.

- b. These probes shall be capable of sensing the static pressure in the proximity of the sensor to within 1% of the actual pressure value while being subjected to a maximum airflow from a radial source.
 - c. The shielded static sensing devices shall be used for both reference and space pressure sensing.
 - d. Pressure sensors used for outside air pressure reference purposes shall be equipped with a conduit seal for pneumatic tubing and bushings for a weather tight installation.
 - e. All sensors shall be installed according to the manufacturer's installation specifications sheet and in a location that is not subject to frequent air disturbance.
3. Static Pressure Traverse Probe
- a. Provide multipoint traverse probes in the duct at each point where static pressure sensing is required.
 - b. Each duct static traverse probe shall contain multiple static pressure sensors located along the exterior surface of the cylindrical probe. Pressure sensing points shall not protrude beyond the surface of the probe.
 - c. The duct static traverse probe shall be of 304 stainless steel construction and be complete with threaded end support rod, sealing washer and nut, and mounting plate with gasket and static pressure signal fitting. The static traverse probe shall be capable of producing a steady, non-pulsating signal of standard static pressure levels without the need for correction factors, and an instrument accuracy of 5% full range.
 - d. The probe shall be installed according to the manufacturer's installation specifications sheet and in a location that is not subject to frequent air disturbance.
4. Flow Meters
- a. Electronic Type Flow Meters: (ONICON F-Series Manufacturer or approved equal)
 - 1) Accuracy of flow meter shall be $\pm 0.5\%$ of reading at calibrated velocity with a pressure drop of less than 1 PSI at 20 ft/s in 1.5" pipe, decreasing in larger pipes and lower velocities.
 - 2) Electronic sensing method shall be electromagnetic.
 - 3) Insertion-type for renovation projects.
 - 4) Inline-type for projects involving new hydronic piping or piping reconfiguration.
 - 5) The standard temperature range shall be 180° F continuous, 200° F peak. High temperature range shall be 280° F continuous, 300° F peak with an operating pressure of 400 PSI maximum.
 - 6) The flow meter shall be wet-calibrated at the manufacturer's laboratory against primary volumetric standards directly traceable to NIST. Provide certification of calibration with each meter.
 - 7) Input signal from flow meter to be 0-10VDC or 4-20mA.
 - 8) Insertion-type meters shall be installed to allow removal of meter removal during system operation.
 - b. Venturi Type Flow Meters:
 - 1) Pressure drop on venturi type flow meters shall not exceed 0.25" WC. Each venturi low and high-pressure taps shall be equipped with nipples, valves, and quick disconnects.

- 2) Equip each venturi with a metal identification tag indicating the size, location, flow (gpm), and meter reading for the flow specified.
 - 3) Provide (1) dial differential pressure meter of the proper range to determine piping system flow rate. The meter shall become the property of AISD.
 - 4) Venturi meters shall utilize flanged or screwed connections for removal purposes and shall be rated for the system operating pressures.
 - 5) The venturi flow meter shall be factory calibrated to provide a minimum of flow accuracy between actual and factory flow calibration data.
5. Current Transformers
- a. The current transformers shall be designed to be installed or removed without dismantling the primary bus or cables. The transformer shall be of a split core design. Solid core current transformers shall not be used without the prior approval from the AISD Energy Management Department.
 - b. The core and windings shall be completely encased in a suitable safety or regulatory agency approved thermoplastic rated 94VA. No metal parts shall be exposed other than the terminals.
 - c. The current transformers shall meet the following specifications:
 - 1) Frequency Limits: 20 to 100 Hz
 - 2) Insulation: 0.6 KV Class, 10 KV BIL
 - 3) Accuracy: $\pm 1\%$ at 5.0 to 25.0 VA accuracy class with U.P.F burden
6. Current Sensing Switches
- a. The split core current sensing switch shall be self-powered with solid-state circuitry. Current sensing switches shall consist of a solid state current sensing circuit, adjustable trip point, solid state switch, single-pole double-throw or double-pole double-throw relay, as required and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device and looped if required to attain the correct sensing value. The current sensing switch shall accept over current up to twice its trip into range.
 - b. It shall be reverse voltage protected and have high over current capability.
 - c. Frequency Limits: 20 to 100 Hz.
 - d. Accuracy: $\pm 0.5\%$ of full scale.
 - e. Response Time: 300 milliseconds to 90% of step change.
7. Power Monitoring
- a. Wattnode BACnet or approved equal.
 - b. Current transformers rated and as required for proper interfacing to electrical gear scheduled to be monitored.
 - c. Provide voltage disconnect switch and CT shorting block equal to ELKOR i-BLOCK or approved equal.
 - d. Install in dedicated control panel.

2.8 CONTROL VALVES AND DAMPERS

A. General Control Valve Requirements

1. All automatic control valves shall be linear, fully proportioning, with modulating ball, plug or V-port inner guidelines unless otherwise specified. The valves shall be quiet in operation and fail safe in either normally open, normally closed position or fail in

last commanded state in the event of loss of electronic output signal. See drawings and sequence of operation for system requirements.

2. All valves shall be capable of operating per sequence when required by the sequence of operation. All control valves shall be sized by the BAS system contractor and/or the valve manufacturer, and shall be guaranteed to meet the heating and cooling loads as specified. All control valves shall be suitable for the pressure conditions, and shall close against the differential pressures involved. Valve body pressure rating and connection type (screwed or flanged) shall conform to ANSI pressure classifications appropriate for the system working pressures.
 3. All valves shall be programmed to be 0% on HMI = 0 signal on DDC controller = Valve Closed to Coil. Likewise, 100% on HMI = 100% Signal (10VDC, 20ma, etc) on DDC controller = Valve Open to Coil. Same holds true for Dampers (Multizone dampers shall be 0% = Full Hot Deck, 100% = Full Cold Deck). Any deviation from this strategy shall require permission from Owner during the 90% Submittal review.
- B. Steam Control Valves: AISD has phased out all steam generating equipment.
- C. Hot and Cold Water Control Valves
1. Hot and cold water globe type control valves shall be single-seated type, with equal percentage flow characteristics. The valve discs shall be composition type and shall be sized using ISA methods.
 2. Pressure drop through the valves shall not exceed 5 PSI when the valve is fully open and under design flow unless otherwise indicated
 3. Ball valves shall be equipped with 316 stainless steel trim, Teflon seals and adjustable packing gland nuts. Provide a handle for manual operation during start-up and maintenance.
- D. Air Terminal Reheat Valves
1. Reheat valves shall be modulating logarithmic equal percentage type globe or ball valves as detailed in paragraph C above. 2-position control is not acceptable.
- E. Two Position Control Valves
1. For open/closed and/or three-way diverting applications, butterfly valves are acceptable and shall be heavy-duty pattern with a body rating comparable to the pipe rating.
 2. Provide each butterfly valve with a replaceable lining suitable for temperature and service requirements.
 3. Equip each with a butterfly valve with disc and stainless steel stem.
 4. Valves used for shut-off or isolation purposes shall be bubble-tight.
- F. Automatic Control Dampers
1. Automatic dampers shall give a feedback of position only when noted in contract documents.
 2. Automatic dampers shall have multiple blades and sized for the application by the BAS Contractor and/or as indicated on the design drawings.
 3. Submit a schedule of damper sizes to the Prime Contractor, with a copy to the Architect/Engineer and AISD within 15 days after being awarded the contract.
 4. Dampers used for throttling airflow shall be opposed blade type arranged for normally open or normally closed operation as required. The damper is to be sized so that when wide open the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear. Multi-section dampers must be provided

- with sufficient interconnecting hardware or jackshaft for unison operation of all blades in the entire assembly.
5. Damper frames and blades shall be constructed of either minimum 16 gauge galvanized steel or 14 gauge aluminum and arranged to facilitate field assembly of several individual sections into a larger damper area and allow secure fastening of damper frame to the surrounding ductwork, collar or fan housing. Maximum blade length in any section shall not be longer than 48 inches. Additional stiffening or bracing shall be provided for any section exceeding 48 inches in height.
 6. Damper blades shall not exceed eight (8) inches in width. All blades except for fume hood exhaust systems shall be galvanized sheet steel. Blades shall be suitable for high velocity performance.
 7. All damper bearings to be made of nylon. Bushings that turn in the bearing are to be oil impregnated sintered metal. Dampers shall be tight closing, low leakage type with synthetic elastomer seals on the blade edges and on the top, bottom and sides of the frame. Dampers shall not leak in excess of 8 cubic feet per minute per square foot when closing against 4 inches water gauge static pressure.
 8. Leakage and flow characteristic charts shall be submitted to the Architect/Engineer for review.

PART 3 - EXECUTION**3.1 GENERAL**

- A. Do not proceed with work without approved submittals. Any alterations and/or changes to the control sequences shall be submitted to the Engineer for approval for such changes prior to design of the control system and submittal of control shop drawings. AISD Energy Management Department to review and comment on shop drawings before work begins. All work performed prior to submittal approval shall be at contractor's own risk.
- B. Provide all hardware, software, programming, materials, labor, licenses, permits and incidentals necessary to provide completely operational digital controls systems. Perform start up and commissioning on each control product, system, and subsystem to provide fully operable systems in accordance with the specified functional performance.
- C. Comply with applicable codes and ordinances. If any conflict arises between these specifications and drawings or codes and ordinances, immediately notify the Architect/Engineer and AISD. Do not deviate from the drawings and specifications nor install any work which may be in conflict with codes and ordinances until the conflict is resolved and the solution accepted by the Architect/Engineer and AISD.
- D. The BAS System Contractor is responsible for providing a complete and operational system as described in the description of operation, in the points lists summary, and/or the mechanical/electrical drawings for this project. Any item referenced in one part of the system documentation but not listed elsewhere shall be covered under contractors pricing (i.e. damper called out in sequence but not indicated on drawings).
- E. The mechanical, electrical, and building automation system drawings show the general arrangement of the respective systems. Follow these drawings, as closely as actual building construction and the work of other trades permit. Provide devices, fittings, and accessories, which may be required but not shown on the drawings or specified herein. Investigate conditions affecting the work and arrange the work accordingly. Provide modifications and accessories as required to meet such conditions.

3.2 COORDINATION OF WORK

- A. Examine and compare the BAS specifications and drawings with the specifications and drawings of the other trades and report any discrepancies between them to the Architect/Engineer and AISD. Obtain the Architect/Engineer's written instructions for changes necessary to the BAS work.
- B. Install and coordinate the BAS work in cooperation with the other trades installing interrelated work including mechanical, testing adjusting and balancing, and electrical (including fire alarm) during bidding and submittal process. All changes required in the work of the contractor, caused by inadequate coordination and noncompliance with specifications, shall be made at contractor's expense.
- C. Where control system will interface with controls provided by equipment manufacturers, ensure that coordination takes place such that all sequences and required control and monitoring points are made available. Documentation stating "work by others" is not acceptable. All work must be clearly coordinated.

- D. Carefully check space requirements with other trades to ensure that all material can be installed in the allotted spaces, including above finished suspended ceilings, between coils sections, etc.
- E. Install the BAS work to permit removal (without damage to other parts) of parts requiring periodic replacement or maintenance.
- F. Renovations/Additions: The BAS contractor shall examine the existing controls system and shall become familiar with all pertinent components and functions of the existing system, including any energy management systems. The contractor shall be responsible for including all work necessary for the following:
 - 1. Existing controls that are to remain in operation after this project shall remain in place and be modified only as required to incorporate new controls.
 - 2. The new controls shall be fully compatible with the existing system.
 - 3. The new controls shall be fully interconnected with the existing system.
 - 4. It shall be the responsibility of the Prime contractor to insure the coordination of proper decommissioning and disconnection/removal of old control system components that will not be reused. Old database and sequences of operation shall be cleaned up, old conduit and wiring removed, old devices and controllers salvaged and returned to the AISD Energy Management Department in a timely manner. Any controllers and/or field devices damaged during the removal process shall be repaired and/or replaced at no cost to AISD.

3.3 WIRING INSTALLATION

A. GENERAL

- 1. BAS contractor shall be responsible for all control and power wiring associated with the control system including any related 120V electrical work that may require interlocks, circuit breakers, and/or connections at the panel boards spares or spaces.
- 2. All electrical work shall be performed in accordance with the requirements of Division 26.
- 3. All wiring shall be run parallel and perpendicular to building lines (no angles) and concealed where possible. All wiring shall be installed in a professional manner and in accordance with the National Electrical Code and local ordinances. Electrical or mechanical inspection sign off does not remove AISD's right to refuse acceptance of the electrical installation for incorrect or noncompliance with NEC and project specifications. Installation must comply with all local control system electrical code requirements.
- 4. The control contractor shall use a licensed, qualified and bonded electrical contractor for all wiring above 24Volts.
- 5. Units already having 120 VAC power run by Division 26 for fans, VAV's, electric heat, etc. shall be provided with required 24 VAC power via a step-down transformer and protected with a circuit breaker, whether provided by the BAS system contractor or unit manufacturer.
- 6. Provide electrical disconnecting means for servicing, for each control panel, digital controller, transformer, power supply, and other devices that are served by 120VAC or higher voltage.
- 7. Raceways:
 - a. Wiring shall be run in EMT conduit in exposed areas and in vertical risers between floors with sleeves and including any new walls or existing walls that

- have additional work being performed. EMT conduit fittings shall be steel compression type. All firewall penetrations shall be caulked with approved fire caulking material.
- b. Low voltage plenum rated wire may be used without conduit in concealed but accessible areas (i.e. above lay-in ceilings) and shall be installed in a professional and workmanship like manner and secured up as high as possible. All wall penetrations by plenum cable shall use sleeves with bushings to avoid sharp edges.
 - c. All conduits on roofs, in areas exposed to weather conditions, in mechanical spaces, and located within six (6) feet above floor level shall be of rigid type conduit with watertight fittings. Use of non-threaded fittings on rigid conduit shall be limited and used only when necessary.
 - d. Underground conduit shall be of the appropriate schedule PVC or coated ridged and back filled per code.
 - e. Where flexible metal conduit is used, the maximum allowable length shall be 36 inches, and the minimum shall be 18 inches. All flex conduit fittings shall be of the compression type. Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18 inches and maximum length of 36 inches shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigidly mounted conduit. Where exposed to the elements or in damp or wet locations, (such as Mechanical rooms) waterproof flexible metal conduit shall be installed at and below 6 feet above floor level. Installation shall be as specified for flexible metal conduit.
 - f. When in crawl spaces, EMT conduit may be used when kept up high to the structure; otherwise rigid type conduit shall be used. Waterproof flexible metal conduit shall be used in crawl spaces with the above length requirements.
 - g. Provide a pull string in all conduits for pulling spare wire.
 - h. No conduit shall be filled to more than 80% of available space.
8. Coordinate with the Mechanical and Electrical Installation Contractors to ensure controls shall be accessible for repair and maintenance.
 9. Provide supervised field-wiring for all alarm panel monitoring points, asset protection points (safeties, sump pumps, maintenance alarms) and all points identified to include supervised wiring on the points schedule.
 10. Separate Ground: Where recommended by controls manufacturer for the system/application involved, DDC system/components shall employ and maintain a separate, “clean earth” grounding protection. “Mixing” of grounding systems shall be prohibited. (Isolate DDC controls conduits/metal boxes from other raceway systems using isolation bushings and other measures as necessary.)
 11. There shall be no power wiring of 120 volts or higher in the same conduit or raceways with communications or low voltage control wiring
 12. There shall be no power wiring of 120 volts or higher in the same conduit or raceways with communications or low voltage control wiring.
 13. Control wiring shall follow the following coloring conventions:
 - a. Orange: BACnet wiring
 - b. Yellow: Thermostat wiring (wall mounted temperature sensors)
 - c. White: All other field wiring
 14. Hardwired Safety Circuit:
 - a. Hardwired safety alarm monitoring and shutdown shall be accomplished through the use of a Fan Safety Relay Board Model: RIBMNLB-6/-4/-2 manufactured by Functional Devices, Inc. or approved equal. The number of

circuits/size of board (6, 4 or 2) shall be selected accordingly to accommodate all the specified safety devices plus one spare relay/circuit. Each safety device shall be manual-reset and shall be homerun to the safety relay board via dedicated wiring. Daisy-chaining of devices shall only be permitted when more than one device of the same kind is required to accomplish the specified scope of work (i.e. two freeze-stats to cover the entire area of the cooling coil). Safety relay board shall be installed in the associated controls cabinet. Enclosed version of this safety relay board shall not be used. Each relay on the board shall be clearly labeled identifying the function of the circuit (i.e. Freeze-Stat, High-Static, Smoke-Detector, etc). The first dry-contact of the master relay shall be used to shut down the fan(s) of the associated unit via the Starter or VFD. The second dry-contact shall be used to report the general status of the safety circuit back to the BMS. Individual status monitoring of safeties shall be provided if specified in the scope of work.

- b. Units scheduled to receive only one safety device (i.e. float switch), are permitted to be installed without a Fan Safety Relay Board if safety device is not scheduled to be monitored by the BMS for status reporting.
- c. Freeze-stat normally-closed contact shall be homerun to control panel to energize a DPDT (Double-Pole, Double-Throw) relay. First contact shall be wired to Fan Safety Relay Board for Fan Shutdown. Second contact shall be wired to cut power to all spring-return actuators.

B. Wiring less than 30 volts:

1. In ceilings of areas where return air plenum is used, plenum rated cable will be allowed unless noted otherwise. Where plenum cable is used, it shall be run parallel with building lines, banded together in bundles, supported without sags or “clothes line” appearance at 5 foot centers or less. Cabling that is not run in a neat fashion shall be removed and reinstalled. Determination of neatness shall be at the discretion of the Owner and Engineer. All plenum rated cabling shall be clearly marked on the outside jacket to indicate “Plenum” service.
2. Exposed, unfinished locations, such as mechanical rooms and below accessible raised flooring: Conductors and cable plenum rated (where local code or officials allow). All plenum rated cables shall be in conduit in unfinished area and mechanical rooms starting 6 feet above finished floor.
3. Concealed, unfinished locations, such as ceiling plenums, ceiling spaces, shafts, crawl spaces, tunnels: Conductors enclosed in raceway and cable enclosed in raceway or plenum-rated cable (where local code or officials allow).

C. Twisted-Pair Communication Media

1. Only use the transceiver manufacturers recommended cable types.
2. Install the network communications segments for device channels using bus topology format. Install the network communications segments for all backbone channels using bus topology format.
3. Provide all network communication cables, terminations to network control devices and network infrastructure components in accordance with the current requirements of the BACnet Wiring Guide.

D. Control Power Wiring

1. BAS system contractor to provide list/location of all control panels requiring 120 VAC power so they may be coordinated with Electrical.

2. The BAS system contractor shall provide final low voltage power supplies and termination of power wiring to network devices and infrastructure components where required.
3. Provide interlock wiring between supply and return fans, electrical wiring for relays (including power feed) for temperature and pressure indication. Provide interlock wiring between refrigeration machines, pumps and condensing equipment as required for the specified sequence of operation and the refrigeration system integral controller(s). Do not provide interlock wiring if a dedicated digital output has been specified for the equipment or the sequence of operation requires independent start/stop.
4. Provide power wiring, conduit and connections for low temperature thermostats, high temperature thermostats, alarms, flow switches, actuating devices for temperature, humidity, pressure and flow indication, point resets and user disconnect switches for electric heating, appliances controlled by this division.

E. Input/Output Control Wiring

1. RTD wiring shall be three-wire or four-wire twisted, shielded, and at a minimum of 18 gauge conductors.
2. Other analog inputs shall use, twisted, shielded, and at a minimum of 18 gauge conductors.
3. Binary control function wiring shall use at a minimum of 18 gauge conductors.
4. Analog output control functions shall be twisted, shielded, and use at a minimum of 18 gauge conductors.
5. Binary input wiring shall be a minimum of 18 gauge conductors.
6. Thermistors shall be equipped with the manufacturers calibrated lead wiring.
7. 120 VAC control wiring shall be minimum of #14 gauge wire, THHN type, in ½” conduit.

F. Conduit and Fittings

1. Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with steel compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections. Rigid steel (RGS) with threaded fittings (connections to junction/outlet boxes and cabinets shall be made with threaded HUBS or double lock-nuts). Provide insulated bushings at all RGS conduit terminations where double lock-nuts are used. The use of Hubs are preferred. The use of threadless RGS fittings shall be kept to a minimum and used only when threading of the GRS is impossible.
2. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.
3. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.
4. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

G. Relays

1. Relays other than those associated with digital output cards shall be general-purpose, enclosed plug-in type protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required. All relays shall be equipped with an LED pilot light. AISD prefers IDEC relays.

2. Solid State Relays (SSR): Solid state relays are not permitted and shall not be used without prior authorization from AISD Energy Management Department.
3. Contactors: Contactors shall be of the single coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches, or semi-permanent magnets. Contractor shall be double-break silver-to-silver type protecting arcing contacts. The number of contacts and rating shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices.

3.4 CONTROL PANELS

- A. Enclosed cabinet type with hinged door for mounting controllers, relays, power supplies and miscellaneous control and communication devices.
- B. Control panels shall be fabricated to match the approved shop drawings submitted by the controls contractor. Fabrication shall be in a neat and workmanlike manner and shall facilitate repair, maintenance, and adjustment of the equipment contained therein.
- C. Locate all panels in mechanical or electrical rooms. Submit proposed locations for approval prior to preparing control drawings.
- D. Control panels shall be fabricated and laid out to incorporate the following features:
 1. Lockable doors. All control panels shall be provided with lockable doors using a cylinder AH2 lock kit.
 2. Hinged door shall swing left.
 3. Identification of all internally and cover mounted devices. Cover mounted labels shall be engraved labels as specified in this section.
 4. Provide one duplex outlet mounted inside the control panel. This receptacle may be served from the control panel 120 VAC power source. Label receptacle with source circuit information.
 5. Each control panel shall be provided with a control power disconnect switch located and wired so as to disconnect all control power in the panel. Provide one control power disconnect switch per system served (i.e. two disconnect switches for control panel serving two units).
 6. All control panels containing electrical equipment shall be NEMA rated for the location in which they are installed. Cover mounted components, tubing penetration, and conduit penetrations shall be made in a manner consistent with the NEMA rating.
 7. All conduits entering the control panel shall be fitted with a plastic insulating bushing to prevent cable damage.
 8. Wires and tubes that pass from the panel interior to cover mounted devices shall be provided with a flex loop that is anchored on both sides of the hinge.
 9. All internal wiring and tubing shall run inside plastic open-slot wire ducts. Wire duct shall be sized to hold the required number of wires and tubes without crimping the wires or tubing and with sufficient space to allow wiring and tubing to be traced during troubleshooting operation.
 10. All control panels shall be provided with removable backplane to allow the panel enclosures to be installed at the job site during rough-in while the panels are fabricated off-site for later installation.
 11. Labels serving all input/output wiring shall be installed between the open-slot wire duct and the controller so that labels are visible without removing the covers from the wire ducts. Labels shall be as specified in this section.

12. All wiring inside the panel shall be separated by classification; i.e., Class 1 circuits shall not be run with Class 2 circuits, etc. Segregation shall be maintained inside the panel to the fullest extent possible. Where low voltage wires carrying low level ac and dc signals cross wires containing power and high level ac signals, the wires shall cross at a 90° angle.
 13. 120 VAC power wiring shall enter the panel separately as close to the point of connection as possible
 14. Provide a wireway above or below the control panel whenever more than six conduits enter the panel. Wireway shall be the width of the panel with a minimum of six inches in height and six inches in depth.
- E. Panel Location:
1. Each control panel is to be located for convenient servicing. Top of panel shall be at six foot above finish floor.
 2. Mount panels adjacent to associated equipment.
- F. Network Control Unit (NCU) Panel:
1. Mount in IDF/MDF room or pre-approved location.
 2. Provide one duplex outlet mounted inside the control panel.
 3. Locate NCU power adapter inside the control panel.

3.5 TEMPERATURE AND PRESSURE SENSOR INSTALLATION

- A. Temperature and pressure sensors shall require no field calibrations, initial calibration and range set at factory. BAS contractor to calibrate the DDC system with the field sensors. Thermistors are not field calibratable, but still must be field calibrated with the DDC system.
- B. Temperature and pressure sensor assemblies shall be readily accessible and adaptable to each type of application in such manner as to allow for quick, easy replacement and servicing without special tools or skills.
- C. Differential pressure transmitters provided with a LCD readout display shall be mounted on wall at 5-feet AFF and nearby from sampling ports in accessible location.
- D. Differential pressure transmitters intended for control of building chilled water or hot water distribution pumps, shall be hardwired to the Local Control Unit (LCU) in direct control of the associated Variable Frequency Drives.
- E. Sensors installed on units shall be provided with their own dedicated handy box and under no circumstances a sensor shall be “tucked in” or hidden in a junction-box. Installation shall allow the replacement of a sensor without dismantling other sensors, wiring or conduit.
- F. Outdoor installation shall be; of weatherproof construction or in appropriate NEMA enclosures. These installations shall be protected from solar radiation and wind effects. Protective shield shall be stainless steel.
- G. Sensors shall be provided with protective enclosure where located on plans in common areas (hallways, library, cafeteria, gymnasium). Enclosure shall be clear plastic and keyed alike. Key type is C254A as in a Honeywell Versa Guard TG510A 1001. All Gymnasium areas shall use a wire basket type of enclosure.
- H. Sensors in duct shall be mounted in locations to sense the correct temperature of the air only and shall not be located in dead air spaces or positions obstructed by ducts, equipment, and

so forth. Locations where installed shall be within the vibration and velocity limit of the sensing element. Ducts shall be securely sealed where elements or connections penetrate ducts to avoid measuring false conditions.

- I. All sensors measuring temperatures in pipes larger than 2 inches in diameter or in pressure vessels shall be supplied with wells properly fabricated for the service. Wells shall be non-corrosive to the medium being measured and shall have sufficient physical strength to withstand pressures and velocities to which they are subjected. Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to affect proper flow across the entire area of the well.

3.6 INSTALLATION OF ACTUATORS

- A. Where damper motors operate outdoor relief, exhaust and fresh air dampers, pretension damper drive linkage to ensure tight closure.
- B. Do not install damper motors on ductwork of less than 0.76 mm thick without first reinforcing it.
- C. Where a damper motor is installed on an insulated surface of a duct plenum, mount it on a standoff bracket so as not to interfere with the continuity of the insulation.
- D. Locate damper motors so that they are easily accessible for testing and servicing.
- E. Damper motors shall be selected for the torque requirements of the damper. Damper operators that are undersized for the application shall be replaced with larger operators, at no extra cost. On retrofit applications, when existing dampers are suspected to be dragging, the next larger torque actuator shall be used.
- F. Provide one damper motor and linkage for every 2-m² damper section area, or as required to meet the torque requirements of the damper under design airflow conditions (or minimum of one damper motor per damper section). Do not use two motors linked together on one shaft, or by jackshaft.
- G. Actuators shall be installed in such manner to avoid damage to actuator due to condensation.

3.7 NETWORK INFRASTRUCTURE INSTALLATION

- A. All network infrastructure components and wiring shall be installed prior to control device installation. For twisted pair networks - install, test, and document test results and physical locations of cabling, conduit, and junction boxes on as-built drawings.
- B. Install and commission all routers, physical layer repeaters, and terminators prior to control device installations. Test routers, etc with the approved network management tool, document results, and identify physical locations of all routers, repeaters, and terminators on as-built drawings.
- C. Install necessary power supplies for infrastructure components and devices prior to device installation. Document the following: power source location indicating panel number and breaker id on the set of as-built drawings, at the source panel, and at each device or infrastructure component.

3.8 CONTROL DEVICE INSTALLATION

- A. Coordinate with mechanical and electrical contractors and identify each physical network device location. For retrofit applications physically inspect the site. Document locations on shop drawings and include with submittals provided to architect/engineer and AISD Energy Management department representative.
- B. Provide all isolation, interfacing, and wiring to complete the installation of equipment items that have integral control systems such as packaged air conditioners, heating units and boiler firing systems. Coordinate with manufacturers prior to submitting proposals and again prior to preparing submittals. Provide all components and circuits and interdisciplinary coordination required to interface the controls system for all required status monitoring, operational features, and fire management functions. Completely test and adjust all systems.
- C. Prior to device installation confirm that wiring for all network media, power supply, and I/O has been completed and is available at each location. Notify architect/engineer and/or owners representative immediately of any discrepancies or missing items
- D. Install each network device as physically close as possible to controlled equipment with respect to environmental and electrical noise conditions.

3.9 NETWORK DEVICE PROGRAMMING, GRAPHICAL DISPLAYS, STANDARD SETPOINTS, ALARMING AND TREND LOGGING.

- A. All network device programming used to implement control sequences shall be provided to AISD. It shall not be necessary for AISD to further program the system. However, provisions shall be made to allow future modification of the installed control programs.
- B. Provide licensed copies of all software tools, programming aids, and connecting cables, used to install, develop and troubleshoot the controls system to AISD.
- C. Implement the control sequences for the equipment on this project as prescribed in the construction documents and drawing sequence of operation descriptions.
- D. Provide the following Graphic User Interfaces (GUI) as the minimum acceptable but not limited to:
 - 1. Home Page (obtain template from AISD)
 - 2. Time Schedule Page
 - 3. Alarm Console Page
 - 4. Trend Logs Page
 - 5. Summary Page(s)
 - 6. Chilled & Hot Water Call Page (if applicable)
 - 7. Floor Plan(s)
 - a. Provide each floor plan with key plans and dynamically highlight which part of the key plan is in current view.
 - b. Mark location of space sensors to match final installation.
 - c. Provide calibrated space readings (i.e. space temp, CO2, RH, etc)
 - d. Provide quick links (buttons) to associated HVAC equipment graphic pages.
 - 8. Dedicated GUI per each equipment being monitored/controlled by the BAS
 - a. Provide dedicated override points for all outputs.
 - b. Group points as follows:
 - 1) Setpoints: Bottom left-hand side

- 2) Status Points: Bottom center (i.e. space temp, effective setpoints, etc)
 - 3) Overrides: Bottom right-hand side
 - 4) Actual Occupancy: Top center.
 - 5) All Other Points: Overlaid around HVAC schematic
- E. Provide the following minimum cooling and heating setpoints for equipment scheduled to control to maintain space temperature:
1. Base (Cooling) setpoint
 2. Slider Adjust Range [default: -3°F/+3°F]
 3. Setpoint Dead-Band
 4. Effective Cooling Setpoint
 5. Effective Heating Setpoint
 6. Base (Cooling) Setpoint + Slider Adjust Value = Effective Cooling Setpoint
 7. Effective Cooling Setpoint – Dead-Band = Effective Heating Setpoint
 8. Night Setup Setpoint (enable)
 9. Night Setback Setpoint (enable)
 10. Night Setup/Setback Dead-Band
- F. Provide Alarm Extensions to the following points:
1. Freeze-Stat (Change of State Alarm)
 2. Condensate Float Switch (Change of State Alarm)
 3. Low/High Static Pressure Alarm (Change of State Alarm)
 4. Fan Command vs Fan Status (Command Failure Alarm)
 5. Compressor Command vs Compressor Status (Command Failure Alarm)
- G. Provide Trend Logs to the following points:
1. All temperature sensors (Change of Value; Tolerance 1.0F)
 2. All outputs
 3. All status points

3.10 LABELS AND IDENTIFICATION

- A. All devices relating to the work or systems included herein, including controllers, valves, relays, etc., shall be identified with a unique identification number or name on the submitted control drawings. This identification number or name, along with the service of the device (discharge air temperature, freeze-stat, etc.), shall be permanently affixed to the respective device.
- B. All field devices shall be supplied with a label indicating its function and point name. Labels shall be “DYMO”-type electronically printed approximately 2-1/2” x 3/4”. Surface shall be cleaned before installing labels. No handwritten labels shall be accepted.
- C. Damper and valve actuators shall be labeled indicating which direction is towards open/bypass position (i.e. CW=BYPASS; CCW=OPEN).
- D. Label ceiling grid where sensors installed above ceiling when applicable.
- E. BAS Panels shall be supplied with a nameplate indicating the equipment being served (i.e. AHU-1 Cafeteria, CO2 Monitoring, etc.). Nameplates shall be engraved on rigid plastic labels approximately 3” x 1”. “DYMO” tape will not be accepted. Only black phenolic with white lettering will be accepted.
- F. All 120 VAC power shall be labeled with source panel and circuit number.

- G. All BAS Junction Boxes covers shall be spray-painted green with “BAS” stenciled over.
- H. All controls wiring, tubing and cabling both inside and outside of control panels shall be labeled at both ends using BRADY PermaSleeve Black on White Wire Marker Sleeves (do not shrink). The wire designations shall match those on the shop and installation drawings. All markings shall be mechanically produced. No handwritten labels shall be accepted.
- I. Communication wiring shall be labeled to specify where is coming from (previous device) and where is going to (next device) at each communication drop (i.e. each controller inside a control panel, each VFD provided with a communication card).

3.11 EQUIPMENT PROTECTION AND CLEANING

- A. The BAS system contractor shall provide adequate means for and shall fully protect all finish parts of the materials and equipment against damage during the progress of the work until final acceptance.
- B. Equipment and accessories shall be thoroughly cleaned of cement, plaster, and other materials; grease and oil spots shall be removed with cleaning solvent and surfaces carefully wiped.

3.12 AIR BALANCING

- A. The BAS system contractor shall assign an individual full time to assist the air balance technician during the air-balancing process to assure full balance compliance.
- B. The air balance plug-in shall have the ability to globally override local set point values and command all VAV air terminal devices to fully closed, fully open, minimum, and maximum damper positions.
- C. All air balance settings and values shall be documented on the as-built control drawings for future reference.

3.13 SUBSTANTIAL PERFORMANCE TEST PROCEDURES

- A. General
 - 1. The work under this section shall undergo a formal Functional Testing Commissioning process as documented in Section 230926c. Contractor shall set aside adequate time for the Commissioning process, including point checkout, sequence verification, and graphics checkout. Contractor shall include adequate time to respond to deficiencies without delaying project completion.
 - 2. Prior to requesting Functional Testing, this Contractor shall have every control point checked end to end to ensure accuracy and integrity of the system.
 - 3. Upon completion of control point end-to-end checkout, Contractor shall submit check-out documentation and DDC O&M Manuals to AISD and Commissioning Authority for review. Refer to Part 1 of this specification for O&M documentation requirements.
 - 4. Upon review and approval of DDC O&M documentation, AISD and Commissioning Authority shall schedule the date for commencement of Functional Testing.
 - 5. Controls Contractor shall make available for the Commissioning process a competent technician who is familiar with the installation and programming of the system.

Contractor's technician shall accompany AISD and Commissioning Authority during Functional Testing.

6. Refer to Section 230926c for detailed description and requirements of the Commissioning process.

B. Documentation

1. Upon successful completion of the Commissioning process, and once all deficiencies identified during Commissioning have been corrected, Contractor shall submit a final As-Built DDC O&M Manual with all programming, control points, network variables, setpoints, and graphics as actually implemented.
2. Provide as-built wiring diagrams showing all device locations, infrastructure component locations, control panels, sensors, actuators, ladder diagrams, for associated hardware interlocks, and sequence of operation descriptions for each subsystem within the network design. Show all interfaces with existing and equipment controls.
3. Provide control panel layout sheets complete with point names, point addresses and wire identification numbers. Attach one copy to each respective panel door.
4. All As-Built (O&M Manuals, etc) documentation, shop drawings, points verification sheets, coordination meeting minutes, etc shall be included in the O&M manuals as well as on a Compact Disc (CD) accompanying the final As-Built.

C. Software Backups & Platform Access

1. Upon successful completion of the Commissioning process, the Contractor shall provide a Platform & Station Backup of the Network Control Unit along with the Credentials to access the NCU Platform.

3.14 PROJECT ACCEPTANCE

- A. Upon receipt and approval of final DDC O&M Controls work shall be considered substantially complete, as recommended by the Commissioning Authority and approved by Owner and Engineer For additional acceptance requirements see Div 230926c.

3.15 POINT LISTS AND SEQUENCES OF OPERATIONS

- A. Refer to drawings.

END OF SECTION 230926a

SECTION 230926c**COMMISSIONING OF BUILDING AUTOMATION SYSTEM (TRIDIUM-BACNET)**

PART 1 - GENERAL

1.0 SCOPE

This specification is Austin Independent School District's Division 230926c Rev. 7/30/2018 and supplements the Commissioning Requirements in Division-1 with specific requirements from Direct Digital Controls (DDC) specified under Division 23. This specification shall be used in its entirety and shall only be modified by, or with permission from AISD-Energy Management Department.

1.1 RELATED DOCUMENTS

- A. Division-1, Section 019113 -Commissioning Requirements, addresses responsibilities and procedures for the commissioning process. All requirements of Division-1 specifications apply to this section.
- B. Division-23, Section 230926a -Direct Digital Controls for Local Building Automation Systems (TRIDIUM-BACNET) addresses requirements for design, installation and testing of DDC system using the BACnet protocol for local control of building HVAC systems. All requirements of Section 230926a apply to this section.

1.2 RESPONSIBILITIES

- A. Commissioning is the joint responsibility of the Contractor (including subcontractors and vendors) and the Commissioning Authority hired directly by the Owner, the Owner, and the Design Engineer. General assignment of responsibilities during the Commissioning process is specified in Section 019113. All the requirements of Section 019113 apply to this section.
- B. (General) Contractor retains responsibility for coordinating participation of Local Building Automation System subcontractors (Section 230926) throughout the commissioning process, and for ensuring participation by other subcontractors and equipment suppliers, vendors and manufacturers as required to conduct activities specified herein.
- C. Building Automation Systems subcontractor (Division 23) is responsible for assigning representatives with expertise and authority to act on behalf of the subcontractor to conduct commissioning activities specified. Building Automation Systems subcontractors are also responsible for providing tools, software and equipment required to conduct commissioning activities.
- D. Commissioning Authority is responsible for organizing, witnessing and documenting commissioning activities specified.
- E. Owner is responsible for assigning personnel with expertise and authority to act on behalf of the Owner as relates to commissioning of Building Automation Systems, and to provide access to facilities, equipment, and servers as required to conduct commissioning tasks.

- F. Design Engineer is responsible for developing a design that is in compliance with the Owner's Project Requirements and Design Guidelines and for responding to Commissioning Authority's comments.

Design Engineer is also ultimately responsible for the proper operation of the system as designed, regardless of whether or not he chooses to participate in testing and demonstrations.

1.3 SUMMARY OF WORK

A. DESIGN PHASE (Information Only)

1. Conceptual Design Meeting: Early during Conceptual Design and prior to making firm decisions on the type of HVAC systems and controls to be provided, Design Team shall request a meeting with AISD Service Center personnel and Owner's Commissioning Authority. The main objective of the meeting is to review the Owner's Standard Specifications and Guidelines and ensure design will proceed in accordance.
2. Preliminary Design Submittal: Design Engineer provides complete DDC points list and sequence of operations for all systems at DD design submittal and again at 95% CD design submittal. Sequences and points lists shall be in accordance with Owner's guidelines and standard points lists. Electronic Submittals shall be provided to AISD Service Center personnel and Owner's Commissioning Authority.
3. Design Review Comments: Owner and Commissioning Authority provide comments upon review of DD and 95% CD design submittals. Comments issued in electronic form.
4. Design Review Meeting: A final design review meeting is held upon review of 95% CD's, to verify inclusion of review comments in design. Meeting is attended (at least) by Design Engineer, Owner, and Commissioning Authority. Commissioning Authority provides written documentation of decisions made during meeting.
5. Design Review Follow-up: Commissioning Authority conducts a follow up review of Construction Documents issued for permitting/bids and forwards comments to Owner and Engineer on any outstanding items.

B. SUBMITTAL PHASE

1. Preliminary Submittal: Controls subcontractor (Div-23) provides preliminary DDC submittal in accordance with specifications, with digital copies transmitted to AISD Service Center and Owner's Commissioning Authority (ACR). This submittal shall occur shortly after contract award and prior to approval of equipment submittals so that systems may be properly coordinated. In addition to requirements of Section 230926, Building Automation System submittal shall include at least the following:
 - a. Detailed written sequences as they will actually be programmed and using the program variable names;
 - b. Complete point lists including all controlled devices, monitored values, status points, set-points and all variables obtained from BACnet devices including those from equipment provided with BACnet communication cards;

2. Preliminary Submittal Review: Owner and Commissioning Authority issue joint review comments on Preliminary Submittal to Engineer for inclusion with Design Team's review comments to Contractor.
3. Preliminary Submittal Review Meeting: Upon acknowledgement of receipt of Preliminary Submittal review comments, Local Controls subcontractor will request through the Contractor and AISD Project Manager, a review meeting with Owner, Engineer, and Commissioning Authority. Commissioning Authority documents action items resulting from meeting for inclusion in Final Submittal.
4. Final Submittal: Upon addressing comments, Local Controls subcontractor issues Final Submittal for review by Engineer, Owner, and Commissioning Authority.
5. Final Submittal Review Comments: Owner, and Commissioning Authority issue joint comments to Engineer for inclusion with Design Team's final submittal review comments to Contractor.
6. No hardware installation should take place prior to receiving submittals that have been approved by Owner, Engineer and Commissioning Authority.

C. PRE-FUNCTIONAL INSPECTION -Local Building Automation Systems Controls

1. Controls Contractor Request for Pre-Functional Inspection: Upon completion of installation and programming of ALL systems, Controls subcontractor shall issue a written request for Pre-Functional Inspection by Engineer, Owner and Commissioning Authority, certifying that the following work is complete and ready for inspection:
 - a. Manufacturer start-up has been conducted for all equipment requiring it - coordinate with Mechanical Contractor;
 - b. Piping has been flushed and (preliminary) test and balance completed - coordinate with Mechanical Contractor;
 - c. All control and monitoring devices installed, wired and tested;
 - d. Point-to-point check to verify correspondence of control points to control devices verified (provide report);
 - e. All operational sequences tested;
 - f. Control Panel layout sheets complete with point name, point address, and wire identification number (indicating DDC device), with one copy attached to each respective panel door;
 - g. All points and devices permanently tagged with point name, address, and panel number;
 - h. As-Built Controls Diagrams and Sequence Documentation reflecting systems as programmed and installed, to be used during inspection.

2. Pre-Functional Inspection: Contractor shall set aside a minimum of two days to conduct a joint Pre-Functional Inspection of Local Controls Building Automation System work with Engineer, Owner and Commissioning Authority. Work will include the following:
 - a. Physical inspection of installation for compliance with specifications;
 - b. Sample testing of sensors and devices for verification of calibration;
 - c. Sample point-to-point checkout to verify correspondence of commanded points to controlled devices;
 - d. Testing of central plant cooling sequences including plant enable/disable sequences and call for unoccupied operation;
 - e. Testing of central plant heating sequences including plant enable/disable and call for unoccupied operation;
 - f. Testing of air handler units operating sequences (sampling) including occupied/unoccupied sequences and call for unoccupied operation;
 - g. Testing of zone controls (fan-coil, dx-split, vav-boxes) operating sequences (sampling) including occupied/unoccupied sequences and call for unoccupied operation;
3. Pre-Functional Inspection Report: Commissioning Authority prepares a report detailing deficiencies identified during Pre-Functional Inspection and submits to Engineer so he may evaluate and forward to Contractor.
4. Pre-Functional Re-Inspection(s) Request: Upon completion of items on Pre-Functional Inspection Report, Local Controls subcontractor issues a request for Pre-Functional Re-Inspection and the process is repeated.
5. Pre-Functional Acceptance: Upon completion of all items identified during Pre-Functional Inspection, Commissioning Authority issues an official notification of Pre-Functional Acceptance to Engineer so he may forward to Contractor.
6. When deemed advantageous to the project, and depending on system configuration, Pre-Functional Inspection and Functional Testing may be combined into a single activity, at CxA's discretion.

D. FUNCTIONAL TESTING

1. Point Check-out Request: Upon completion of controls installation, the Controls Contractor shall submit documentation and issue written notification to Owner, Engineer, and Commissioning Authority stating that the entire system is ready for Point Check-out, including all graphics.
2. Point Check-out & Report: Commissioning Authority shall inspect system via the Web-based Graphic User Interface (GUI) to verify that all specified points are present, that they are reading properly and that they are accessible, commandable and

overridable as specified. Commissioning Authority will issue a point check-out report listing deficiencies to be corrected.

3. Point Check-out Corrections: Controls contractor shall correct deficiencies listed in the Point Check-out Report and issue written notification when system is ready for Functional Testing.
4. Functional Testing: Upon notification by controls contractor that deficiencies in the Point Check-out Report have been corrected, Engineer, Owner, and Commissioning Authority will meet controls contractor at the project site to conduct Functional Testing as described in Part-4 of this specification.
5. Functional Test Report: Upon completion of Functional Testing, Commissioning Authority shall issue a report listing deficiencies to be corrected.
6. Functional Testing Deficiencies Resolution: Controls contractor shall resolve deficiencies in Functional Test Report. Corrections shall be accomplished within a period of no more than 2 weeks. Upon correction of deficiencies, Contractor shall notify Owner and Commissioning Authority when system is ready for Final Functional Testing.
7. Final Functional Test & Report: Upon receiving notification from Contractor, Owner and Commissioning Authority will verify corrections to controls systems. Commissioning Authority will complete a Final Functional Test Report documenting that systems work as per design intent, and/or outlining any recommendations for future improvement.

E. O&M MANUALS AND AS-BUILT DOCUMENTS

1. Requirements for O&M Manuals and As-Built Documentations are included in Section 230926a.
2. Commissioning Authority shall conduct review of O&M's and As-Built's concurrently with Engineer and track documentation.

F. TRAINING

1. Requirements for training of Owner's personnel are included in Section 230926a.
2. Commissioning Authority shall review training material and attend selected training sessions as deemed useful in order to document adequacy.

PART 2 - PRODUCTS -NOT APPLICABLE

PART 3 - EXECUTION -NOT APPLICABLE

PART 4 - FUNCTIONL TESTING PROCEDURES

4.0 GENERAL

- A. Seven (7) Day Performance Test: Contractor shall schedule a seven (7) day period to conduct Functional Testing specified herein. Any upset of system operational functionality greater than (2) hours during the seven (7) day test period shall cause the test to be restarted.
- B. Prerequisites for Functional Testing: The following must be complete prior to proceeding with Functional Testing
 - 1. Pre-Functional Testing and Acceptance Notice by Commissioning Authority.
 - 2. End to End Point Checkout by Contractor.
 - 3. Point Checkout Report by Commissioning Authority.
 - 4. Time schedules built and in control of time-controlled equipment.
 - 5. Graphics displays installed and fully operational for each unit, system, and subsystem.
- C. Trending: Implement the following trends prior to initiating testing.
 - 1. Each space sensors shall be placed on a five (5) minute trend for 24 hours to document accurate temperature control of room or zone. Trends shall be recorded electronically for inclusion in Commissioning Report.
 - 2. Each control loop measured variable, controlled variable and setpoint if calculated shall be place on a one (1) minute continuous trend for at least twenty-four (24) hours to document stability of loop. Trends shall be recorded electronically for inclusion in Commissioning Report.
 - 3. Runtime totalizer shall be set on selected digital outputs.
 - 4. Additional variables will be trended at the request of Owner/Commissioning Authority.

4.1 FUNCTIONAL TESTING

- A. Local Network Testing (BACnet)
 - 1. The fire alarm system shall be enabled at the time of testing to ensure correct action of all fire and smoke sequences that interface with controls.
 - 2. Network traffic for each device channel shall be measured for 24 hours utilizing a protocol analyzer tool. Channel analysis shall include bandwidth utilization, and error

statistics. Reconfigure nodes and/or install additional routers as necessary to maintain traffic at a no more than 60% of channel bandwidth capacity. Backbone channels that contain permanent HMI's shall consume no more than 30% of total bandwidth capacity.

3. Each network control device, intelligent router, and network interface shall be tested and health verified using the protocol analyzer diagnostics application. Test results shall include neuron error log statistics, self-test results and device state information.
4. A power failure for the building shall be simulated and system recovery monitored. A protocol analyzer log shall record the network traffic for each channel for a 60-minute period following building power restoration.
5. Disable all sending (upstream) devices and simulate connection failures for receiving devices (downstream) that implement fail-safe configuration settings. Verify that downstream devices play failsafe values in the event that network variable updates are not detected by downstream devices within the minimum receive update intervals.
6. Test results shall be printed, recorded electronically and submitted to Owner, Engineer and Commissioning Authority.

B. Functional Testing of Sequences and Controls

1. **Functional Checklists:** Functional Testing forms shall be developed by Commissioning Authority for each specific system or subsystem to be tested, identifying all control and monitoring points that must be active.
2. **End-to-End Verification:** Proper operation/response of controlled points shall be verified from the Web-based Graphic User Interface (GUI) front-end to the actual physical devices in the field, as follows:
 - a. Controlled devices shall be commanded to a value at the GUI and its reaction observed in the field.
 - b. Status points shall be changed and observed both in the field and at the GUI.
 - c. Selected sensors shall be tested for accuracy and proper placement to ensure that sensors are properly assigned to the area served.
 - d. Selected points shall be disabled in the field and the proper alarm/response verified at the GUI.
3. **Sequence Verifications:** Proper operation of programmed sequences shall be verified for each major system type and sampled for multiple identical systems. Sequence verification will include the following as directed by the CxA:
 - a. Response to time schedule commands.
 - b. Response to changes in setpoints.

- c. Responses to changes in field conditions.
- d. Response to loss and restoration of power.
- e. Response to loss and restoration of communication.

END OF SECTION 230926c

SECTION 23 23 00 – REFRIGERANT PIPING (10 TONS AND SMALLER)

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Refrigerant piping.
2. Unions, flanges and couplings.
3. Pipe hangers and supports.
4. Refrigerant moisture and liquid indicators.
5. Valves.
6. Refrigerant filter-driers.
7. Expansion valves.

B. Related Sections:

1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 08 31 13 - Access Doors and Frames: Access doors for concealed valves and accessories.
3. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
4. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.

1.02 REFERENCES

A. Air-Conditioning, Heating and Refrigeration Institute:

1. AHRI 710 - Liquid-Line Driers.
2. AHRI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Dryers.
3. AHRI 750 - Thermostatic Refrigerant Expansion Valves.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

C. American Society of Mechanical Engineers:

1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 2. ASME B31.5 - Refrigeration Piping.
- D. ASTM International:
1. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 2. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 3. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
- E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- F. International Mechanical Code.

1.03 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.
- C. Provide pipe hangers and supports in accordance with ASME B31.5.

1.04 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.
- C. Product Data:
 1. Piping: Submit data on pipe materials, fittings and accessories.
 2. Valves: Submit manufacturer's catalog information with valve data and ratings for each service.
 3. Hangers and Supports: Submit manufacturer's catalog information including load capacity.
 4. Refrigerant Specialties: Submit manufacturer's catalog information including capacity, component sizes, rough-in requirements, and service sizes for the following:

- a. Refrigerant moisture and liquid indicators.
- b. Refrigerant filter-driers.

1.05 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of valves, equipment and refrigerant accessories.
- C. Operation and Maintenance Data: Submit instructions for installation and changing components and exploded assembly views.
- D. Test Reports: Indicate results of refrigerant leak test.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.
- B. Perform Work in accordance with the applicable code .

1.07 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of experience.
- B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years of experience.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.
- C. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

PART 2 PRODUCTS

2.01 REFRIGERANT PIPING

- A. Copper Tubing: ASTM B280, ACR, Type L, drawn.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.
- B. Copper Tubing Less Than or Equal to 0.625 inch OD: ASTM B280, ACR, Type L annealed.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.02 UNIONS, FLANGES AND COUPLINGS

- A. 2 inches and Smaller:
 - 1. Copper Pipe: Bronze, brazed joints.

2.03 PIPE HANGERS AND SUPPORTS

- A. Conform to ASME B31.5.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
- C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- D. Vertical Support: Steel riser clamp.
- E. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange.
- F. Copper Pipe Support: Carbon steel rings, adjustable, copper plated.
- G. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- H. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
- I. Sheet Lead: ASTM B749, 0.039 inch thick.

2.04 REFRIGERANT MOISTURE AND LIQUID INDICATORS

- A. Indicators:
 - 1. Port: Single, UL listed.
 - 2. Body: Brass, with solder ends.

3. Sight glass: Color-coded moisture indicator and plastic cap.
4. Maximum working pressure: 500psig.
5. Maximum working temperature: 200 degrees F.

2.05 VALVES

A. Service Valves:

1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, solder ends.
2. Maximum working pressure: 500 psig.

2.06 REFRIGERANT FILTER-DRIERS

A. Permanent Straight-Through Type:

1. AHRI 710, UL listed, steel shell with molded desiccant filter core, for maximum working pressure of 500 psig.
2. Rating: AHRI 730 flow capacity of nominal scheduled capacity served by line.

2.07 EXPANSION VALVES

- ##### A. Provide with equipment. See equipment specification.

PART 3 EXECUTION

3.01 EXAMINATION

- ##### A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.03 INSTALLATION – INSERTS

- A. Provide inserts for placement in concrete forms.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

- C. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.04 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install hangers and supports in accordance with ASME B31.5.
- B. Support horizontal piping hangers as scheduled.
- C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
- G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
- H. Provide sheet lead packing between hanger or support and piping.
- I. Prime coat exposed steel hangers and supports in accordance with Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.05 INSTALLATION – PIPING SYSTEMS

- A. Route piping parallel to building structure and maintain gradient.
- B. Install piping to conserve building space, and not interfere with use of space.
- C. Group piping whenever practical at common elevations.
- D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.
- E. Install pipe identification in accordance with Section 23 05 53.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints or connected equipment.
- G. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 13.
- H. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required per manufacturer's instructions. Slope horizontal piping 0.40 percent in direction of flow.
- I. Flood refrigerant piping system with nitrogen when brazing.

- J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- K. Install valves with stems upright or horizontal, not inverted.
- L. Insulate piping; refer to Section 23 07 00.
- M. Fully charge completed system with refrigerant after testing.
- N. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
- O. Install refrigerant piping in accordance with ASME B31.5.

3.06 INSTALLATION – REFRIGERANT SPECIALTIES

- A. Refrigerant Liquid Indicators:
 - 1. Install line size liquid indicators in main liquid line downstream of condenser.
- B. Refrigerant Valves:
 - 1. Install service valves on compressor suction and discharge.
 - 2. Install gauge taps at compressor inlet and outlet.
- C. Filter-Driers:
 - 1. Install permanent filter-drier in systems containing hermetic compressors.

3.07 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting and balancing.
- B. Test refrigeration system in accordance with ASME B31.5.
- C. Pressure test refrigeration system with dry nitrogen to 500 psig.
- D. Repair leaks.
- E. Retest until no leaks are detected.

3.08 SCHEDULES

- A. Pipe Hanger Spacing:

B.

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	MINIMUM HANGER ROD DIAMETER COPPER TUBING Inches
1/2	5	3/8
3/4	5	3/8
1	6	3/8
1-1/4	7	3/8
1-1/2	8	3/8
2	8	3/8
2-1/2	9	1/2
3	10	1/2
4	10	1/2
5	10	1/2
6	10	5/8

END OF SECTION

SECTION 23 31 00 – HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Duct materials.
2. Single wall spiral round and flat oval ducts.
3. Ductwork fabrication.
4. Duct cleaning.
5. Duct liner.

B. Related Sections:

1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
2. Section 09 90 00 - Painting and Coating: Execution requirements for Weld priming, weather resistant, paint or coating specified by this section.
3. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers, supports and sleeves for placement by this section.
4. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.

1.02 REFERENCES

A. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
3. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
4. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
5. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
6. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated

(Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

7. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 8. A1011/A1011M-07 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 9. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 10. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 11. ASTM C534 – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation – Type II, Grade 1, Sheet Materials.
 12. ASTM C1534 – Specification for Flexible Polymeric Foam Sheet Insulation Used as Thermal and Sound Absorbing Liner for Duct Systems.
 13. ASTM G21/C1338 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 14. ASTM G22 – Standard Practice for Determining Resistance of Plastics to Bacteria.
- B. Greenguard Environmental Institute:
1. GEI - Greenguard Certification Standards for Low-Emitting Products.
- C. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
 2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- D. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - Fibrous Glass Duct Construction Standards, most recent edition.
 2. SMACNA - HVAC Air Duct Leakage Test Manual, most recent edition.
 3. SMACNA - HVAC Duct Construction Standard - Metal and Flexible, most recent edition.
- E. Underwriters Laboratories Inc.:
1. UL 94 – Standard for Safety of Flammability of Plastic Materials .
 2. UL 181 - Factory-Made Air Ducts and Connectors.

- F. South Coast Air Quality Management District:
 - 1. SCAQMD Rule 1168 – Adhesive and Sealant Applications, amended January 7, 2005.
 - a. Metal to metal: Maximum VOC content 30 g/L.
- G. U.S. Environmental Protection Agency (EPA)
 - 1. EPA-registered antimicrobial agent for HVAC duct lining

1.03 PERFORMANCE REQUIREMENTS

- A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.04 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:
 - 1. Fabrication, assembly and installation details, including plans, elevations, sections, details of components, and attachments to other work.
 - 2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
 - 3. Fittings.
 - 4. Reinforcing details and spacing.
 - 5. Seam and joint construction details.
 - 6. Penetrations through fire rated and other walls.
 - 7. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
- C. Product Data: Submit data for duct materials, duct liner and duct connectors.
- D. Duct Pressure Test Form.

1.05 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

- C. Duct Pressure Test Report: Indicate pressure tests performed. Include date, section tested, duct design static pressure, test apparatus information (model, fan HP, orifice calibration certificate) test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual, most recent edition.

1.06 SUSTAINABLE DESIGN SUBMITTALS

- A. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.
 - 1. Materials Resources Certificates:
 - a. Certify recycled material content for recycled content products.
 - b. Certify source for local and regional materials and distance from project site.
 - 2. Indoor Air Quality Certificates:
 - a. Certify volatile organic compound content for each interior adhesive and sealant, related primer and waterproof coating.

1.07 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.
- B. Construct ductwork to NFPA 90A standards and in accordance with applicable mechanical code.

1.08 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years of experience.

1.09 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.
- C. Maintain temperatures during and after installation of duct sealant.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.01 DUCT MATERIALS

- A. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G90 zinc coating of in conformance with ASTM A90/A90M.
- B. Steel Ducts: ASTM A1008/A1008M, ASTM A1011/A1011M or ASTM A568/A568M.
- C. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.
- D. Stainless Steel Ducts: ASTM A240/A240M or ASTM A666, Type 316.
- E. Fasteners: Rivets, bolts or sheet metal screws.
- F. Hanger Rod: ASTM A36/A36M; carbon steel or galvanized; threaded both ends, threaded one end, or continuously threaded.
- G. Duct Sealants: Fire-resistive, water-based, indoor/outdoor, U.V.-resistant, non-fibrous sealant for use on low-, medium- and high-velocity duct seams. Foster 32-19; Childers CP-146; Duro Dyne SAS UL.
- H. Adhesive: Water based. Used to adhere duct liner and/or duct Wrap (up to 3#/cu. ft.) to metal. Foster 85-60, Childers CP-127, Duro Dyne SSG

2.02 SINGLE WALL SPIRAL ROUND DUCTS

- A. Product Description: UL 181, Class 1, round or flat oval spiral lockseam duct with light reinforcing corrugations.
- B. Construct round or oval duct in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, most recent edition and as indicated on Drawings. Provide duct material, gauges, reinforcing and sealing for operating pressures indicated.
- C. Fabricate continuously welded round duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Minimum 4-inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
- D. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.
- E. All elbows 45-degree and 90-degree shall be die-stamped for less than or equal to 10 inches diameter. Elbows greater than 10 inches diameter shall be of the gored type and according to the following: 30-degree shall be 2-gore, 45-degree shall be 3-gore and 90-degree shall be 5-gore.
- F. Seal joints between duct sections and duct seams with mastic adhesive regardless of duct pressure classification.
 - 1. Sealants, Mastics and Tapes: Conform to UL 181A. Provide products bearing appropriate UL 181A markings.
 - 2. Do not provide sealing products not bearing UL approval markings.
- G. Exposed ductwork to be painted shall have a matte, paint-grip finish.

2.03 RECTANGULAR DUCTWORK FABRICATION

- A. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and [as indicated on Drawings]. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- B. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation. Provide access door upstream of all turning vanes for inspection and cleaning.
- C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- D. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.
- E. Seal joints between duct sections and duct seams with gasket and/or mastic adhesives, regardless of duct pressure classification.
 - 1. Sealants, Mastics and Tapes: Conform to UL 181A. Provide products bearing appropriate UL 181A markings.
 - 2. Do not provide sealing products not bearing UL approval markings.
- F. Offsets shall be radius ogee type where possible. Where space does not allow radius ogee offsets, shop-fabricated mitered offsets with a maximum 30 degree offset angle shall be used.

2.04 THERMAL DUCT LINER (FIBERGLASS FREE)

- A. Flexible closed cell elastomeric foam duct insulation liner, free of CFCs, HFCs, HCFCs, PBDEs or formaldehyde.
 - 1. 'K' ('ksi') Value: ASTM C 518, 0.25 at 75°F mean temperature.
 - 2. Maximum service temperature: 220°F.
 - 3. Maximum moisture absorption: 0.20 percent by volume.
 - 4. Density: 3.0 – 6.0 lb./cu. ft.
 - 5. Water vapor permeability 0.05 perm-in.
 - 6. Antimicrobial Protection: lining shall contain EPA-registered antimicrobial agent "built-in" to liner, not a protective coating.
 - 7. UL Greenguard Gold Certificate for low VOC emissions.
 - 8. Recognized under Underwriters Laboratories UL 94 Plastic Component Classification.
 - 9. Maximum Flame Spread: ASTM E84, 25.

- 10. Maximum Smoke Developed: ASTM E84; 50.
- B. For duct liner installed within interior ductwork, minimum liner thickness shall be one-inch.
- C. For duct liner installed within exterior ductwork, minimum liner thickness shall be two-inches or as required to obtain a minimum insulation value of R-8.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify sizes of equipment connections before fabricating transitions.

3.02 INSTALLATION

- A. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. During construction, install temporary closures of metal or taped polyethylene on all open ductwork, installed or in storage, to prevent construction dust from entering ductwork system.
- C. Duct inlet and outlet areas shall be clean and free of dirt, oil and other bond inhibiting contaminants.
- D. Install duct hangers and supports in accordance with SMACNA Duct Construction Standards.
- E. Use double nuts and lock washers on threaded rod supports.
- F. Install in accordance with manufacturer's instructions.
- G. Duct sizes are inside clear dimensions.
- H. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- I. For outdoor ductwork, protect ductwork, ductwork supports, linings and coverings from weather.
- J. All ductwork that is exposed shall be joined with gasketed couplings. For metal to metal joining that cannot be gasketed shall be sealed from the inside. Sealant should not be visible to the end user.
- K. Set plenum doors 6 to 12 inches above floor. Arrange door swing so fan static pressure holds door in closed position.

3.03 DUCT LINER INSTALLATION

- A. Fabricate and install all duct liner in accordance with SMACNA Installation Standards for Rectangular Ducts using flexible liner with the following exceptions:
1. For liners which are coated, apply liner with coated side at the air stream side,
 2. All pins or mechanical fasteners shall have beveled or cupped contact edges.
 3. Installed pin length, measured from metal duct surface to underside of pin contact washer, shall equal the thickness of the liner, within a tolerance range of plus or minus 1/16 inch.
 4. Apply liner manufacturer's contact adhesive to all fabrication cuts and seams.
 5. Apply liner manufacturer's coating to repair any tears or damage to the airstream surface prior to final installation.
- B. Clean sheet metal with denatured alcohol to remove bond-breaking substances. Adhere the liner to the sheet metal with 100 percent coverage of adhesive. Coat all exposed edges and joints with manufacturer's contact adhesive.
1. The liner shall be additionally secured with mechanical fasteners which shall hold it securely in place and prevent sagging.
 2. Fasteners shall start within 3 inches of the upstream transverse edges of the liner and 3 inches from the longitudinal joints and shall be spaced at a maximum of 6 inches on center around the perimeter of the duct, except that there may be a maximum of 6 inches from a corner break. Elsewhere, they shall be a maximum of 16 inches on center, except that they shall be placed not more than 6 inches from a longitudinal joint of the liner nor 12 inches from a corner break.
- C. For all equipment installations:
1. Install 24 gauge channel nosing on the leading and trailing edge of all raw insulation.
 2. Welded pins affixed at 6-inch intervals parallel to the nosing.
- D. Cut the liner accurately to assure overlapped and compressed longitudinal corner joints and tightly butted transverse joints.
- E. Fabricate all duct liner with precision machinery. Make only minor, onsite manual adjustments to liner.
- F. Provide insulated "build-out" sections to maintain the continuity of the liner when specialties, such as dampers and turning vanes, are secured to the sides of the duct. Build-outs shall be secured to the duct with sheet metal fasteners or welds.
1. Use of a hat section for "build-out" is optional, and its use shall be evaluated for each specialty. Liner shall be adequately protected from damage or erosion, and friction loss through the section shall be minimized.
- G. Increase duct size over those shown on the drawings where it is scheduled to receive liner. Sizes on drawings are inside clear dimension.

3.04 INTERFACE WITH OTHER PRODUCTS

- A. Install openings in ductwork where required to accommodate thermometers and controllers. Install pitot tube openings for testing of systems. Install pitot tube complete with metal can with spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.
- B. Where exposed ductwork penetrates a ceiling or wall in finished spaces, install sectional plates or escutcheons to cover the annular opening between pipe and sleeve. Solid plates with set screws shall be used where the sectional plates will not stay in place or are not available in the required size, or where other individual specification section(s) require one piece or greater quality escutcheons or plates. Refer to Section 23 00 01 for additional requirements.

3.05 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air flow, clean one half of system completely before proceeding to other half. Protect equipment with potential to be harmed by excessive dirt with temporary filters, or bypass during cleaning.
- C. Clean duct systems with high power vacuum machines. Protect equipment with potential to be harmed by excessive dirt with filters, or bypass during cleaning. Install access openings into ductwork for cleaning purposes.

3.06 TESTING

- A. For ductwork designed for 3 inches w.c. above ambient per pressure class schedule below, pressure test minimum 25 percent of ductwork after duct cleaning, but before duct insulation is applied or ductwork is concealed.
 - 1. Test in accordance with SMACNA HVAC Air Duct Leakage Test Manual.
 - 2. Maximum Allowable Leakage: In accordance with applicable, local code.

3.07 SCHEDULES

- A. Ductwork Material Schedule:

AIR SYSTEM	MATERIAL
Indoor Supply and Return	Galvanized Steel, Internally Lined
General Exhaust	Galvanized Steel, Aluminum
Outside Air Intake	Galvanized Steel
Transfer	Galvanized Steel, Internally Lined

- B. Ductwork Pressure Class Schedule:

AIR SYSTEM	PRESSURE CLASS
Constant Volume Supply	2 inch w.g.
Return and Relief	2 inch w.g.
General Exhaust	2 inch w.g.

END OF SECTION

SECTION 23 32 00 - CLEANING AND SEALING OF COMMERCIAL HVAC SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Cleaning and sealing of duct systems

B. Related Sections:

1. Section 23 31 00 – HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.

1.02 REFERENCES

- A. National Air Duct Cleaners Association (NADCA): "Assessment, Cleaning & Restoration of HVAC Systems (ACR 2005)," 2004.
- B. National Air Duct Cleaners Association (NADCA): "Understanding Microbial Contamination in HVAC Systems," 1996.
- C. National Air Duct Cleaners Association (NADCA): "Introduction to HVAC System Cleaning Services," 2004.
- D. National Air Duct Cleaners Association (NADCA): Standard 05 "Requirements for the Installation of Service Openings in HVAC Systems," 2004.
- E. Underwriters' Laboratories (UL): UL Standard 181.
- F. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE): Standard 62-89, "Ventilation for Acceptable Indoor Air Quality".
- G. Environmental Protection Agency (EPA): "Building Air Quality," December 1991.
- H. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): "HVAC Duct Construction Standards - Metal and Flexible," 1985.
- I. North American Insulation Manufacturers Association (NAIMA): "Cleaning Fibrous Glass Insulated Air Duct Systems," 1993.

1.03 QUALIFICATIONS

- A. Membership: The HVAC system cleaning contractor shall be a certified member of the National Air Duct Cleaners Association (NADCA), or shall maintain membership in a nationally recognized non-profit industry organization dedicated to the cleaning of HVAC systems.
- B. Certification: The HVAC system cleaning contractor shall have a minimum of one (1) Air System Cleaning Specialist (ASCS) certified by NADCA on a full time basis, or shall have staff certified by a nationally recognized certification program and organization dedicated

to the cleaning of HVAC systems.

- C. Supervisor Qualifications: A person certified as an ASCS by NADCA, or maintaining an equivalent certification by a nationally recognized program and organization, shall be responsible for the total work herein specified.
- D. Experience: The HVAC system cleaning contractor shall submit records of experience in the field of HVAC system cleaning. Firms shall be regularly engaged in HVAC system maintenance with an emphasis on HVAC system cleaning and decontamination.
- E. Equipment, Materials and Labor: The HVAC system cleaning contractor shall possess and furnish all necessary equipment, materials and labor to adequately perform the specified services.
 - 1. The contractor shall assure that its employees have received safety equipment training, medical surveillance programs, individual health protection measures, and manufacturer's product and material safety data sheets (MSDS) as required for the work by the U.S. Occupational Safety and Health Administration, and as described by this specification. For work performed in countries outside of the U.S.A., contractors should comply with applicable national safety codes and standards.
 - 2. The contractor shall maintain a copy of all current MSDS documentation and safety certifications at the site at all times, as well as comply with all other site documentation requirements of applicable OSHA programs and this specification.
- F. Licensing: The HVAC system cleaning contractor shall provide proof of maintaining the proper license(s), if any, as required to do work in this state. Contractor shall comply with all Federal, state and local rules, regulations, and licensing requirements.

1.04 STANDARDS

- A. NADCA Standards: The HVAC system cleaning contractor shall perform the services specified here in accordance with the current published standards of the National Air Duct Cleaners Association (NADCA).
 - 1. All terms in this specification shall have their meaning defined as stated in the NADCA Standards.
 - 2. NADCA Standards must be followed with no modifications or deviations being allowed.
- B. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.05 COORDINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.

1.06 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures: Submittal procedures.
- B. Copy of NADCA Certification, Supervisor qualifications, Licensing requirements and

experience records.

- C. Contractor shall submit all Material Safety Data Sheets (MSDS) for all chemical products proposed to be used in the cleaning process.

1.07 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Closeout procedures.
- B. Reports as specified in Part 2 of this section.

PART 2 PRODUCTS

2.01 SCOPE OF WORK

- A. Scope: This section defines the minimum requirements necessary to render HVAC components clean, and to verify the cleanliness through inspection and/or testing in accordance with items specified herein and applicable NADCA Standards.

The Contractor shall be responsible for the removal of visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications.

Existing Duct Systems: All existing supply air, return air, outside air and exhaust air duct systems indicated on the plans to remain shall be cleaned. In addition, after cleaning, existing duct systems having internal duct liner insulation shall be sealed with Foster 40-30 fungicidal protective coating or approved equal. Apply sealant per manufacturer's recommendations.

The HVAC system includes any interior surface of the facility's air distribution system.

2.02 HVAC SYSTEM COMPONENT INSPECTIONS AND SITE PREPARATIONS

- A. HVAC System Component Inspections: Prior to the commencement of any cleaning work, the HVAC system cleaning contractor shall perform a visual inspection of the HVAC system to determine appropriate methods, tools, and equipment required to satisfactorily complete this project. The cleanliness inspection should include representative areas of the HVAC system ductwork.

The cleanliness inspection shall be conducted without negatively impacting the indoor environment through excessive disruption of settled dust, microbial amplification or other debris. In cases where contamination is suspected, and/or in sensitive environments where even small amounts of contaminant may be of concern, environmental engineering control measures should be implemented

1. Damaged system components found during the inspection shall be documented and brought to the attention of the Owner.

- B. Site Evaluation and Preparations: Contractor shall conduct a site evaluation, and establish a specific, coordinated plan which details how each area of the building will be protected during the various phases of the project.
- C. Inspector Qualifications: Qualified personnel should perform the HVAC cleanliness inspection to determine the need for cleaning. At minimum, such personnel should have an understanding of HVAC system design, and experience in utilizing accepted indoor

environmental sampling practices, current industry HVAC cleaning procedures, and applicable industry standards.

2.03 GENERAL HVAC SYSTEM CLEANING REQUIREMENTS

- A. Containment: Debris removed during cleaning shall be collected and precautions must be taken to ensure that debris is not otherwise dispersed outside the HVAC system during the cleaning process.
- B. Particulate Collection: Where the Particulate Collection Equipment is exhausting inside the building, HEPA filtration with 99.97% collection efficiency for 0.3-micron size (or greater) particles shall be used. When the Particulate Collection Equipment is exhausting outside the building, Mechanical Cleaning operations shall be undertaken only with Particulate Collection Equipment in place, including adequate filtration to contain Debris removed from the HVAC system. When the Particulate Collection Equipment is exhausting outside the building, precautions shall be taken to locate the equipment down wind and away from all air intakes and other points of entry into the building.
- C. Controlling Odors: Measures shall be employed to control odors and/or mist vapors during the cleaning process.
- D. Component Cleaning: Cleaning methods shall be employed such that all HVAC system components must be Visibly Clean as defined in applicable standards (see NADCA Standards). Upon completion, all components must be returned to those settings recorded just prior to cleaning operations.
- E. Air-Volume Control Devices: Dampers and any air-directional mechanical devices inside the HVAC system must have their position marked prior to cleaning and, upon completion, must be restored to their marked position.
- F. Service Openings: The contractor shall utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry, and inspection.
 - 1. Contractor shall utilize the existing service openings already installed in the HVAC system where possible.
 - 2. Other openings shall be created where needed and they must be created so they can be sealed in accordance with industry codes and standards.
 - 3. Closures must not significantly hinder, restrict, or alter the airflow within the system.
 - 4. Closures must be properly insulated to prevent heat loss/gain or condensation on surfaces within the system.
 - 5. Openings must not compromise the structural integrity of the system.
 - 6. Construction techniques used in the creation of openings should conform to requirements of applicable building and fire codes, and applicable NFPA, SMACNA and NADCA Standards.
 - 9. All service openings capable of being re-opened for future inspection or remediation shall be clearly marked and shall have their location reported to the

Owner in project report documents.

- G. Ceiling sections (tile): The contractor may remove and reinstall ceiling sections to gain access to HVAC systems during the cleaning process.
- H. Air distribution devices (registers, grilles & diffusers): The contractor shall clean all air distribution devices.
- J. Duct Systems. Contractor shall:
 - 1. Create service openings in the system as necessary in order to accommodate cleaning of otherwise inaccessible areas.
 - 2. Mechanically clean all duct systems to remove all visible contaminants, such that the systems are capable of passing Cleaning Verification Tests (see NADCA Standards).

2.04 HEALTH AND SAFETY

- A. Safety Standards: Cleaning contractors shall comply with applicable federal, state, and local requirements for protecting the safety of the contractor's employees, building occupants, and the environment. In particular, all applicable standards of the Occupational Safety and Health Administration (OSHA) shall be followed when working in accordance with this specification.
- B. Occupant Safety: No processes or materials shall be employed in such a manner that they will introduce additional hazards into occupied spaces.
- C. Disposal of Debris: All Debris removed from the HVAC System shall be disposed of in accordance with applicable federal, state and local requirements.

2.05 MECHANICAL CLEANING METHODOLOGY

- A. Source Removal Cleaning Methods: The HVAC system shall be cleaned using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. It is the contractor's responsibility to select Source Removal methods that will render the HVAC system Visibly Clean and capable of passing cleaning verification methods (See applicable NADCA Standards) and other specified tests, in accordance with all general requirements. No cleaning method, or combination of methods, shall be used which could potentially damage components of the HVAC system or negatively alter the integrity of the system.
 - 1. All methods used shall incorporate the use of vacuum collection devices that are operated continuously during cleaning. A vacuum device shall be connected to the downstream end of the section being cleaned through a predetermined opening. The vacuum collection device must be of sufficient power to render all areas being cleaned under negative pressure, such that containment of debris and the protection of the indoor environment are assured.
 - 2. All vacuum devices exhausting air inside the building shall be equipped with HEPA filters (minimum efficiency), including hand-held vacuums and wet-vacuums.

3. All vacuum devices exhausting air outside the facility shall be equipped with Particulate Collection including adequate filtration to contain Debris removed from the HVAC system. Such devices shall exhaust in a manner that will not allow contaminants to re-enter the facility. Release of debris outdoors must not violate any outdoor environmental standards, codes or regulations.
 4. All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods will include those, which will not potentially damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork or system components.
- B. Antimicrobial Agents and Coatings
1. Antimicrobial agents shall be applied if and only if active fungal growth is reasonably suspected, or where unacceptable levels of fungal contamination have been verified through testing.
 2. Application of any antimicrobial agents used to control the growth of fungal or bacteriological contaminants shall be performed after the removal of surface deposits and debris.
 3. When used, antimicrobial treatments and coatings shall be applied in strict accordance with the manufacturer's written recommendations and EPA registration listing.
 4. Antimicrobial coatings shall be applied according to the manufacturer's written instructions. Coatings shall be sprayed directly onto interior ductwork surfaces, rather than "fogged" downstream onto surfaces.

2.06 CLEANLINESS VERIFICATION

- A. General: Verification of HVAC System cleanliness will be determined after mechanical cleaning and before the application of any treatment or introduction of any treatment-related substance to the HVAC system, including biocidal agents and coatings.
- B. Visual Inspection: The HVAC system shall be inspected visually to ensure that no visible contaminants are present.
1. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean; however, the Owner reserves the right to further verify system cleanliness through Surface Comparison Testing or the NADCA vacuum test specified in the NADCA standards.
 2. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.
 3. NADCA vacuum test analysis should be performed by a qualified third party experienced in testing of this nature.
- C. Verification of Coil Cleaning
1. Cleaning must restore the coil pressure drop to within 10 percent of the pressure

drop measured when the coil was first installed. If the original pressure drop is not known, the coil will be considered clean only if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection (see NADCA Standards).

2.07 PRE-EXISTING SYSTEM DAMAGE

- A. Contractor is not responsible for problems resulting from prior inappropriate or careless cleaning techniques of others. Notify Owner and Architect/Engineer in writing upon discovery of existing system damage.

2.08 POST-PROJECT REPORT

- B. At the conclusion of the project, the Contractor shall provide a report to the Owner indicating the following:
 - 1. Success of the cleaning project, as verified through visual inspection and/or gravimetric analysis.
 - 2. Areas of the system found to be damaged and/or in need of repair.

END OF SECTION

SECTION 23 33 00 – AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Branch duct take-off fittings.
2. Back-draft dampers.
3. Combination fire-and-smoke dampers.
4. Dynamic fire dampers – curtain blade type.
5. Dynamic fire dampers – multi-blade type.
6. Dynamic fire dampers – true round type
7. Ceiling radiation fire dampers.
8. Smoke dampers.
9. Manual volume balancing dampers.
10. Flexible duct connectors.
11. Duct access doors.
12. Duct test holes.

B. Related Sections:

1. Section 23 09 23 – Direct-Digital Control System for HVAC: Execution and Product requirements for connection and control of Smoke Dampers and Control Dampers for placement by this section.
2. Section 23 31 00 – HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.
3. Section 26 05 03 – Equipment Wiring Connections: Execution requirements for connection of electrical Combination Smoke and Fire Dampers specified by this section.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 – Test Methods for Louvers, Dampers, and Shutters.

B. National Fire Protection Association:

1. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems.
- C. Sheet Metal and Air Conditioning Contractors:
1. SMACNA – HVAC Duct Construction Standard - Metal and Flexible.
 2. SMACNA – Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems.
- D. Underwriters Laboratories Inc.:
1. UL 555 – Standard for Safety for Fire Dampers.
 2. UL 555C – Standard for Safety for Ceiling Dampers.
 3. UL 555S – Standard for Safety for Smoke Dampers.

1.03 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.
- C. Product Data: Submit data for shop fabricated assemblies and hardware used.
- D. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
1. Air device take-offs.
 2. Fire dampers including locations and ratings.
 3. Smoke dampers including locations and ratings.
 4. Combination fire and smoke dampers including locations and ratings.
 5. Ceiling radiation fire dampers including locations and ratings.
 6. Backdraft dampers.
 7. Flexible duct connectors.
 8. Volume control dampers.
 9. Duct access doors.
- E. Product Data: For fire dampers, smoke dampers, combination fire and smoke dampers, and ceiling radiation fire dampers submit the following:
1. Include UL ratings, dynamic ratings, leakage, pressure drop and maximum pressure data.

2. Indicate materials, construction, dimensions, and installation details.
3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.
4. Manufacturer's Installation Instructions: Submit for each damper type.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of access doors and test holes.
- C. Operation and Maintenance Data: Submit for Combination Smoke and Fire Dampers.

1.05 QUALITY ASSURANCE

- A. Dampers tested, rated and labeled in accordance with the latest UL requirements.
- B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 – Product Requirements: Product storage and handling requirements.
- B. Protect dampers from damage to operating linkages and blades.
- C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
- D. Storage: Store materials in a dry area indoor, protected from damage. Products on site, but not yet installed shall be stored in boxes. The open airside ends of installed equipment shall be plastic wrapped during construction.
- E. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.09 COORDINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.
- B. Coordinate Work where appropriate with building control Work.

1.10 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.

1.11 EXTRA MATERIALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two fire damper fusible links of each size and type.

PART 2 PRODUCTS

2.01 BRANCH DUCT TAKE-OFF FITTINGS

- A. Provide all branch duct take-off fittings with construction that is suitable for the duct pressure class as scheduled in section 23 31 00, HVAC Ducts and Casings. Fittings shall be minimum 24-gauge galvanized sheet metal. If trunk ductwork is fabricated from aluminum or stainless steel, takeoffs shall be manufactured from same material.
- B. All branch duct take-off fittings serving air devices shall be provided with a manual volume damper equal to Flexmaster model BO3 with 3/8" aluminum square shaft secured to damper blade with U-bolts, nylon bushings, locking quadrant and 2-inch build out for insulation. (The 2-inch build out is not required on uninsulated ductwork.)
- C. All branch duct take-off fittings serving terminal units shall be provided without a volume damper.
- D. Branch duct take-offs from rectangular ductwork: Fittings shall be constructed for up to 4" w.g pressure rating, with all seams sealed. Connection to trunk duct shall be rectangular in shape with a 45° entry and shall have 1-inch flanges with double-sided adhesive gasket. Transition from rectangular to round branch shall be in an eccentric and tapered configuration. Take-off fittings shall be equal to Flexmaster model STO.
- E. Optional branch duct take-offs from rectangular ductwork: Fittings shall be constructed for up to 4" w.g pressure rating, with all seams sealed. Connection to trunk duct shall be round in shape with a conical entry and shall have 1-inch flanges with double-sided adhesive gasket. Take-off fittings shall be equal to Flexmaster model CB-SOG.
- F. Branch duct take-offs from round ductwork: Provide saddle tap take-off fitting for spiral duct sizes up to 24" diameter. Fitting shall have rectangular to round outlet and constructed for up to 4" w.g. pressure rating. Fitting shall transition from rectangular to round in an eccentric and tapered configuration. Fitting shall be equal to Flexmaster model STO-ST 90° or model STO-ST 45°.
- G. Branch duct take-offs from round ductwork with duct pressure class exceeding 4" w.g.: Fitting shall be designed to be low loss and have contoured saddle tap for connection to either a flat oval or round duct as indicated on the drawings. The fitting outlet shall transition to round duct. Fitting shall be a United McGill Model "SADDLE LO-LOSS TEE TAP" or equal.

2.02 BACK-DRAFT DAMPERS

- A. Extruded aluminum multi-blade, back-draft dampers: Parallel-action, gravity-balanced,

with adjustable counterbalance weights to permit setting for varying differential static pressure.

B. Ratings:

1. Leakage: Dampers shall have a maximum leakage of 15 CFM at 1 in. W.G., tested in accordance with AMCA standard 500-D.
2. Differential Pressure: Dampers shall have a maximum differential pressure rating of 2.5 in. W.G.
3. Velocity: Dampers shall have a maximum velocity rating of 2000 FPM.

C. Construction:

1. Frame: 0.063 in. extruded aluminum.
2. Blades: .050 in. extruded aluminum.
3. Seals: Blade edge seals shall be vinyl, mechanically fastened to each blade.
4. Linkage: On blade, plated steel material.
5. Axles: Aluminum.
6. Bearings: Axle bearings shall be synthetic polycarbonate sleeve.
7. Finish: Mill finish.

2.03 COMBINATION FIRE AND SMOKE DAMPERS

- A. Fabricate in accordance with NFPA 90A, UL 555, and UL 555S.
- B. Fire Resistance: 1-1/2 hour or 3 hour as required. Refer to the Architectural Life Safety drawing for wall, partition and floor ratings.
- C. Leakage Rating: Class I, maximum of 8 CFM at 4 in. W.G. differential pressure, and 11 CFM at 8 in. W.G. differential pressure.
- D. Damper Temperature Rating: 250 degrees F.
- E. Damper Velocity and Pressure Rating:
 1. Single skin blades: 2000 fpm at 6 in. WG.
 2. Double skin airfoil blades: 3000 fpm at 4 in. WG.
- F. Frame: 16 gauge, galvanized steel.
- G. Blades:
 1. Style: Single skin with 3 longitudinal grooves or airfoil-shaped, single piece, double skin.
 2. Action: Opposed.

3. Orientation: Horizontal.
 4. Material: Galvanized steel, minimum 16 gauge for single skin blades or 14 gauge equivalent thickness for double skin blades.
 5. Width: Maximum 6 inches.
- H. Bearings: Stainless steel pressed into frame.
- I. Seals: Silicone blade edge seals and flexible stainless steel jamb seals.
- J. Linkage: Concealed in frame.
- K. Actuator:
1. Type: Electric 120 volt, 60 hertz, two-position, fail close.
 2. Mounting: External.
 3. Actuator shall be installed by the damper manufacturer at time of fabrication.
- L. Release Device: Electric heat responsive device that causes actuator's spring return mechanism to close damper when temperature setting is reached. Device shall be manually resettable. Release temperature shall be 165 degrees F (or approximately 50 degrees F. above normal temperature within duct system).
- M. Damper Mounting: Vertical or horizontal as indicated on Drawings.
- N. Finish: Mill galvanized.
- O. Factory-installed sleeve: Furnish silicone caulk factory applied to sleeve at damper frame to comply with leakage rating requirements.
- P. Provide factory-assembled multiple section dampers where required sizes exceed maximum single section damper size.

2.04 DYNAMIC FIRE DAMPERS – CURTAIN BLADE TYPE

- A. Fabricate in accordance with NFPA 90A and UL 555.
- B. Fire Resistance: 1-1/2 hour or 3 hour as required. Refer to the Architectural Life Safety drawing for wall, partition and floor ratings.
- C. Dynamic Closure Rating: Dampers classified for dynamic closure to 2000 fpm and 4 inches wg static pressure.
- D. Construction:
1. Integral Sleeve Frame: Roll formed galvanized steel, in gauge required by UL listing.
 2. Blades:
 - a. Style: Curtain type
 - b. Action: Spring or gravity closure upon fusible link release.

- c. Material: Roll formed, galvanized steel, in gauge required by UL listing.
- 3. Closure Springs: Stainless steel, constant force type.
- E. Fusible Link Release Temperature: 165 degrees F.
- F. Mounting: Vertical or horizontal as indicated on Drawings.
- G. Duct Transition Connection, for Curtain Damper Style:
 - 1. B style - rectangular connection, blades out of air stream, high free area.
 - 2. CR style - round connection, blades out of air stream, sealed.
 - 3. CO style - oval connection, blades out of air stream, sealed.
 - 4. Style A Grille Mount - Out of wall damper for use at sidewall grilles, blades in air stream; 1-1/2 hour UL555 rated.
- H. Finish: Mill galvanized.
- I. Provide factory-assembled multiple section dampers where required sizes exceed maximum single section damper size.

2.05 DYNAMIC FIRE DAMPERS – MULTI-BLADE TYPE

- A. Fabricate in accordance with NFPA 90A and UL 555.
- B. Fire Resistance: 1-1/2 hour or 3 hour as required. Refer to the Architectural Life Safety drawing for wall, partition and floor ratings.
- C. Damper Temperature Rating: 250 degrees F.
- D. Damper Velocity Rating: 4000 fpm for sizes up to 32 in. x 50 in.; 2000 fpm for larger sizes.
- E. Damper Pressure Rating: 8 in. WG.
- F. Frame: 16 gauge, galvanized steel.
- G. Blades:
 - 1. Style: Single skin with 3 longitudinal grooves or airfoil-shaped, single piece, double skin.
 - 2. Action: Opposed.
 - 3. Orientation: Horizontal.
 - 4. Material: Galvanized steel, minimum 16 gauge for single skin blades or 14 gauge equivalent thickness for double skin blades.
 - 5. Width: Maximum 6 inches.
- H. Bearings: Stainless steel pressed into frame.
- I. Seals: stainless steel jamb seals.

- J. Linkage: Concealed in frame.
- K. Fusible Link Release Temperature: 165 degrees F.
- L. Damper Mounting: Vertical or horizontal as indicated on Drawings.
- M. Finish: Mill galvanized.
- N. Factory-installed sleeve: Furnish silicone caulk factory applied to sleeve at damper frame to comply with leakage rating requirements.
- O. Provide factory-assembled multiple section dampers where required sizes exceed maximum single section damper size.

2.06 DYNAMIC FIRE DAMPERS – TRUE ROUND TYPE

- A. Fabricate in accordance with NFPA 90A and UL 555.
- B. Fire Resistance: 1-1/2 hour. Refer to the Architectural Life Safety drawing for wall, partition and floor ratings.
- C. Dynamic Closure Rating: Dampers classified for dynamic closure to 2000 fpm and 4 inches wg static pressure.
- D. Leakage: Dampers shall have a UL555S leakage rating of Class I at differential pressure rating of 4 inches wg.
- E. Construction:
 - 1. Frame and Sleeve: The damper frame and sleeve shall be of one piece design, made with 20 ga. galvanized steel and a groove for added strength.
 - 2. Blades: Double skin, minimum 14 ga. equivalent thickness, galvanized steel.
 - 3. Axles: Minimum ½ inch dia. plated steel.
 - 4. Bearings: Minimum ½ inch dia. plated steel.
 - 5. Fire Closure Device: Dampers shall be supplied with fusible link.
 - 6. Mounting: Vertical or horizontal, as detailed on drawings
 - 7. Retaining Plates: Single or two, as detailed on drawings.
 - 8. Finish: Galvanized steel

2.07 CEILING RADIATION FIRE DAMPERS

- A. Fire Rating: UL 555C classified and labeled as a 1-1/2 hour ceiling damper.
- B. Air Flow Rating: UL approved for dual directional air flow.
- C. Frame: Minimum 3 inches by minimum 20 gauge galvanized steel with roll formed ridge for blade stop.
- D. Blades:

1. Style: Two-piece, single-thickness with blade insulation, hinged in center, and held open with fusible link.
 2. Action: Butterfly.
 3. Orientation: Horizontal.
 4. Material: Minimum 20 gauge galvanized steel.
- E. Hinge: Spring stainless steel, mechanically attached to blades.
- F. Mounting: Horizontal.
- G. Temperature Release Device: Fusible link, 165 degrees F.
- H. Finish: Mill galvanized.
- I. Performance Data:
1. Pressure Drop: Maximum 0.1 inches W.G. at 500 FPM across 18 x 18 inch damper.
- J. Fusible Volume Adjust: UL classified.
- K. Extended Frame:
1. Rectangular Dampers: 8 inches.
 2. Round Dampers: 8-1/2 inches.
- L. Thermal Blanket: Provide ceramic fiber type.

2.08 SMOKE DAMPERS

- A. Fabricate in accordance with NFPA 90A and UL 555S.
- B. Leakage Rating: Class I, maximum of 8 CFM at 4 in. WG differential pressure, and 11 CFM at 8 in. W.G. differential pressure.
- C. Damper Temperature Rating: 250 degrees F.
- D. Frame: 16 gauge, galvanized steel.
- E. Damper Velocity and Pressure Rating:
1. Single skin blades: 2000 fpm at 6 in. W.G.
 2. Double skin airfoil blades: 3000 fpm at 4 in. W.G.
- F. Blades:
1. Style: Single skin with 3 longitudinal grooves or airfoil-shaped, single piece, double skin.

2. Action: Opposed.
 3. Orientation: Horizontal.
 4. Material: Galvanized steel, minimum 16 gauge for single skin blades or 14 gauge equivalent thickness for double skin blades.
 5. Width: Maximum 6 inches.
- G. Bearings: Stainless steel pressed into frame.
- H. Seals: Silicone blade edge seals and flexible stainless steel jamb seals.
- I. Linkage: Concealed in frame.
- J. Actuator:
1. Type: Electric 120 volt, 60 hertz, two-position, fail close.
 2. Mounting: External.
 3. Actuator shall be installed by the damper manufacturer at time of fabrication.
- K. Damper Mounting: Vertical or horizontal as indicated on Drawings.
- L. Finish: Mill galvanized.
- M. Provide factory-assembled multiple section dampers where required sizes exceed maximum single section damper size.

2.09 MANUAL VOLUME BALANCING DAMPERS

- A. Fabricate in accordance with current SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- B. Rectangular Dampers:
1. Single Blade Dampers: Duct sizes up to 36 inches in width. Blade dimension perpendicular to the axle rod shall be a maximum of 12 inches, for dimensions greater than 12 inches use a multi-blade damper. Furnish with 20 gauge galvanized steel blade, continuous axle rod and end bearings.
 2. Multi-Blade Damper: Fabricate of opposed blade pattern with a maximum blade size of 8 x 48 inches. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware. Blades shall be minimum 18 gauge galvanized steel and frame shall be minimum 16 gauge galvanized steel.
 3. End Bearings: Furnish for single and multiple blade dampers. On multiple blade dampers, furnish synthetic or bronze bearings.
 4. Quadrants:
 - a. Furnish locking, indicating quadrant regulators on dampers.
 - b. On insulated ducts mount quadrant regulators on standoff mounting

- brackets, bases, or adapters.
 - c. Where rod lengths exceed 30 inches furnish regulator at both ends.
- C. Round Dampers: Sleeve and blade shall be G90 galvanized steel construction, manufactured from 24 gauge or heavier material as required to meet SMACNA for commercial construction. Provide a continuous 3/8" square shaft secured to damper blade with u-bolt(s). Provide with nylon bearings, locking quadrant and 2-inch build out for insulation. Damper shall be Flexmaster Model SL with BO3 build out or equal.
- D. Concealed quadrant regulators:
 - 1. Manufacturers:
 - a. Young Regulator Co.
 - b. Metropolitan Air Technology.
 - c. Vent Fabrics.
 - d. Or equal.
 - 2. Locations: Provide on round and rectangular dampers in the following locations:
 - a. Where damper regulator is located above an inaccessible ceiling (i.e. gypsum board) and a ceiling access door is not provided.
 - b. Where the quadrant regulator is remote and is not accessible via a ceiling access door or by removal of a lay-in ceiling panel.
 - c. As indicated on the drawing.
 - 3. Flexible Cable Type Regulator:
 - a. Regulator shall consist of a remote cable control system with 1/4" rotary motion flexible steel shaft for control of round and rectangular dampers.
 - b. Provide with mounting controls, ceiling cup and hardware as required for installation of control mechanism in gypsum board ceiling, unless indicated on the drawings for the control mechanism(s) to terminate at a central control station.

2.10 FLEXIBLE DUCT CONNECTORS

- A. Fabricate in accordance with current SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- B. Connector: Fabric crimped into metal edging strip.
 - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
 - 2. Net Fabric Width: Approximately 3 inches wide.
 - 3. Metal: 3 inch wide, 24 gauge galvanized steel.

2.11 DUCT ACCESS DOORS

- A. Access doors for rectangular, round and oval ductwork shall be Ductmate model Sandwich Access Doors or equal.
- B. Fabrication: Sandwich-style insulated access door.

1. Panels: The insulated sandwich access door shall consist of three layers of precision stamped steel. The inside panel shall consist of two layers of metal which are spot welded together along the rim encapsulating high density fiberglass insulation with Ecosse Technology UL classified FHC25/50.
2. Gasket: Closed-cell neoprene gasket UL94HF1 listed with a service temperature range of (ASTM D746) -20 degrees F to 200 degrees F. The gasket shall be bonded to the inside of the door.
3. Springs: Zinc-plated conical springs shall be installed, between the inner and outer door, to facilitate opening.
4. Knobs: Polypropylene molded knobs shall have threaded metal inserts to eliminate thread stripping. Knobs shall be easily turned by hand. Knobs shall be UL94HB listed.
5. Bolts: Zinc plated carriage bolts are secured to inner door.
6. Template: Self-adhesive template shall be provided for the exact size of duct opening required.
7. Available Door sizes:
 - a. 8" x 4"
 - b. 10" x 6" (rectangular and oval duct only)
 - c. 12" x 8"
 - d. 16" x 12"
 - e. 18" x 14"
 - f. 24" x 18"
8. The sizes and location of the doors to be provided shall be as specified in Part 3 of this specification.

2.12 DUCT TEST HOLES

- A. Permanent Test Holes: Factory fabricated, air-tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.
- B. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.
- B. Verify fire and smoke rated walls are ready for damper installation.
- C. Verify ducts and equipment installation is ready for accessories.
- D. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.02 INSTALLATION

- A. Install in accordance with NFPA 90A and follow current SMACNA HVAC Duct Construction Standards – Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.
- B. Install back-draft dampers on exhaust ducts nearest to the outside and where indicated on Drawings.
 - 1. Adjust back-draft damper counterbalance weights to open damper with minimal differential pressure.
- C. Access Doors: Install access doors at the following locations and as indicated on Drawings:
 - 1. Spaced every 20 feet of horizontal return air duct as required by NFPA 90A.
 - 2. Upstream of each duct mounted filter.
 - 3. Upstream of each duct mounted coil.
 - 4. At each automatic control damper.
 - 5. At each backdraft damper.
 - a. Access door shall allow for access to adjust counterbalance weights.
 - 6. At each fire damper, smoke damper, combination fire smoke damper.
 - a. Access door shall allow for access to all components, provide additional doors as necessary.
 - b. Access doors shall be labeled, with minimum ½" high letters, to identify location and type of fire protection device within, in accordance with NFPA and the locally adopted mechanical code.
- D. Access Door Sizes: Provide the largest door, from the sizes herein specified, that the duct size as indicated on the drawing can accommodate.
- E. Install temporary duct test holes where indicated on Drawings and required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- F. Install permanent duct test holes where indicated on Drawings and required for testing and balancing purposes.
- G. Install all dampers at locations as indicated on Drawings.
 - 1. Install dampers square and free from racking with blades running horizontally.
 - 2. Do not compress or stretch damper frame into duct or opening.
 - 3. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jack shaft.

4. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.
5. Provide identification at each access door.
- H. Install fire dampers, smoke dampers and combination fire smoke dampers in accordance with manufacturer's UL approved instructions, applicable building and mechanical codes, NFPA 90A and SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems. Install with required perimeter retaining angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- I. Provide flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment.
- J. Provide balancing dampers where indicated on the drawings and as required for air balancing where branch ducts are taken from larger ducts at points on: constant volume supply air systems; supply air system downstream of air terminal units; return air systems and exhaust air systems.
- K. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

3.03 DEMONSTRATION

- A. Section 01 70 00 – Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate re-setting of fire and fire smoke dampers to Owner's representative.

END OF SECTION

SECTION 23 34 00 – HVAC FANS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Direct-drive ceiling mounted centrifugal exhaust fans.

B. Related Sections:

1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
2. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment: Roof curbs.
3. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment: Product requirements for resilient mountings and snubbers for fans for placement by this section.
4. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
5. Section 23 31 00 - HVAC Ducts and Casings: Product requirements for hangers for placement by this section.
6. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
7. Section 26 05 03 - Equipment Wiring Connections: Execution and product requirements for connecting equipment specified by this section.

1.02 REFERENCES

A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:

1. AMCA 99 - Standards Handbook.
2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test

Data.

- C. American National Standards Institute:
 - 1. ANSI S1.4 – Specifications for Sound Level Meters
- D. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
 - 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. Underwriters Laboratories Inc.:
 - 1. UL 705 - Power Ventilators.

1.02 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.
- C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified design and maximum and minimum operating points plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity (measured in accordance with ANSI S1.4), electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Submit fan manufacturer's instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.03 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.04 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. UL Compliance: UL listed and labeled, designed, manufactured and tested in accordance with UL 705.
- D. Balance Quality: Conform to AMCA 204.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.

- B. Installer: Company specializing in performing Work of this section with minimum three years of documented experience.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect motors, shafts and bearings from weather and construction dust.

1.07 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.08 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish one-year manufacturer's warranty for fans.

1.09 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.

1.10 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two sets of belts for each fan.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Greenheck
- B. Cook

2.02 DIRECT DRIVE CEILING MOUNTED CENTRIFUGAL EXHAUST FANS

- A. General Description:
 - 1. Base fan performance at standard conditions (density 0.075 Lb/ft³)
 - 2. Maximum. operating temperatures is 130 Fahrenheit.
 - 3. UL listed
 - 4. Each fan shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number.
- B. Wheel:

1. Forward curved centrifugal wheel.
2. Constructed of galvanized steel or calcium carbonate filled polypropylene .
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05.

C. Motors:

1. Motor enclosures shall be open driproof (ODP), opening in the frame body and or end brackets.
2. Motors are permanently lubricated sleeve bearing type to match with the fan load and furnished at the specific voltage and phase.
3. Motor shall be mounted on vibration isolators and be accessible for maintenance.
4. Thermal overload protection.

D. Housing:

1. Constructed of heavy gauge galvanized steel.
2. Interior shall be lined with 0.5 inches of acoustical insulation.

E. Spring Loaded Aluminum Backdraft Damper:.

F. Outlet:

1. Type of outlet: Square or Round
2. Field rotatable from horizontal to vertical discharge.
3. Duct collar shall include an aluminum backdraft damper.

G. Grille:

1. Types: Aluminum
2. Constructed of aluminum.

H. Mounting Brackets:

1. Fully adjustable for multiple installation conditions.

I. Options/Accessories:

1. Disconnect Switches:
 - a. NEMA rated: 1
 - b. Positive electrical shut-off.
 - c. Wired from fan motor to junction box installed within motor compartment.
 - d. Access for wiring shall be external.

2. Motion Detectors:
 - a. Mounted Location: Grille
 - b. Infrared motion detector shall automatically turn on the fan when there is a change in temperature.
 - c. Viewing area of 180 degrees.
 - d. Adjustable time delay shutoff setting of 1 to 20 minutes.
3. Speed Controls:
 - a. Fan can be adjusted to 60 percent of full speed
4. Flat Roof Caps:
 - a. Type: Model GRS
 - b. Aluminum exterior construction.
 - c. Galvanized steel internal supports.
 - d. Integral birdscreen.
 - e. Built in curb cap.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

3.02 INSTALLATION

- A. Install fans in accordance with manufacturer's instructions.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer's field services.
- B. Instruct Owner on operation and maintenance.

3.04 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean as recommended by manufacturer. Do not use material or methods which may damage finish surface or surrounding construction.
- C. Vacuum face of fan grille and inside of fan cabinet.

3.05 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate fan operation and maintenance procedures.

3.06 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Do not operate fans until ductwork is clean and fan has been test run under observation.

3.07 SCHEDULES

- A. See plans.

END OF SECTION

SECTION 23 37 00 – AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Indoor air devices.
 - 2. Roof hoods.
- B. Related Sections:
 - 1. Section 08 91 00 – Louvers: Wall Louvers.
 - 2. Section 09 90 00 – Painting and Coating: Execution and product requirements for Painting of ductwork visible behind outlets and inlets specified by this section.
 - 3. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment: Roof curbs.
 - 4. Section 23 31 00 – HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.
 - 5. Section 23 33 00 – Air Duct Accessories: Volume dampers for inlets and outlets.

1.02 REFERENCES

- A. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500 – Test Methods for Louvers, Dampers, and Shutters.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 70 – Method of Testing for Rating the Performance of Air Outlets and Inlets.
- C. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA – HVAC Duct Construction Standard – Metal and Flexible.

1.03 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures: Submittal procedures.
- B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- C. Test Reports: Rating of air outlet and inlet performance.
- D. Submit manufacturer's installation instructions under provisions of Section 01 33 00 –

Submittal Procedures.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of air outlets and inlets.

1.05 QUALITY ASSURANCE

- A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.
- B. Test and rate louver performance in accordance with AMCA 500.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.07 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.

1.08 EXTRA MATERIALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Titus.
- B. E.H. Price Company.
- C. Krueger.
- D. Nailor Industries, Inc.
- E. Greenheck.
- F. Metalaire.
- G. Substitutions: Section 01 60 00 – Product Requirements.

2.02 INDOOR AIR DEVICES – As Scheduled.

2.03 ROOF HOODS – As Scheduled.

- A. As Scheduled.

- B. Roof Curb: Provide curb to match dimensions of hood throat. Refer to Section 23 05 29 for curb requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.
- B. Verify inlet and outlet locations.
- C. Verify ceiling and wall systems are ready for installation.

3.02 INSTALLATION

- A. Install diffusers to ductwork with airtight connection.
- B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly. Refer to Section 23 33 00.
- C. Paint visible portion of ductwork behind air outlets and inlets matte black. Refer to Section 09 90 00.
- D. Install items in accordance with manufacturer's instructions.
- E. Insulate tops of all supply ceiling diffusers with min R-6 flexible duct insulation with vapor barrier.
- F. Install return and exhaust register with blades to minimize sight through outlets or inlets.
- G. Transfer Grilles: Provide two grilles, one on each side of wall with connecting sheetmetal collar.
- H. Transfer Ducts: Provide two grilles, one on each end of duct where ducted into space.
- I. Locations of air distribution devices on Drawings are approximate and shall be coordinated with other trades to make symmetrical pattern and shall be influenced by the established general pattern of the lighting fixtures or architectural reflected ceiling plan, but primarily located to maintain proper air distribution.
- J. Provide all specialties and frames for air distribution devices as required for proper installation in ceiling type as indicated on the architectural drawings. Provide all cutting and patching of T-bars, gypsum board, and other ceilings systems as required for installation of air devices.
- K. Install curbs per Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.
- L. Install supply and return devices with a minimum of 24" separation.
- M. Integral OBDs shall be installed fully open and only adjusted if tap tampers are

inaccessible or it is necessary for balancing.

3.03 INTERFACE WITH OTHER PRODUCTS

- A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.04 SCHEDULES – See Drawings.

END OF SECTION

SECTION 23 40 00 – HVAC AIR CLEANING DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Disposable, extended area panel filters.
2. Short-depth, high-efficiency media filters.
3. Filter frames and housings.
4. Filter gauges.

B. Related Sections:

1. Section 23 81 03 – Packaged Rooftop Air Conditioning Units – Up to 25 Tons.
2. Section 23 81 26 – Split-System Air Conditioners and Heat Pumps.

1.02 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. AHRI 850 - Commercial and Industrial Air Filter Equipment.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

C. Underwriters Laboratories Inc.:

1. UL 900 - Air Filter Units.

1.03 PERFORMANCE REQUIREMENTS

A. Conform to AHRI 850 Section 7.4.

B. Dust Spot Efficiency: Plus or minus 5 percent.

1.04 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate filter assembly and filter frames, dimensions, motor locations, and electrical characteristics and connection requirements.

C. Product Data: Submit data on filter media, filter performance data, dimensions, and electrical characteristics.

D. Manufacturer's Installation Instructions: Submit assembly and change-out procedures.

- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.05 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions for operation, changing and periodic cleaning.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years of documented experience.

1.07 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

1.08 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two sets of filters for each filter bank.

PART 2 PRODUCTS

2.01 DISPOSABLE, EXTENDED AREA PANEL FILTERS

- A. Media: UL 900 Class 2, pleated, lofted, non-woven, reinforced cotton and synthetic fabric supported and bonded to welded wire grid.
 - 1. Frame: Water-resistant cardboard.
 - 2. Nominal thickness: 2 inches.
- B. Rating, ASHRAE 52.2:
 - 1. Minimum efficiency rating value: MERV 8.
 - 2. Arrestance value: >90 percent.
 - 3. Initial resistance at 500 fpm face velocity: 0.31 inch.
 - 4. Recommended final resistance: 1.0 inch w.g.
 - 5. Maximum continuous operating temperature: 200 degrees F.

2.02 SHORT-DEPTH, HIGH-EFFICIENCY MEDIA FILTERS

- A. Media: UL 900 Class 2, synthetic fiber pleated media with welded wire support and kraft board enclosing frame.
 - 1. Thickness: 2 inch.
- B. Performance Rating, ASHRAE 52.2:
 - 1. Minimum efficiency rating value: MERV 13.
 - 2. Arrestance value: >98 percent.
 - 3. Initial Resistance at 500 fpm face velocity: 0.41 inch w.g.
 - 4. Recommended Final Resistance: 1.0 inches w.g.

2.03 FILTER FRAMES AND HOUSINGS

- A. General: Fabricate filter frames and supporting structures of 16 gauge galvanized steel or extruded aluminum T-section construction with necessary gaskets between frames and walls.
- B. Filter housing shall be provided with air-handler units.

PART 3 EXECUTION

3.01 INSTALLATION

- C. Install air cleaning devices in accordance with manufacturer's instructions.
- D. Install filters with felt, rubber or neoprene gaskets to prevent passage of unfiltered air around filters.
- E. Provide temporary filters for system start-up. Install filter media over all return air duct openings when fans are operated during construction activities. Do not operate fan system until temporary or permanent filters are in place. Replace temporary filters used during construction and testing, with clean set.

3.02 SCHEDULES

- A. Refer to Equipment Schedules.

END OF SECTION

SECTION 23 81 03 – PACKAGED ROOFTOP AIR CONDITIONING UNITS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Packaged rooftop air conditioning units.
2. Condensate drain piping.

B. Related Sections:

1. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment: Requirements for roof curbs provided with equipment.
2. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment: Vibration isolators.
3. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
4. Section 22 17 00 - Facility Natural-Gas Piping: Natural gas piping connections.
5. Section 23 33 00 - Air Duct Accessories: Flexible connections.
6. Section 26 05 03 - Equipment Wiring Connections: Electrical connection to units.

1.02 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. AHRI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. AHRI 270 - Sound Rating of Outdoor Unitary Equipment.
3. AHRI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.

B. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
2. ASHRAE 62 - Ventilation for Acceptable Indoor Air Quality.
3. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

- D. ASTM International:
 - 1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- E. International Code Council:
 - 1. International Energy Conservation Code.
 - 2. International Mechanical Code
- F. National Fire Protection Association:
 - 1. NFPA 54 - National Fuel Gas Code.
 - 2. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.03 DEFINITIONS

- A. Energy Efficiency Ratio (EER) - Ratio of net cooling capacity in Btuh to total rate of electric input in watts under designated operating conditions.
- B. Seasonal Energy Efficiency Ratio (SEER) - Total cooling output of an air conditioner during its normal annual usage period for cooling (in Btu) divided by total electric energy input during the same period (in Wh).

1.04 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data indicating:
 - 1. Cooling and heating capacities.
 - 2. Dimensions.
 - 3. Weights.
 - 4. Rough-in connections and connection requirements.
 - 5. Duct connections.
 - 6. Electrical requirements with electrical characteristics and connection requirements.
 - 7. Controls.
 - 8. Accessories.
 - 9. Sound data – provide unweighted sound power levels for each octave band between 63Hz and 4000Hz.
- C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

1.05 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of controls installed remotely from units.
- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.06 QUALITY ASSURANCE

- A. Cooling Capacity: Rate in accordance with AHRI 210/240 and AHRI 340/360.
- B. Sound Rating: Measure in accordance with AHRI 270.
- C. Insulation and adhesives: Meet requirements of NFPA 90A.
- D. Performance Requirements: Conform to minimum EER and SEER prescribed by the International Energy Conservation Code or ASHRAE 90.1 when tested in accordance with AHRI 210/240 and AHRI 340/360.
- E. Outside Air Damper Leakage: Test in accordance with AMCA 500.

1.07 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept units on site. Inspect for damage.
- C. Protect units from damage by storing off roof until roof mounting curbs are in place.

1.09 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate installation of roof curbs with roof structure, roof deck and roof membrane installation.

1.10 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer's parts and labor warranty including controls and

refrigerant loss.

1.11 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Maintenance service.

1.12 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish one set of spare filters and fan belts for each unit.

PART 2 PRODUCTS

2.01 PACKAGED ROOFTOP AIR CONDITIONING UNITS

- A. Acceptable Manufacturers:
 - 1. Carrier Corp.
 - 2. Lennox International
 - 3. Daikin Applied
 - 4. Johnson Controls, Inc.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Self-contained, packaged, factory assembled and wired, consisting of roof curb, cabinet, supply fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, heating section as scheduled in the Drawings, air filters, mixed air casing, controls, and accessories.
- C. Configuration: Downflow or horizontal air delivery as indicated on Drawings.
- D. Roof Mounting Curb: curb to be provided with equipment; refer to Section 23 05 29 for curb requirements.
- E. Cabinet:
 - 1. Designed for outdoor installation with weatherproof construction.
 - 2. Panels: Constructed of galvanized steel with baked enamel finish meeting salt spray test in accordance with ASTM B117. Furnish access doors or removable access panels.
 - 3. Insulation: Factory applied to exposed vertical and horizontal panels. Provide aluminum foil faced glass fiber with edges protected from erosion or closed cell foam, with a minimum total thermal resistance value of R-4.
- F. Supply Fan: Centrifugal type, resiliently mounted with direct drive or V-belt drive high efficiency motor, as scheduled. Motor permanently lubricated with built-in thermal

overload protection.

- G. Evaporator Coil: Constructed of copper tubes expanded onto aluminum fins. Stainless steel drain pan with piping connection. Factory leak tested under water.
- H. Hot-Gas Reheat Coil: Provide hot-gas reheat coil, piping and valves to provide humidity control, where scheduled in the Drawings.
- I. Compressor: Hermetically sealed, resiliently mounted with positive lubrication, and internal motor overload protection. Furnish internal vibration isolators and short cycle protection. Provide capacity control as scheduled in the Drawings.
- J. Refrigeration circuit: Furnish the following for each circuit, thermal expansion valve, filter-drier, suction, discharge, and liquid line service valves with gauge ports, high and low pressure safety controls. Dehydrate and factory charge each circuit with oil and refrigerant.
- K. Condenser:
 - 1. Coil: Copper tube aluminum coil assembly or aluminum micro-channel assembly and galvanized steel hail guard. Factory leak tested under water.
 - 2. Condenser Fan: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Motor permanently lubricated with built-in thermal overload protection. Furnish high efficiency fan motors and fan guards
- L. Gas-Fired Heating Section:
 - 1. Fuel: Natural gas
 - 2. Heat Exchangers: Stainless steel, welded construction.
 - 3. Gas Burner: Induced draft type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shut-off pilot. Require unit fan operation before allowing gas valve to open.
- M. Air Filters: 2 inch thick glass fiber disposable media in metal frames. MERV 13 efficiency based on ASHRAE 52.2.
- N. Mixed Air Casing:
 - 1. Outside Air Damper Leakage: Maximum 3.0 cfm per square foot at 1.0 inches wg pressure differential.
 - 2. Outside Air Damper: 2-position motorized modulating damper with spring return and without actuator. Furnish rain hood with screen.
 - 3. Economizer: Provide factory installed fully modulating (0-100%) outside air and return air dampers. Provide barometric relief damper with powered exhaust, rain hood and screen.
- O. Controls:

1. Units shall be BACNET compatible and controlled as noted on the control sequences in the Drawings.
 2. Furnish control to provide low ambient cooling to 0 degrees F.
 3. Provide factory wired float switch in drain pan to de-energize unit when the primary condensate drain is clogged.
 4. Furnish terminal strip on unit for connection of operating controls to building management system.
 5. Thermostat: [7 day] programmable electronic space thermostat with [2] stage heating and [2] stage cooling with automatic changeover and heating setback and cooling setup capability. Furnish system selector switch with [off-heat-auto-cool] [fan control switch, auto-on] option.
- P. Accessories:
1. Convenience Receptacle: Provide factory installed, field wired 115 volt, 15 amp, GFCI type, internally mounted. Receptacle shall be separately wired from unit disconnect feed.
- Q. Capacity: See Schedule on Drawings.
- R. Electrical Characteristics and Components: In accordance with Section 26 05 03 and as scheduled.
1. Disconnect Switch: Factory mounted, non-fused type, interlocked with access door, accessible from outside unit, with power lockout capability.
 2. Electrical Connection: The unit shall have capability of single point power supply connection from below, up through the roof level.

2.02 CONDENSATE DRAIN PIPING

- A. Furnish and install condensate drain piping from each air conditioning unit as shown on the Drawings. Refer to section 23 05 29 for requirements for supports.
- B. Condensate drain piping shall be Type 'L' hard drawn copper piping with wrought copper fittings.
- C. Provide cleanout at each change of direction.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.02 INSTALLATION

- A. Roof Curb:
 - 1. Assemble roof curb.
 - 2. Install roof curb level.
 - 3. Coordinate curb installation and flashing with specified roofing system.
 - 4. Install units on roof curb providing watertight enclosure to protect ductwork and utility services.
 - 5. Install gasket material between unit base and roof curb.
- B. Connect units to supply and return ductwork with flexible connections. Refer to Section 23 33 00.
- C. Install condensate piping with trap and route from drain pan as shown on Drawings. Refer to Section 23 05 29 for supports.
- D. Install components furnished loose for field mounting.
- E. Install electrical devices furnished loose for field mounting.
- F. Install control wiring between unit and field installed accessories.
- G. Any panels permanently removed from units during installation shall be removed from roof and dispose off-site.

3.03 INSTALLATION - NATURAL GAS HEATING SECTION

- A. Connect natural gas piping in accordance with NFPA 54.
- B. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.
- C. Install the following piping accessories on natural gas piping connections as specified in Section 22 11 23.
- D. Install natural gas piping accessories above roof.

3.04 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish initial start-up for all rooftop units. Provide manufacturer's start-up report for each unit.
- C. Manufacturer's technician shall coordinate startup with controls contractor to verify that all controls are fully operational. Provide sign-off to this effect.
- D. Manufacturer's technician shall participate in one 8-hour session with Owner's Commissioning Authority to verify operation of units in accordance with design intent. This is in addition to Owner training, which should take place AFTER successful commissioning.

3.05 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean coils and inside of unit cabinet.
- C. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.06 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate unit operation and maintenance.
- C. Furnish services of manufacturer's technical representative for one (8) hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

END OF SECTION

SECTION 23 81 26 – SPLIT-SYSTEM AIR CONDITIONERS AND HEAT PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Air handling unit.
2. Outdoor heat pump units.
3. Condensate drain piping.

B. Related Sections:

1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for concrete foundations specified by this section.
2. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment: Vibration isolators.
3. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
4. Section 23 23 00 - Refrigerant Piping: Execution requirements for connection to refrigerant piping specified by this section.
5. Section 23 33 00 - Air Duct Accessories: Flexible connections.
6. Section 25 50 00 - Integrated Automation Facility Controls: Control systems remote from unit.
7. Section 26 05 03 - Equipment Wiring Connections: Electrical connection to units.

1.02 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. AHRI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. AHRI 270 - Sound Rating of Outdoor Unitary Equipment.
3. AHRI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
4. AHRI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ASTM International:
 1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- D. International Code Council:
 1. International Energy Conservation Code.
 2. Uniform Mechanical Code
- E. National Electrical Manufacturers Association:
 1. NEMA MG 1 - Motors and Generators.
- F. National Fire Protection Association:
 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures.
- B. Product Data: Submit data indicating:
 1. Cooling and heating capacities.
 2. Dimensions.
 3. Weights.
 4. Rough-in connections and connection requirements.
 5. Duct connections.
 6. Electrical requirements with electrical characteristics and connection requirements.
 7. Controls.
 8. Accessories.
- C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of controls installed remotely from units.

- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.05 QUALITY ASSURANCE

- A. Cooling Capacity: Rate in accordance with AHRI 210/240.
- B. Sound Rating: Measure in accordance with AHRI 270.
- C. Insulation and adhesives: Meet requirements of NFPA 90A.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing and protecting products.
- B. Accept units and components onsite in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- C. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.
- D. Protect units from weather and construction traffic by storing in dry, roofed location.

1.08 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate installation of condensing units and heat pumps with concrete pad.
- C. Coordinate installation of air handling units with building structure.

1.09 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish five year parts and labor warranty including controls and refrigerant loss for the entire system.

1.10 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.

1.11 MAINTENANCE MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.
- B. Furnish two sets of filters for each unit.

PART 2 PRODUCTS

2.01 SPLIT SYSTEM AIR CONDITIONERS AND HEAT PUMPS

- A. Manufacturers:
 - 1. Carrier Corp.
 - 2. Lennox International
 - 3. Daikin Applied
 - 4. The Trane Company
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Split system consisting of air handling unit and condensing unit or heat pump including cabinet, evaporator fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, electric heating coil, air filters, controls, air handling unit accessories, condensing unit accessories, and refrigeration specialties.

2.02 AIR HANDLING UNIT

- A. Configuration: As indicated on Drawings.
- B. Cabinet:
 - 1. Panels: Constructed of galvanized steel with baked enamel finish. Access Panels: Located for easy removal. Furnish with duct collars on outlet.
 - 2. Insulation: Factory applied to each surface to insulate entire cabinet. 1/2 inch thick aluminum foil faced glass fiber with edges protected from erosion.
- C. Evaporator Fan: Forward curved centrifugal type, resiliently mounted with drive as scheduled. Motor permanently lubricated with built-in thermal overload protection.
- D. Evaporator Coil: Constructed of copper tubes expanded onto aluminum fins. Galvanized drain pan, drain connection, and refrigerant piping connections.
- E. Refrigeration System: Single refrigeration circuit controlled by factory installed thermal expansion valve.
- F. Electric Heating Coil: Helical nickel-chrome resistance wire coil heating elements with refractory ceramic support bushings easily accessible with automatic reset thermal cut-out, built-in contactors and galvanized steel frame. Number of stages as indicated on Drawings. The heater shall fit inside the air handler unit's internal compartment, and have plug-in control wiring.

- G. Air Filters: 2 inch thick glass fiber disposable media in metal frames. 25 to 30 percent efficiency based on ASHRAE 52.1.
- H. Controls: Unit to be controlled as noted on control diagrams. Provide control circuit transformer and fuse if unit is provided with thermostat.

2.03 OUTDOOR HEAT PUMP UNITS

- A. General: Factory assembled and tested outdoor heat pump unit, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.
- B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, motors, and drives.
- C. Compressor: Scroll or hermetic, resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling.
- D. Refrigeration Accessories: Filter Drier, high pressure switch (auto reset), service valves and gauge ports, reversing valve, thermometer well (in liquid line). Provide thermostatic expansion valves and check valve. Provide refrigerant lines, factory cleaned, dried, pressurized and sealed, with insulated suction line.
- E. Air Cooled Condenser: Aluminum fin and copper tube coil, with hail guard, direct drive axial propeller fan resiliently mounted, galvanized fan guard.
- F. Electrical Characteristics: As Scheduled.
- G. Operating controls: Furnished with internal controls to allow for defrost/timed-off control. Units shall be controlled as noted on control diagrams.

2.04 CONDENSATE DRAIN PIPING

- A. Furnish and install an insulated condensate drain piping from each air conditioning unit to a plumbing fixture or other approved location as shown on the Drawings.
- B. Condensate drain piping shall be Type "L" hard drawn copper piping with wrought copper fittings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify concrete pad for condensing unit or outdoor heat pump unit is ready for unit installation.
- C. Verify that proper power supply is available for equipment.

3.02 INSTALLATION - AIR HANDLING UNIT

- A. Install in accordance with manufacturer's instructions.
- B. Connect air handling units to supply and return ductwork with flexible connections. Refer to Section 23 33 00.
- C. Install components furnished loose for field mounting.
- D. Install connection to electrical power wiring in accordance with Section 26 05 03.

3.03 INSTALLATION – OUTDOOR HEAT PUMP UNIT

- A. Install in accordance with manufacturer's instructions.
- B. Install outdoor heat pump units on vibration isolators. Refer to Section 23 05 48.
- C. Install refrigerant piping from unit to outdoor heat pump unit. Install refrigerant specialties specified in Section 23 23 00.
- D. Evacuate refrigerant piping and install initial charge of refrigerant in accordance with ASHRAE 15.
- E. Install electrical devices furnished loose for field mounting.
- F. Install control wiring between air handling unit, condensing unit, and field installed accessories.
- G. Install connection to electrical power wiring in accordance with Section 26 05 03.

3.04 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish initial start-up for units. Provide manufacturer's start-up report for each unit.
- C. Manufacturer's technician shall coordinate startup with controls contractor to verify that all controls are fully operational. Provide sign-off to this effect.
- D. Manufacturer's technician shall participate in one 8-hour session with Owner's Commissioning Authority to verify operation of units in accordance with design intent. This is in addition to Owner training, which should take place AFTER successful commissioning.

3.05 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean coils and inside of unit cabinet.
- C. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.06 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate equipment operation and maintenance.

3.07 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Do not operate air handling units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

3.08 SCHEDULES

- A. See Drawings.

END OF SECTION

SECTION 26 00 01 – BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Basic Electrical Requirements specifically applicable to all Division 26 Sections, in addition to Division 1 - General Requirements.

1.02 OWNER-FURNISHED PRODUCTS

- A. Products furnished to the site and paid for by Owner:
 - 1. Where indicated on the Drawings or other sections of the specifications.

1.03 WORK SEQUENCE

- A. Install work in sequence to accommodate Owner's occupancy requirements during the construction period. Coordinate schedule and operations with Architect/Engineer and Owner.

1.04 BASIS OF BID

- A. The Bidders shall bid the work on the basis of the design presented on the Drawings and in the specifications. If in the opinion of the Bidder, the design will not be acceptable to the authorities having jurisdiction, he shall notify the Architect/Engineer, in writing, at least ten days prior to bid opening. After receipt of notice, and concurrence by the Architect/Engineer, changes to the design will be issued by addendum to all bidders of record.

1.05 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code, current edition with local amendments, if any.
- B. Applicable Building Code.
- C. All work installed under this contract shall comply with the requirements of the referenced standards.
- D. All materials and labor furnished by the Contractor shall be in strict accordance with the rules and requirements of the National Board of Fire Underwriters, NEC, State and Municipal regulations, telephone company, power company and other authorities who may have lawful jurisdiction over the work being done.

1.06 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 – Submittal Procedures.
- B. Submit Shop Drawings and product data grouped to include complete submittals of related systems, products and accessories in a single submittal.

- C. Mark dimensions and values in units to match those specified. Include wiring diagrams of electrically powered equipment.

1.07 REGULATORY REQUIREMENTS

- A. Conform to referenced codes.
- B. Obtain permits, and obtain all required inspections from authority having jurisdiction.
- C. The Contractor will be responsible for all permits and inspections required by law for the completion of his work. Cost of all permits and inspections shall be paid by the Contractor. The Contractor shall obtain and pay for all certificates of approval which must be delivered to the Architect before final acceptance of the job.
- D. All Division 26 work shall be done under the supervision of a currently licensed State of Texas Master Electrician.

1.08 PROJECT/SITE CONDITIONS

- A. Contractor shall visit the site prior to bid and carefully familiarize himself with all existing conditions as may be determined by visual inspection without removing permanent finishes. If discrepancies are noted between the Drawings and existing conditions, the contractor shall notify the Architect/Engineer, in writing, no later than ten days prior to bid opening of the discrepancies. Upon receipt of notice of discrepancies, and verification, the Architect/Engineer will issue corrections by addendum to all bidders of record.
- B. Prepare Drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections.

1.09 QUALITY ASSURANCE

- A. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings or engineering parameters from those indicated on the contract documents, the contractor shall be responsible for all costs, including costs of all trades affected, involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.
- B. All materials, except medium voltage equipment and components, shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, if available, applicable and approved by Architect/Engineer, shall apply and such items shall bear those labels.

1.10 CONTINUITY OF EXISTING SERVICES AND SYSTEMS

- A. No outages shall be permitted on existing systems except at the time and during the interval specified by the Owner and by the Architect/Engineer Project Representative. The Owner may require written approval. Any outage must be scheduled when the interruption causes the least interference with normal schedules and business routines. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours.

- B. This Contractor shall restore any circuit interrupted as a result of this work to proper operation as soon as possible.

1.11 INTENT

- A. The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.
- B. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications or exists within the Drawings, the Contractor shall furnish the item, system, or workmanship, which is the highest quality, largest, or most closely fits the Architect/Engineer's intent (as determined by the Architect/Engineer Project Manager).
- C. The details and Drawings are diagrammatic. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.
- D. All sizes as given are minimum except as noted.
- E. Whenever a particular manufacturer's specific product is named, it is intended to establish a level of quality and performance requirements.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 SCOPE

The accompanying Plans and Specifications as outlined in the various sections of this Division cover the furnishing of all labor, materials, tools, transportation services, etc., necessary for complete and working installation of electrical facilities.

3.02 EXISTING WORK

- A. Remove exposed abandoned equipment wiring connections, raceway systems, and cables, including those located above accessible ceiling finishes.
- B. Disconnect abandoned utilization equipment and remove wiring connections. Remove abandoned components when connected raceway is abandoned and removed. Install blank cover for abandoned boxes and enclosures not required to be removed.
- C. Extend existing equipment connections where indicated on the Drawings. Where existing circuits to remain are interrupted, replace interrupted portions to maintain continuity. Use materials and methods compatible with existing electrical installations and as specified.

3.03 FIRESTOPPING

- A. Unless specifically indicated otherwise on the Drawings, all penetrations of fire-rated walls

and floors shall be made in accordance with specification Section 07 84 00.

3.04 TESTING

- A. General: Provide all labor, materials and equipment necessary to make the required tests as required by code or per other Division 26 sections.

3.05 EXCAVATION AND BACKFILL

- A. Perform all excavation and backfill work to accomplish indicated electrical systems installation in accordance with provisions of Division 31. Blasting will not be allowed without written permission of the Architect/Engineer and Owner.

3.06 CONCRETE WORK

- A. All cast-in-place concrete unless noted otherwise elsewhere will be provided under Division 3. Provide all Layout Drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for the support of electrical equipment.

3.07 BUILDING ACCESS

- A. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.08 EQUIPMENT ACCESS

- A. Install all piping, conduit, ductwork and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Where access is required in plaster or drywall walls or ceilings, provide the access doors.

3.09 COORDINATION

- A. Cooperate with other trades and Architect/Engineer's personnel in locating work. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost to the Project. The Contractor shall check location of electrical outlets with respect to other installations before installing.
- B. The Contractor shall verify that all devices are compatible for the surfaces in or on which they will be used. This includes, but is not limited to light fixtures, panelboards, devices, etc. and recessed or semi-recessed heating units installed in/on architectural surfaces.
- C. Coordinate all work with other trades prior to installation. Any installed work that is not coordinated and that interferes with other trades' work shall be removed without additional cost.

3.10 SLEEVES

- A. Pipe sleeves for conduits 6" in diameter and smaller, in new poured concrete construction, shall be schedule 40 steel pipe, plastic removable sleeve or sheet metal sleeve, all cast in place.
- B. In wet area floor penetrations, provide Schedule 40 sleeves only. Top of sleeve to be 2 inches above the adjacent floor. In existing wet area floor penetrations, core drill sleeve openings large enough to insert Schedule 40 sleeve and grout the area around the sleeve. If a pipe clamp resting on the sleeve supports the pipe penetrating the sleeve, weld a collar or struts to the sleeve that will transfer weight to the existing floor structure. Wet areas for this paragraph are rooms or spaces containing air handling unit coils, converters, pumps, chillers, boilers and similar waterside equipment.
- C. Pipe penetrations in existing concrete floors that are not in wet areas may omit the use of a core drilled opening without the sleeve, provided that the firestopping requirements of Article 3.02 are met.

3.11 HOUSEKEEPING AND CLEANUP

- A. The Contractor shall clean up and remove from the premises, on a daily basis, all debris and rubbish resulting from its work and shall repair all damage to new and existing equipment resulting from its work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

END OF SECTION

SECTION 26 01 00**COMMISSIONING OF ELECTRICAL SYSTEMS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section includes commissioning process requirements for electrical systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section 019113 – “GENERAL COMMISSIONING REQUIREMENTS” for general commissioning process requirements.
 - 2. Division 22 Section 220100 – “COMMISSIONING OF PLUMBING SYSTEMS”.
 - 3. Division 23 Section 230100 - “COMMISSIONING OF MECHANICAL SYSTEMS”.

1.3 DEFINITIONS

- A. Refer to section 019113 - GENERAL COMMISSIONING REQUIREMENTS.

1.4 CONTRACTOR’S COMMISSIONING RESPONSIBILITIES

- A. Refer to section 019113 - GENERAL COMMISSIONING REQUIREMENTS.
- B. Prepare submittals
- C. Review pre-functional/installation checklists prepared by CxA for electrical system components.
- D. Complete pre-functional/installation checklists prepared by CxA.
- E. Provide competent technical personnel, tools, equipment, and manpower to assist CxA during field-verification of pre-functional checklists completed by Contractor.
- F. Provide competent technical personnel, tools, equipment, and manpower to assist CxA during functional testing of electrical systems and equipment.
- G. Correct deficiencies identified by CxA in Commissioning Log, as directed by Design Team.

- H. Accompany CxA during verification of corrective action.
- I. Provide training.
- J. Provide O&M and As-built documentation
- K. Provide test data, inspection reports, and certificates.

1.5 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing pre-functional/installation checklists and manufacturer's pre-start and startup checklists for plumbing systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certification that installation, pre-start checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that plumbing systems, subsystems, equipment, and associated controls are ready for pre-functional third-party verification by CxA.
 - 6. Certificate of readiness certifying that plumbing systems, subsystems, equipment, and associated controls are ready for functional third-party testing by CxA.
 - 7. Test and inspection reports and certificates.
 - 8. Corrective action documents.

1.6 SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, pre-start, and startup activities.
- C. Electrical equipment submittals and installation manuals.
- D. Electrical shop and coordination drawings required for Commissioning.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to section 019113 - GENERAL COMMISSIONING REQUIREMENTS.

3.2 PRE-FUNCTIONAL CHECKLISTS

- A. Contractor shall conduct Pre-functional Testing to document compliance with installation and start-up checklists prepared by Commissioning Authority for the Division-26 items.
- B. Refer to Section 019113 - GENERAL COMMISSIONING REQUIREMENTS for issues relating to pre-functional checklists and testing, including list of systems to be commissioned, description of process, details on non-conformance issues relating to pre-functional checklists and test.
- C. Contractor shall participate in Pre-Functional testing activities to document electrical work associated with mechanical and plumbing systems.
- D. Do not proceed with system start-up or functional testing until after CxA has conducted third-party verification of pre-functional checklists.

3.3 SYSTEM START-UP

- A. Contractor is solely responsible for system start-up. CxA may, at his discretion, witness start up procedures, but will not perform any Functional Testing of systems until General Contractor has completed start-up and resolved all operating deficiencies.

3.4 FUNCTIONAL TESTING PREPARATION

- A. Certify that electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- D. Inspect and verify the position of each device and interlock identified on checklists.
- E. Check all notification and initiation devices and interlocks with associated systems during each mode of operation.
- F. Testing Instrumentation: Provide instrumentation and personnel as required to conduct tests.

3.5 FUNCTIONAL TESTING PROCEDURES OF SYSTEMS TO BE COMMISSIONED

- A. All Electrical and Electrically Powered Equipment
 - 1. Inspect electrical wiring and grounding for proper connections, color coding, and quality of installation.
 - 2. Verify supply voltage, all hot legs.

3. Verify amperage is within allowable limits.
4. Inspect for physical damage, proper installation, anchorage.
5. Verify equipment runs smoothly and quietly.
6. Verify operation of safeties.
7. Verify all required means of disconnect are in place.
8. Verify maintenance and NEC clearances are maintained.

B. Service Grounding Test:

1. CxA will witness ground tests to be conducted by Contractor in accordance with specifications. Contractor will provide CxA ample advance notice of test so that CxA may be witness, or he shall re-test in CxA's presence. Ground resistance testing is to include lightning protection system as well as electrical power systems.
2. Provide ground test report for review by CxA.

C. Electrical Distribution System

1. Switchboards and Panelboards.
 - a. Wiring:
 - 1) Verify wiring connections are secure.
 - 2) Verify ground wires properly terminated, panels are grounded.
 - 3) Verify wiring color coding is proper.
 - b. Verify panel is properly identified.
 - c. Verify load indicated in circuit directory is actual load served in space (by opening circuit breaker and observing response in space).
 - d. Verify load identification is adequately descriptive of load.
 - e. Verify phase rotation
 - f. Verify phase to phase and phase to neutral volts.
 - g. Document phase balance.
2. Receptacle and Device Test:
 - a. Test receptacle with a receptacle circuit tester for proper polarity.
 - b. Test each receptacle or branch circuit breaker having ground-fault circuit protection.

D. Lighting Systems:

1. Light Fixtures: Verify all lamps work without flicker.
2. Verify light levels
3. Light Switches: Verify switches control lights per design
4. Lighting Controls:
 - a. Verify sensors pick up motion and turn on lights immediately.
 - b. Verify that lights turn off after specified time.
 - c. Verify sensor coverage includes entire room area being sensed.
 - d. Verify sensor does not pick up occupancy outside the area sensed.
 - e. For ceiling mounted occupancy switches, verify light switches still function in circuit.

5. Emergency Egress: Verify operation of emergency egress lighting and associated light levels.

E. Transformers

1. Verify primary and secondary voltages are within acceptable range and secondary voltage taps (where applicable) are appropriate.
2. Document phase to phase and phase to neutral voltages.
3. Document ground resistance
4. Verify transformers operate without “hum”.

F. Emergency Generator Systems and Transfer Switches

1. Megger test insulation and ground resistance.
2. Verify phase rotation and consistency.
3. Notify CxA to witness manufacturer’s start-up procedure to include:
 - a. No-load test
 - b. Load-bank test
 - c. Building-load test (witness activation of transfer switch and generators upon a real building power loss)
 - d. Other tests as specified
 - e. Provide copy of manufacturer’s start-up report.
4. Document response of building systems upon a real building power-loss, activation of generator, and return of normal power.
5. Provide infrared scanning report.

3.6 TRAINING

- A. Refer to sections 019113 - GENERAL COMMISSIONING REQUIREMENTS.

3.7 O&M MANUALS

- A. Refer to sections 019113 - GENERAL COMMISSIONING REQUIREMENTS and section 017800 CLOSEOUT SUBMITTALS.

END OF SECTION 26 01 00

SECTION 26 05 03 – EQUIPMENT WIRING CONNECTIONS

PART 1 GENERAL

1.01 SUMMARY

- A. The work under this section includes electrical connections to equipment specified under other Divisions and/or Sections, or furnished by Owner, including, but not limited to:
 - 1. HVAC motors, VFDs and panels.
 - 2. Plumbing motors, VFDs and panels.
 - 3. Elevators
 - 4. Coolers and Freezers
 - 5. Kitchen Equipment
 - 6. Architectural Equipment (Overhead doors, motorized partitions, backstops, etc.)
- B. Related Sections:
 - 1. Section 26 05 19 - Building Wire and Cable.
 - 2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.02 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA WD 1 - General Requirements for Wiring Devices.
 - 2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures.
- B. Product Data: Submit wiring device manufacturer's catalog information showing dimensions, configurations and construction.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Submittal procedures.
- B. Project Record Documents: Record actual locations, sizes and configurations of equipment connections.

1.05 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

- B. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- C. Determine connection locations and requirements.
- D. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- E. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.01 CORD AND PLUGS

- A. Attachment Plug Construction: Conform to NEMA WD 1.
- B. Configuration: NEMA WD 6; match receptacle configuration with outlet furnished for equipment.
- C. Cord Construction: Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
- D. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

2.02 RACEWAYS, BUILDING WIRE AND CABLE, AND ENCLOSED SWITCHES

- A. As specified in other Division 26 sections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify equipment is ready for electrical connection, for wiring and to be energized.

3.02 INSTALLATION

- A. Make electrical connections. Utilize cord, receptacles and attachment plugs for portable equipment or for any equipment furnished by manufacturer with cord and plug connections. Install receptacle outlet to accommodate connection with attachment plug. Install cord and cap for field-supplied attachment plug. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes. Provide wire basket type strain reliefs, both ends for any suspended cords. Connect all other equipment with raceways and provide suitably rated disconnecting means, capable of being locked in the "off" position.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for

temperatures encountered.

- D. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- E. Install terminal block jumpers to complete equipment wiring requirements.
- F. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements. Install in accordance with equipment vendor's requirements.
- G. Coolers and Freezers:
 - 1. Provide all 120V and above interconnecting wiring as required to provide a complete and working system.
 - 2. Provide rigid conduit, IMC or PVC for all surface wiring in coolers and freezers. Whenever possible avoid the use of surface wiring and run conduit in space behind or above insulated panels.
 - 3. Provide non-metallic nipple and sealing fittings whenever conduit pierces wall of cooler or freezer. Provide grounding conductor.
 - 4. All openings cut in walls of cooler or freezer shall be patched and insulation integrity shall be maintained. Patching shall be approved by freezer or cooler installer.
 - 5. Install all wiring for lighting, switches, evaporator, coil fans, compressors, interlocks, defrost heaters, door heaters, drain heaters, alarms or any other electric devices supplied with unit.
 - 6. Seal all conduits entering and leaving temperature-controlled areas.
- H. HVAC and Plumbing Connections:
 - 1. Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source through starters, variable frequency drives (VFDs), and disconnects to motors or to packaged control panels. Packaged control panels may include disconnects and starters and overcurrent protection. Provide all wiring between packaged control panels and motors.
 - 2. VFD Installations: Install VFD input wiring and output wiring in separate conduit systems. Do not mix VFD input power and output power, or control wiring in a common raceway.
 - 3. Provide 120 volts to each temperature control panel. Coordinate requirements with HVAC/DDC contractors.
 - 4. Unless otherwise specified, all control devices such as aquastats, float and pressure switches, fan-powered VAV boxes, switches, electro-pneumatic switches, solenoid valves and damper motors requiring mechanical connections shall be furnished and installed and wired under other divisions of these specifications.

5. Each motor terminal box shall be connected with a minimum 12", maximum 36" piece of flexible PVC-coated metal conduit to a fixed junction box. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
 6. Check for proper rotation of each motor.
- I. Kitchen Equipment Connections:
1. Check loose equipment delivered to job by equipment installer against approved Shop Drawings or other required Drawings. Connect loose electrical equipment including disconnects, starters, thermostats, controls, local and remote switches.
 2. Contractor shall rough in for kitchen equipment only from approved kitchen equipment Shop Drawings.
 3. Rough-in location shall be within three inches of equipment. If direct connection is required, use liquid-tight flexible conduit. If receptacle connection is required, verify proper receptacle configuration with equipment vendor.
 4. Final connections shall include extension of all service to each piece of equipment. All labor and material required to completely connect the equipment ready to operate shall be included in the final connections. All control wiring not integral with equipment shall be included.
 5. For kitchen exhaust hoods provide all required power and control wiring.

3.03 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting and balancing.
- B. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

3.04 EQUIPMENT TO BE CONNECTED

- A. Unless specifically noted otherwise, each piece of utilization equipment shown on the Drawings, whether Owner furnished or Contractor furnished, shall be connected by the Contractor.

END OF SECTION

SECTION 26 05 19 – 600-VOLT BUILDING WIRE AND CABLE

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes building wire; armored cable; metal-clad cable; and wiring connectors and connections.
- B. Related Sections:
 - 1. Section 26 05 23 – Electronic Cables.

1.02 REFERENCES

- A. NFPA 70 – National Electrical Code

1.03 SYSTEM DESCRIPTION

- A. Conductors intended for power wiring and control wiring operating at above 50 volts to 600 volts nominal. Section includes both individual conductors and cable assemblies.

1.04 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit for building wire and each cable assembly type.

1.05 QUALIFICATIONS

- A. Manufacturer: Company supplying products listed by UL or CSA.

PART 2 PRODUCTS

2.01 GENERAL

- A. All conductors shall be copper unless specifically noted or otherwise allowed in specifications or on Drawings. Conductor sizing shown on plans and schedules is based on copper unless specifically noted otherwise.
- B. All conductors shall be new, delivered to site in unbroken original packaging out of manufacturer's stock.

2.02 CONDUCTORS

- A. Conductor: Copper in sizes #14 and larger.
 - 1. #14 AWG and larger for control circuits.
 - 2. #12 AWG and larger for power and lighting circuits.

3. All control wiring and motor connections shall utilize stranded conductors.
 4. Use stranded conductors for all feeders and branch circuits #10 AWG and larger.
- B. Conductor: Aluminum conductors may be used where copper conductors are scheduled in sizes 1/0 or larger, under the following requirements:
1. Aluminum alloy conductors shall be compact stranded conductors of a recognized Aluminum Association 8000 Series aluminum alloy conductor material (AA-8000 series alloy).
 2. The contractor shall increase the size of the raceways and enclosures, if necessary, to accommodate the aluminum conductors and meet applicable code requirements.
 3. The contractor shall increase the size of the aluminum conductor to match or exceed the ampacity of the copper conductor circuit shown on the Drawings.
 4. The contractor shall submit a feeder schedule to the Engineer for all conductor substitutions indicating the aluminum conductor wire size and the conduit size. The contractor shall not begin the installation until reviewed by the Engineer.
- C. Terminations:
1. Split Bolt Connectors: Not Acceptable.
 2. Solderless Pressure Connectors: High copper alloy terminal. May be used only for conductor terminations to equipment pads or terminals. Not approved for splicing.
 - a. 3M
 - b. Ideal
 - c. T & B
 - d. Substitutions: Section 01 60 00 - Product Requirements.
 3. Spring Wire Connectors: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.
 - a. Buchannan
 - b. Ideal
 - c. T & B
 - d. Substitutions: Section 01 60 00 - Product Requirements.
 4. Compression (Crimp) Connectors: Long barrel; seamless, with internally beveled barrel ends. Connector shall be dual rated (AL7CU or AL9CU) and Listed by UL for use with aluminum and copper conductors, and sized to accept conductors of the required ampacity. Connectors shall be marked with wire size, die index, number and location of crimps and shall be suitably color-coded. Using a suitable stripping tool, remove insulation from the required length of the conductor. Crimp the connection per the connector manufacturer's recommendation.
 - a. Burndy
 - b. T & B
 - c. Substitutions: Section 01 60 00 - Product Requirements.

5. Mechanical Connectors: For use on copper conductors only. Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances, unless otherwise noted specifically on plans.
 - a. Burndy
 - b. IlSCO
 - c. T & B
 - d. Substitutions: Section 01 60 00 - Product Requirements.
6. All aluminum conductors shall terminate on a compression-type connector, IlSCO series or equal, or listed copper pigtail type adapters only. Wire brush the conductor and apply a Listed joint compound. Wipe off any excess joint compound after crimping.
7. When terminating conductors to plated bus, prepare a compression-type connection. Bolts shall be plated or galvanized medium carbon steel; heat treated, quenched and tempered equal to current ASTM standard or SAE grade 5. Nuts shall conform to current ANSI standards. Washers shall be steel, Type A plain, standard wide series conforming to current ANSI standards. Belleville conical spring washers shall be of hardened steel, cadmium plated or silicone bronze. Lubricate and tighten the hardware per manufacturer's recommendations.
8. Underground Connectors: All wire connectors used in underground or exterior pull boxes shall be gel filled twist connectors or a connector designed for damp and wet locations.

2.03 BUILDING WIRE

- A. Product Description: Single conductor insulated wire.
- B. Insulation Types and Permitted Uses:
 1. Type THHN/THWN, XHHW for all interior copper branch circuits and feeders.
 2. Type XHHW-2 for all exterior conductors.
 3. Type XHHW-2 for all aluminum conductors.

2.04 ARMORED CABLE

- A. Product Description: NEC Type 'AC' Armored Cable.
- B. Conductor: Copper, sizes 12 AWG through 1 AWG.
- C. Armor Material: Flexible metal tape Per NEC 320.100.
- D. Insulation: Type THHN/THWN.

2.05 METAL-CLAD CABLE

- A. Product Description: NEC Type 'MC' Metal Clad Cable
- B. Conductor:

1. Copper in sizes 12 AWG and larger
2. Aluminum in sizes 1/0 and larger
- C. Armor Material: Metallic covering per NEC 330.116
- D. Insulation: Type THHN/THWN

2.06 PERMITTED USES – TYPES MC AND AC CABLE

- A. Home Runs: All home runs shall be in conduit.
- B. Uses Permitted, type AC or MC Cable:
 1. Fixture whips, 6 foot maximum, from individual fixtures to junction boxes only. Direct connections between fixtures are not acceptable.
 2. Branch circuits only.
 3. Dry interior locations only.
 4. Feeders only where specifically shown on plans (Type MC only).
 5. Concealed in walls or above ceilings.
 6. Use of cable only allowed from concealed devices in wall to junction box above ceiling and on wall directly above device, no exposed cables.

2.07 WIRE COLOR

- A. General
 1. Provide color coding in accordance with local code or Owner's established requirements. If not governed by local code requirements, verify with Owner if any special requirements apply. If not, provide colors as follows:
 - a. Black and red for single phase circuits at 120/240 volts.
 - b. Orange color reserved for high leg of 120/240V delta systems.
 - c. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - d. Purple, brown, and yellow for circuits at 277/480 volts single or three phase.
 - e. Neutral Conductors: 120/240V and 120/208V systems, White; 277/480V systems, Gray.
 - f. Ground Conductors: Green. Isolated ground conductors: green with yellow trace.
 2. For wire sizes 10 AWG and smaller, install wire with insulation colors in accordance with the above.
 3. For wire sizes 8 AWG and larger, provide insulation colors as above or identify wire with colored tape at terminals, splices and boxes.
- B. Neutral Conductors: White. When two or more neutrals are located in one conduit,

individually identify each with proper circuit numbers.

- C. Branch Circuit Conductors: Install multi-wire circuits with each phase uniquely color coded.

2.08 MISCELLANEOUS ACCESSORY MATERIALS

A. Conductor Phase Marking Tape:

- 1. Furnish materials in accordance with referenced standards and authority having jurisdiction.
- 2. Tape: Colored adhesive tape, equal to 3M Type 35.

B. Wire Markers

- 1. Furnish materials in accordance with referenced standards and authority having jurisdiction.
- 2. Description: Split sleeve type wire markers.
- 3. Legend:
 - a. Control Circuits: Control wire number as indicated on schematic and interconnection diagrams.

C. Cable Pulling Lubricant

- 1. Products: Ideal 'Yellow 77+' or equal

D. Aluminum Joint Termination Compound

- 1. Products: ALNOX or equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify interior of building has been protected from weather.
- C. Verify mechanical work likely to damage wire and cable has been completed.
- D. Verify raceway installation is complete and supported.
- E. Verify field measurements are as indicated on Drawings.

3.02 COORDINATION

- A. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required to meet project conditions.

- B. Wire and cable routing is approximate unless dimensioned.

3.03 EXISTING WORK

- A. Remove exposed abandoned wire and cable, including abandoned wire and cable above accessible ceiling finishes. Patch surfaces where removed cables pass through building finishes.
- B. Disconnect abandoned circuits and remove circuit wire and cable. Remove abandoned boxes when wire and cable servicing boxes is abandoned and removed. Install blank cover for abandoned boxes not removed.
- C. Provide access to existing wiring connections remaining active and requiring access. Modify installation or install access panel.
- D. Extend existing circuits using materials and methods compatible with existing electrical installations, and as specified.

3.04 INSTALLATION

- A. All wiring shall be installed as individual conductors contained in raceway systems, unless specifically noted otherwise on the Drawings or otherwise specified. Cables are not raceways.
- B. Provide separate neutral conductors for all single phase circuits. The use of multi-wire circuits with common neutrals is not allowed.
- C. Neatly train and lace wiring inside boxes, equipment and panelboards.
- D. Provide minimum 10 AWG conductors for 20 ampere, 120 volt branch circuit home runs longer than 75 feet.
- E. Provide minimum 10 AWG conductors for 20 ampere, 277 volt branch circuit home runs longer than 200 feet.
- F. Special Techniques – Building Wire in Raceway:
 - 1. Pull conductors into raceway at same time.
 - 2. Install building wire 1/0 AWG and larger with motorized pulling equipment.
 - 3. Use Listed wire pulling lubricant for pulling 4 AWG and larger wires and for other conditions when necessary.
 - 4. Place all conductors of a given circuit in the same raceway. This includes phase wires, neutral (if any), and ground conductor. If parallel phase and/or neutral wires are used, place an equal number of phase and neutral conductors in same raceway.
 - 5. Maintain equal lengths on all parallel conductors.
 - 6. Completely and thoroughly swab raceway before installing wire.

- G. Special Techniques – Types AC and MC Cable:
1. Protect exposed cable from damage.
 2. Support cables above accessible ceiling, using spring metal clips to support cables from structure. Supporting methods utilizing either ceiling support or dedicated hanger wires are not acceptable. Do not rest cable on ceiling panels.
 3. Use suitable cable fittings and connectors.
 4. Each cable shall be supplied by only one (1) branch circuit breaker (one, two or three poles).
- H. Special Techniques - Direct Burial Cable:
1. Trench and backfill for direct burial cable installation. Refer to Section 31 23 23 and Section 31 23 17. Install warning tape along entire length of direct burial cable, within 6 inches of grade.
 2. Use suitable direct burial cable fittings and connectors.
- I. Special Techniques - Wiring Connections:
1. Clean conductor surfaces before installing lugs and connectors.
 2. Make splices, taps and terminations to carry full ampacity of conductors with no perceptible temperature rise.
 3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
 4. Split bolt connectors are unacceptable for any purpose. Listed compression type connectors installed with compatible tooling may be used. Utilize manufacturer's preformed insulating devices when available and listed for use with installed connection.
 5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
 6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
 7. Install suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.
- J. Do not place stranded conductors directly under wiring device screws.
- K. Conductor Phase Marking Tape:
1. Install to identify phasing on all conductors #8 and larger, at each termination and in junction boxes, gutters and pull boxes.

L. Wire Marker Installation:

1. Install wire marker for each conductor at equipment cabinets, pull boxes, outlet and junction boxes.

3.05 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements and Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting and balancing.

B. Provide visual and mechanical inspections on all conductors 1/0 AWG and larger as follows:

1. Inspect exposed sections for physical damage.
2. Verify cable is supplied and connected in accordance with single line diagram.
3. If cables are terminated through window-type CTs, make an inspection to verify that neutrals and grounds are properly terminated for normal operation of protective devices.
4. Inspect for visual jacket and insulation condition.
5. There shall be NO tests performed on existing cable without specific direction from the Engineer.
6. Visually inspect cables, lugs, connectors and all other components for physical damage and proper connections.
7. Check all cable connectors for tightness (with a torque wrench) and clearances. Torque test conductor and bus terminations to manufacturer's recommendations.

C. Provide electrical tests on conductors as follows:

1. All secondary conductors from the utility transformers to service equipment and all phase conductors 1/0 and larger shall be subjected to insulation tests using a 500 vdc megger.
2. Check for proper grounding resistance at all services and at transformers. Resistance shall be 2 ohms maximum.

D. Test results and report shall be provided to the engineer.

E. Contractor shall correct all deficiencies reported in the test report.

END OF SECTION

SECTION 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Rod electrodes.
2. Active electrodes.
3. Wire.
4. Grounding well components.
5. Mechanical connectors.
6. Exothermic connections.
7. Bus

B. Related Sections:

1. Section 03 20 00 – Concrete Reinforcing: Bonding or welding bars when reinforcing steel is used for electrodes.

1.02 REFERENCES

A. International Electrical Testing Association:

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

B. National Fire Protection Association:

1. NFPA 70 - National Electrical Code (NEC), Articles 250 and 517.

C. ANSI/IEEE 142 (Latest edition):

1. Recommended Practice for Grounding of Industrial and Commercial Power Systems.

1.03 SYSTEM DESCRIPTION

- A. All ground and bonding as required by NEC Article 250.**

1.04 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.**

- B. Product Data: Submit data on grounding connections. Submit data on made electrodes**

(as defined by NEC) only when made electrodes are required specifically by the project Drawings.

- C. Manufacturer's Installation Instructions: Submit for active electrodes.

1.05 CLOSEOUT SUBMITTALS

- A. Section 01 70 -00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.06 QUALITY ASSURANCE

- A. Provide grounding materials conforming to requirements of NEC, and listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.
- B. Perform Work in accordance with NEC Article 250 and any other special requirements adopted by Authorities Having Jurisdiction.

1.07 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical and mechanical damage, by storing in original packaging.

1.09 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Complete grounding and bonding to building reinforcing steel prior to concrete placement.

PART 2 PRODUCTS

2.01 ROD ELECTRODES

- A. Product Description:
 - 1. Material: Copper-clad steel.
 - 2. Diameter: 3/4 inch.

3. Length: 10 feet (3.5 m) minimum. Rod shall be driven at least 9' 6" deep.
4. Connector: Connector for exothermic welded connection or listed U-bolt clamp.
5. Provide only when shown on the Drawings or when made electrodes per NEC Article 250 are required.

2.02 ACTIVE ELECTRODES

A. Manufacturers:

1. Apache Grounding/Erico Inc.
2. Copperweld, Inc.
3. Erico, Inc.
4. O-Z Gedney Co.
5. Thomas & Betts, Electrical

B. Product Description:

1. Material: Metallic-salt-filled copper-tube electrode.
2. Shape: As indicated on Drawings.
3. Length: 8 feet.
4. Connector: Connector for exothermic welded connection or listed compatible U-bolt clamp.

2.03 WIRE

- A. Material: Stranded copper.
- B. Foundation Electrodes/Ufer Grounds: Bare copper sized per NEC Article 250, but not smaller than #2 AWG, or as shown on Drawings.
- C. Grounding Electrode Conductor: Copper conductor bare, sized per NEC Article 250, but not smaller than #2 AWG or as shown on Drawings.
- D. Bonding Conductor: Copper conductor sized per NEC Article 250.
- E. Equipment Grounding Conductors: Insulated copper run with circuit conductors and sized as indicated on the Drawings or per NEC Article 250 where size is not indicated on the Drawings. Provide an equipment grounding conductor in all feeders and branch circuits.

2.04 GROUNDING WELL COMPONENTS

- A. Well Pipe: 8 inches NPS by 24 inches long fiberglass pipe with belled end.
- B. Well Cover: Cast iron with legend "GROUND" embossed on cover.

2.05 MECHANICAL CONNECTORS

A. Manufacturers:

1. Copperweld, Inc.
2. Erico, Inc.
3. ILSCO Corporation
4. O-Z Gedney Co.
5. Thomas & Betts, Electrical

B. Description:

1. The mechanical connector bodies shall be manufactured from high-strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolt type.
2. Split bolt connector types are NOT allowed. Exception: the use of split bolts is acceptable for grounding of wire-basket type cable tray, and for cable shields/straps of medium voltage cable.
3. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

2.06 EXOTHERMIC CONNECTIONS

A. Manufacturers:

1. Cadweld, Inc.
2. Erico, Inc.

B. Product Description: Listed exothermic materials, accessories and tools for preparing and making permanent field connections between grounding system components.

2.07 GROUNDING BUS

A. Material:

1. Copper (aluminum not permitted).

B. Size:

1. 1/4" X 2" minimum.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify final backfill and compaction has been completed before driving rod electrodes.

3.02 PREPARATION

- A. Remove paint, rust, mill oils, surface contaminants at connection points.
- B. Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.
- C. Ground connection surfaces shall be cleaned and all connections shall be made so that they are immovable.
- D. Attach grounds permanently before permanent building service is energized.
- E. All grounding electrode conductors shall be installed in PVC conduit, in exposed locations.

3.03 EXISTING WORK

- A. Modify existing grounding system to maintain continuity to accommodate renovations.
- B. Extend existing grounding system using materials and methods compatible with existing electrical installations, and as specified.

3.04 INSTALLATION

- A. Install in accordance with NEC and in accordance with manufacturer's instructions. Unless specifically indicated otherwise on the Drawings, Contractor may utilize any arrangement of components which fully complies with both.
- B. Install grounding and bonding conductors concealed from view to extent practical.
- C. Install grounding well pipe with cover at rod locations as indicated on Drawings. Install well pipe top flush with finished grade.
- D. Install grounding electrode conductor and connect to reinforcing steel in foundation footing utilizing a connection method listed for the purpose.
- E. Bond together reinforcing steel and metal accessories in pool and fountain structures.
- F. Bond exposed structural steel elements not intentionally grounded as required by NEC 250.104 (C).
- G. Provide code sized copper grounding electrode conductors where required by NEC Article 250.
- H. Install ground grid under access floors where indicated. Construct grid of #4 AWG bare copper wire installed on 72 inch centers both ways. Bond each access floor support pedestal to grid.

- I. Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors. Bond to underfloor ground grid. Use #4 AWG bare copper conductor.
- J. Equipment Grounding Conductor: Provide separate, insulated equipment grounding conductor within each raceway. Terminate each end on suitable lug, bus, enclosure or bushing. Provide a ground wire from each device to the respective enclosure.
- K. Provide communications system grounding conductor at point of service entrance and connect to building common grounding electrode system.

3.05 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS.
- B. Grounding and Bonding: Perform inspections and tests listed in NETA ATS.
- C. Perform ground resistance testing in accordance with IEEE 142. The following tests are acceptable methods for the resistance-to-ground verification:
 - 1. Clamp-on Induced Frequency Resistance-to-Ground method.
 - 2. 3-point Fall-of-Potential method.

END OF SECTION

SECTION 26 05 27 – WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Wall switches; wall dimmers; receptacles; multi-outlet assembly; lighting control devices; and device plates and decorative box covers.
 - 1. Wall Switches.
 - 2. Incandescent Wall Dimmers.
 - 3. Receptacles.
 - 4. Device Plates, Covers and Colors.
 - 5. Multi Outlet Assembly.
 - 6. Lighting Power Pack Relays.
 - 7. Stand Alone Low Voltage Relay Panels.
 - 8. Low Voltage Switches.
 - 9. Low Voltage Wall Mounted Motion Sensor.
 - 10. Wall-Mounted Line Voltage Occupancy Sensor Switch.
 - 11. Ceiling Mounted Low Voltage Occupancy Sensors.
 - 12. High Bay Low Voltage Occupancy Sensors.
 - 13. Exterior Line Voltage Photocells.
 - 14. Interior Low Voltage Photocells.
 - 15. Ambient Light Sensor Control Unit.
 - 16. Time Clocks.
 - 17. Timer Switches.
- B. Related Sections:
 - 1. Section 26 05 33 - Raceway and Boxes for Electrical Systems: Outlet boxes for wiring devices.

1.02 REFERENCES

- A. National Electrical Manufacturers Association:

1. NEMA WD 1 - General Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.
3. UL 498 - Receptacles
4. UL 20 - Switches

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures.
- B. Product Data: Submit manufacturer's catalog information showing dimensions, colors and configurations.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section.

1.05 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two of each style, size and finish wall plate.

1.06 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish five-year manufacturer warranty for components.

PART 2 PRODUCTS

2.01 WALL SWITCHES

- A. Manufacturers:
 1. Cooper: CSB Series.
 2. Hubbell: CSB Series.
 3. Leviton: CSB Series.
 4. Pass and Seymour: CSB Series.
 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA WD 1, Commercial Spec Grade AC only general-use snap switch, side and back wired.
- C. Body and Handle: Plastic with toggle handle, unless otherwise noted on plans. Use red

for devices connected to emergency systems.

- D. Indicator Light: Lighted handle type switch, where shown on plans.
- E. Ratings:
 - 1. Voltage: 120-277 volts, AC.
 - 2. Current: 20 amperes.

2.02 INCANDESCENT WALL DIMMERS

- A. Manufacturers:
 - 1. Leviton Series 81500.
 - 2. Lutron Series NT-1500P and NTHF-40-277/120.
 - 3. Pass and Seymour CD1600 series.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA WD 1, Type I semiconductor dimmer for incandescent lamps.
- C. Body and Handle: Plastic with linear slide.
- D. Voltage: Refer to Drawings.
- E. Power Rating: As indicated on Drawings.
- F. Accessory Wall Switch: Match dimmer appearance.

2.03 RECEPTACLES

- A. Duplex Receptacle
 - 1. Product Description: NEMA WD 1, WC-596 Federal spec grade receptacle, 20 amp.
 - 2. Configuration: NEMA WD 6, side and back wired.
 - 3. Device Body: Plastic, unless otherwise noted on Drawings. Use red for devices connected to emergency systems.
 - 4. Manufacturers:
 - a. Cooper: 5362 Series
 - b. Hubbell: HBL5362 Series
 - c. Leviton: 5362 Series
 - d. Pass and Seymour: 5362-A Series
 - e. Substitutions: Section 01 60 00 - Product Requirements.

5. Use Hospital Grade devices on all hospital projects.

B. Simplex Receptacle

1. Product Description: NEMA WD 1, Commercial Spec Grade receptacle, 20 amp.
2. Configuration: NEMA WD 6, side and back wired.
3. Device Body: Plastic, unless otherwise noted on Drawings. Use red for devices connected to emergency systems.
4. Manufacturers:
 - a. Cooper: 1877 Series
 - b. Hubbell, HBL 5261 Series
 - c. Leviton: 5891 Series
 - d. Pass and Seymour: 5361 Series
 - e. Substitutions: Section 01 60 00 - Product Requirements.

C. GFCI Receptacle

1. Product Description: NEMA WD 1, Heavy-duty general use receptacle, 20 amp. Provide with weather-resistant rating when located outdoors.
2. Configuration: NEMA WD 6, UL943, side and back wired, feed thru type.
3. Device Body: Plastic, unless otherwise noted on Drawings. Use red for devices connected to emergency systems.
4. Manufacturers:
 - a. Cooper: VGF20 Series
 - b. Hubbell: GF20L Series
 - c. Leviton: 8898 Series
 - d. Pass and Seymour: 2095 Series
 - e. Substitutions: Section 01 60 00 - Product Requirements.

D. Twist Lock Receptacle

1. Product Description: NEMA Lx-xx, UL 94, Twist Lock receptacle.
2. Configuration: NEMA type as indicated on Drawings.
3. Device Body: Black plastic, unless otherwise noted on Drawings. Use red for devices connected to emergency systems.
4. Manufacturers:
 - a. Cooper
 - b. Hubbell
 - c. Leviton.
 - d. Pass and Seymour
 - e. Substitutions: Section 01 60 00 - Product Requirements.

E. Special Purpose Receptacle

1. Product Description: Heavy-duty Special Purpose Receptacle, Straight Blade or Pin and Sleeve Type.
2. Configuration:
 - a. Range receptacle: NEMA 14-50
 - b. Dryer receptacle: NEMA 14-30
 - c. Other types: As indicated on drawings.
3. Device Body: Black plastic, unless otherwise noted on Drawings. Use red for devices connected to emergency systems.
4. Manufacturers:
 - a. Cooper.
 - b. Hubbell.
 - c. Leviton.
 - d. Pass and Seymour.
 - e. Substitutions: Section 01 60 00 - Product Requirements.

F. Isolated Ground Duplex Receptacle

1. Product Description: NEMA WD 1, WC-596 Federal Spec. Grade Isolated Ground receptacle.
2. Configuration: NEMA WD 6, side and back wired.
3. Device Body: Plastic, unless otherwise noted on Drawings. Use red for devices connected to emergency systems.
4. Manufacturers:
 - a. Cooper: IG5362 Series
 - b. Hubbell: CR5362IG Series
 - c. Leviton: 5362IG Series
 - d. Pass and Seymour: IG5362 Series
 - e. Substitutions: Section 01 60 00 - Product Requirements.
5. Use Hospital Grade devices on all hospital projects.

2.04 DEVICE PLATES, COVERS AND COLORS

- A. Manufacturers: To match device manufacturer.
- B. Device Colors:
 1. Wall Devices: IVORY
 2. Ceiling Devices: WHITE

- C. Decorative Cover Plate: Smooth nylon.
- D. Jumbo Cover Plate: Smooth nylon. For use at masonry walls only.
- E. Weather Resistant Cover Plate: Gasketed cast metal plate with hinged and gasketed device cover. Provide weatherproof-while-in-use type covers where indicated on the Drawings.
- F. Devices and plates shall be red color when installed on emergency systems.

2.05 MULTI-OUTLET ASSEMBLY

- A. Manufacturers: Wiremold.
 - 1. Substitutions: Section 01 60 00 - Product Requirements.
- B. Receptacles: NEMA WD 6, type 5-15R, single receptacle.
- C. Receptacle Spacing: As indicated on Drawings.
- D. Receptacle Color: Ivory.
- E. Channel Finish: Ivory.
- F. Fittings: Furnish manufacturer's standard couplings, elbows, outlet and device boxes, and connectors.

2.06 LIGHTING POWER PACK RELAYS

- A. Manufacturers:
 - 1. Leviton OSP20-D0 Series.
 - 2. Sensor Switch PP-20 Series.
 - 3. Wattstopper BZ-50 Series.
 - 4. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: 120/277 volt power pack relays for powering motion sensors and control of circuits/switch legs as shown on plans.
- C. Contacts: Rated 20 amperes at 120/277volts. Rated for lighting applications with fluorescent or HID lamps, 1 HP maximum motor loads.
- D. Line Voltage Connections: Pigtail leads.
- E. Enclosure: 1/2" nipple mount to electrical box for line voltage leads.

2.07 STAND-ALONE LOW VOLTAGE RELAY PANELS

- A. Manufacturers:

1. Hubbell LX Series.
 2. LCD Blue Box LT/Master Series.
 3. Leviton RE4BD-104 Series.
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Stand-alone relay panel with integral time clock, power supply, and 4-single pole relays.
- C. Configuration: Latching relays, 2 wire control.
- D. Input Voltage: 120/277 volts, 60 Hertz.
- E. Relays: Four, 1 pole relays, 20 amp, HID rated.
- F. Inputs: Photocells, low voltage switches, motion sensors.
- G. Accessories:
1. Cover-mounted astronomical time clock with LCD readout.
 2. Cover-mounted programming controls.
- H. Enclosure: NEMA 1.

2.08 LOW-VOLTAGE SWITCHES

- A. Manufacturers:
1. Hubbell Incorporated Model LV Series.
 2. Leviton Manufacturing Co., Inc. Model LVS Series.
 3. Wattstopper RS2 Series.
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Wall Switch: Specification Grade unlighted momentary push-button type for overriding relays.
1. Material: Plastic, provide with cover plate.
 2. Color: Per Section 2.04

2.09 LOW VOLTAGE WALL-MOUNTED MOTION SENSOR

- A. Manufacturers:
1. Hubbell Model LODIA.
 2. Sensor Switch Model WV PDT 16.

3. Watt Stopper Model DT-200.
 4. Substitutions: Section 01 60 00 - Product Requirements
- B. Dual Technology ultrasonic and PIR sensor.
- C. Separate sensitivity and time delay adjustments with LED indication of sensed movement. User adjustable time-delay: 8 to 32 minutes.
- D. Provide with self adaptive technology to adapt to room size automatically.
- E. Installation: Wall mount typically one foot below ceiling on corridor wall.
- F. Coverage Sensitivity:
1. Capable of detecting motion over 1600 square foot area.
 2. Capable of being wired in master-slave configuration to extend area of coverage.

2.10 WALL-MOUNTED LINE VOLTAGE OCCUPANCY SENSOR SWITCH

- A. Manufacturers:
1. Hubbell Model LHIRS1.
 2. Sensor Switch Model LWS-P.
 3. Watt Stopper Model WS-250.
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. 800 watt, 120/277 volt line voltage control. Passive infrared and ambient light sensing.
- C. Separate sensitivity and time delay adjustments. User adjustable time-delay: 30 seconds to 30 minutes. 0-200 foot candle adjustability for ambient light control.
- D. Furnish with manual override.
- E. Operation: Silent.
- F. Coverage Sensitivity: Capable of detecting motion over nominal 900 square foot area.

2.11 CEILING-MOUNTED LOW VOLTAGE OCCUPANCY SENSOR

- A. Manufacturers:
1. Hubbell Model OMNIUS2000.
 2. Sensor Switch Model CM PDT 10.
 3. Watt Stopper Model DT-300.
 4. Substitutions: Section 01 60 00 - Product Requirements.

- B. Dual Technology ultrasonic and PIR sensor.
- C. Separate sensitivity and time delay adjustments with LED indication of sensed movement. User adjustable time-delay: 8 to 32 minutes.
- D. Provide with self adaptive technology to identify and adjust to room size automatically.
- E. Installation: Ceiling mounted as shown on plans, maximum 15' heights.
- F. Coverage Sensitivity:
 - 1. Capable of detecting motion over 2000 square foot area
 - 2. Capable of being wired in master-slave configuration to extend area of coverage.

2.12 HIGH BAY LOW-VOLTAGE OCCUPANCY SENSOR

- A. Manufacturers:
 - 1. Hubbell Model LOFLHB.
 - 2. Sensor Switch Model CM6 Series.
 - 3. Watt Stopper Model HB3x0-Lx Series.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Fluorescent high bay PIR sensor.
- C. Separate sensitivity and time delay adjustments with LED indication of sensed movement. User adjustable time-delay: 8 to 32 minutes.
- D. Provide with lens options to change coverage areas.
- E. Installation: Ceiling mount as shown on plans, 12 to 45 foot mounting heights.
- F. Coverage Sensitivity:
 - 1. Variable based on lens options.
 - 2. Capable of being wired in master-slave configuration to extend area of coverage.

2.13 EXTERIOR LINE VOLTAGE PHOTOCELLS

- A. Manufacturers:
 - 1. Tork Model 2101 (120 volts) / 2104 (208-277 volt).
 - 2. Substitutions: Section 01 60 00 - Product Requirements.
- B. General: 1/2" conduit mount, 180 degree sensing photocell with swivel mount, 2800 va load capacity. Galvanized housing. Slide cover sensitivity control.

2.14 INTERIOR LOW-VOLTAGE PHOTOCELLS

A. Manufacturers:

1. Hubbell Model LXSPSPC1 Series.
2. Leviton PCIND/PCATR Series.
3. Watt Stopper Model LS-290C Series.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. General: Consist of sensor mounted as indicated on Drawings with separate control-calibration module. Sensor connected to control-calibration module via single shielded conductor with maximum distance of 500 feet (150 m). Control unit powered by 24 VAC.

C. Control-Calibration Module: Furnish with the following:

1. Capable of being switched between 4 measurement ranges.
2. Separate trip points for high and low response settings.
3. Momentary contact device to override photocell relays.
4. Three-minute time delay between switching outputs to avoid nuisance tripping.

D. Sensor Devices: Each sensor employs photo diode technology to allow linear response to daylight within illuminance range.

1. Indoor Lighting: Sensor with Fresnel lens providing for 60 degree cone shaped response area to monitor indoor office lighting levels.
2. Atriums: Sensor with translucent dome with 180 degree field of view and respond in range of 100-1,000 foot candles nominal (1,076-10,760 lx).

2.15 AMBIENT LIGHT SENSOR CONTROL UNIT

A. Manufacturers:

1. Hubbell Model LXPSCLMP Series
2. Leviton Mini-Z Series
3. Watt Stopper Model LCO_203 Series.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Photodiode control unit with PHOTOCELL ENABLE and MASTER OVERRIDE inputs for remote control, 3 minute time delay, and with selectable ranges 100-1000 footcandle (1,076-10,760 lx).

2.16 TIME CLOCKS

- A. Manufacturers:
 - 1. Tork Model DZM200BP, or as otherwise indicated on the Drawings.
 - 2. Substitutions: Section 01 60 00 - Product Requirements.
- B. Two-channel digital astronomical time clock, LCD display, permanent schedule retention.

2.17 TIMER SWITCHES

- A. Manufacturers:
 - 1. Hubbell TD 200.
 - 2. Pass and Seymour RT12.
 - 3. Wattstopper TS 400.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: 0-12 hour timer switch, ability to interconnect multiple units for 3-way switching.
- C. Body and Handle: Plastic with push button control.
- D. Ratings:
 - 1. Voltage: 120-277 volts, AC.
 - 2. Load: 0-800 watt ballast.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify outlet boxes are installed at proper height.
- C. Verify wall openings are neatly cut and completely covered by wall plates.
- D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.02 PREPARATION

- A. Clean debris from outlet boxes.

3.03 EXISTING WORK

- A. Disconnect and remove abandoned wiring devices.

- B. Modify installation to maintain access to existing wiring devices to remain active.
- C. Clean and repair existing wiring devices to remain or to be reinstalled.

3.04 INSTALLATION

- A. Install devices plumb and level.
- B. Install switches with OFF position down.
- C. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- D. Do not share neutral conductor on load side of dimmers.
- E. Install receptacles with grounding pole on top.
- F. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.
- G. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- H. Connect wiring devices by wrapping solid conductor around screw terminal. When stranded conductors are used in lieu of solid, use back wiring connections. Do not place bare stranded conductors directly under device screws.
- I. Use jumbo size plates for outlets installed in masonry walls.
- J. Install galvanized steel covers on outlet boxes and junction boxes in unfinished areas and above accessible ceilings.

3.05 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided under Section 26 05 33 to obtain mounting heights as specified.

3.06 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting and balancing.
- B. Inspect each wiring device for defects.
- C. Operate each wall switch with circuit energized and verify proper operation.
- D. Verify each receptacle device is energized.
- E. Test each receptacle device for proper polarity and ground.
- F. Test each GFCI receptacle device for proper operation.

3.07 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting and balancing.
- B. Adjust devices and wall plates to be flush and level.
- C. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.
- D. Test each system component after installation to verify proper operation.
- E. Test relays, contactors and switches after installation to confirm proper operation. Provide sensitivity adjustments on motion sensors to avoid nuisance, undesired operation.
- F. Confirm correct loads are recorded on directory card in each panel.

3.08 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean exposed surfaces to remove splatters and restore finish.

3.09 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate operation of the following system components:
 - 1. Operation of switches.
 - 2. Operation of occupancy sensors. Demonstrate for all zones.
 - 3. Operation of each type of photocell/ambient lighting control zone.
- C. Furnish 4 hours to instruct Owner's personnel in operation and maintenance of system. Schedule training with Owner, provide at least 7 days' notice to Architect/Engineer and Owner of training date.

END OF SECTION

SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Conduit supports.
2. Formed steel channel.
3. Spring steel clips.
4. Sleeves.
5. Mechanical sleeve seals.
6. Equipment bases and supports.

B. Related Sections:

1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.

1.02 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Hangers and Supports: Submit manufacturer's catalog data including load capacity.

C. Design Data: Indicate load carrying capacity of hangers and supports.

D. Manufacturer's Installation Instructions:

1. Hangers and Supports: Submit special procedures and assembly of components.

1.03 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section.

1.04 DELIVERY, STORAGE AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

- C. Protect from weather and construction traffic, dirt, water, chemical and mechanical damage, by storing in original packaging.

PART 2 PRODUCTS

2.01 CONDUIT SUPPORTS

- A. Furnish materials in accordance with referenced standards and authority having jurisdiction.
- B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads, 1/4" for single conduits 1" and smaller, 3/8" minimum for trapezes and single conduits 1 1/4" and larger.
- C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
- D. Conduit Clamps for Trapeze Hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
- E. Conduit Clamps - General Purpose: One-hole plated steel for surface-mounted conduits. Provide with malleable iron clamp backs in damp and wet locations. Provide with pre-galvanized finish.
- F. Cable Ties: High-strength nylon temperature rated to 185 degrees F; self-locking.

2.02 FORMED STEEL CHANNEL

- A. Furnish materials in accordance with referenced standards and authority having jurisdiction.
- B. Product Description: Galvanized 12 gauge thick steel, minimum 1 5/8" x 1 5/8" section when used for trapezes, with holes 1-1/2 inches on center.

2.03 SPRING STEEL CLIPS

- A. Furnish materials in accordance with referenced standards and authority having jurisdiction.
- B. Product Description: Mounting hole and screw closure.

2.04 MECHANICAL AND CONDUIT SLEEVE SEALS

- A. Manufacturers:
 - 1. O-Z/Gedney.
 - 2. Thunderline Link-Seal, Inc.
 - 3. Substitutions: Section 01 60 00 - Product Requirements.
- B. Furnish materials in accordance with referenced standards and authority having

jurisdiction.

- C. Product Description: Mechanical type, consisting of rubber sealing elements to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.

3.02 INSTALLATION - HANGERS AND SUPPORTS

- A. Anchors and Fasteners:
 - 1. Concrete Structural Elements: Provide precast inserts, expansion anchors or preset inserts.
 - 2. Steel Structural Elements: Provide beam clamps or spring steel clips. Do not drill structural elements unless approved by Structural Engineer.
 - 3. Concrete Surfaces: Provide expansion anchors.
 - 4. Hollow Masonry, Plaster and Gypsum Board Partitions: Provide toggle bolts.
 - 5. Solid Masonry Walls: Provide expansion anchors.
 - 6. Sheet Metal: Provide sheet metal screws.
 - 7. Wood Elements: Provide wood screws.
- B. Install conduit and raceway support and spacing in accordance with NEC.
- C. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit. Do not fasten to suspended ceiling grid system.
- D. Install multiple conduit runs on common hangers.
- E. Supports:
 - 1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
 - 2. Install surface mounted cabinets and panelboards with minimum of four anchors.
 - 3. In wet and damp locations install steel channel supports to stand cabinets and

panelboards 1 inch off wall.

4. Support vertical conduit at every floor.
 5. File and de-bur cut ends of support channel and spray paint with cold galvanized paint to prevent rusting.
- F. Install Work in accordance with referenced standards and authority having jurisdiction.

3.03 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 3 inches beyond supported equipment, under all switchboards, motor control centers, floor mounted transformers, and other locations as indicated on the Drawings. Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

END OF SECTION

SECTION 26 05 33 – RACEWAY SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.
- B. Not included in this section: Electrical underground ductbank systems requiring concrete encasement or manholes.

1.02 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
 - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
 - 3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).
 - 4. ANSI C80.6 – Intermediate Rigid Conduit
 - 5. ANSI/UL 5 – Surface Metal Raceway
 - 6. ANSI/UL 5 – Surface Non-Metallic Raceway
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - 7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.03 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, device mounting, equipment connections, and compliance with

regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system. Except where other wiring methods are specifically allowed by other sections of the specifications, or specifically indicated on the Drawings, all wiring on this project shall consist of conductors installed in complete raceway systems as specified in this section of the specifications.

1.04 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures.
- B. Product Data: Submit for the following:
 - 1. Flexible metal conduit.
 - 2. Liquid-tight flexible metal conduit.
 - 3. Non-metallic conduit.
 - 4. Flexible non-metallic conduit.
 - 5. Non-metallic tubing.
 - 6. Raceway fittings.
 - 7. Conduit bodies.
 - 8. Surface raceway.
 - 9. Wireway.
 - 10. Pull and junction boxes.
 - 11. Handholes.

1.05 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements.
- B. Project Record Documents:
 - 1. Record actual routing of conduits larger than 2 inch (DN50). Include locations of junction and pull boxes.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 - Product Requirements
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- C. Protect PVC conduit from sunlight.

1.07 COORDINATION

- A. Section 01 30 00 - Administrative Requirement: Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.
- B. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes. Coordinate locations with architectural features, the work of other trades, obstructions and constraints. Where specific location information is shown on the Architectural Drawings, the information on those Drawings shall govern.

PART 2 PRODUCTS

2.01 SELECTION OF PRODUCTS

- A. Unless specifically indicated otherwise at particular locations on the Drawings, products shall be selected according to installation conditions as described in this article.
- B. Outdoor Below Grade Locations: Non-metallic conduit, schedule 40 or 80.
- C. Outdoor Above Grade Locations and other Wet Locations (as defined by the NEC): Rigid steel or intermediate metal conduit (IMC).
- D. Within or Under Concrete Construction Located On or Below Grade: Non-metallic conduit. Comply with Structural Specifications and Drawings regarding limitations on sizes and placement.
- E. Within Concrete Construction Located Above Grade: Non-metallic conduit, rigid steel conduit or intermediate metal conduit. Comply with Structural Specifications and Drawings regarding limitations on sizes and placement.
- F. Damp Locations as defined by the NEC including exposed work in any protected locations directly communicating with outside ambient air such as crawl spaces, breezeways, covered porches, under canopies, and similar locations: Rigid steel or intermediate metal conduits (IMC) conduits.
- G. Interior Dry Locations (as defined by the NEC): Rigid steel, intermediate metal conduits (IMC), or electric metallic tubing.
- H. Motor and Equipment Connections: Liquid-tight conduit not to exceed 24" in length.
- I. Lighting Fixtures: Flexible metal conduit.
- J. Special Conditions.
 - 1. Wiring between fire pump controllers and fire pumps: Rigid steel conduit, intermediate metal conduit (IMC), and liquid-tight flexible conduit.
 - 2. Classified (explosion proof) areas: Provide materials and fittings required to fully comply with all applicable NEC requirements.

2.02 METAL CONDUIT

- A. Rigid Steel Conduit: ANSI C80.1.

- B. Rigid Aluminum Conduit: ANSI C80.5. Install only where specifically indicated on the Drawings.
- C. Intermediate Metal Conduit (IMC): ANSI C80.1.
- D. The term "metal conduit" does not include Electric Metallic Tubing (EMT).
- E. Fittings: NEMA FB 1; material to match conduit.
- F. Conduit Bodies: NEMA FB 1; shall be malleable iron with steel conduit. Aluminum conduit bodies are not acceptable except for use with aluminum conduit.

2.03 PVC-COATED METAL CONDUIT

- A. Product Description: NEMA RN 1; rigid steel conduit with external PVC coating, 40 mil (0.1 mm) thick.
- B. Fittings and Conduit Bodies: NEMA FB 1; steel fittings with external PVC coating to match conduit.

2.04 NON-METALLIC CONDUIT

- A. Product Description: NEMA TC 2; Schedule 40 or 80 PVC.
- B. Fittings and Conduit Bodies: NEMA TC 3.

2.05 FLEXIBLE METAL CONDUIT

- A. Product Description: Interlocked steel or aluminum construction. Lightweight extra flexible type is not acceptable.
- B. Fittings: NEMA FB 1.

2.06 LIQUID-TIGHT FLEXIBLE METAL CONDUIT

- A. Product Description: Interlocked steel construction with PVC jacket, UL listed for grounding purposes.
- B. Fittings: NEMA FB 1.

2.07 ELECTRICAL METALLIC TUBING (EMT)

- A. Product Description: ANSI C80.3; galvanized tubing.
- B. Fittings and Conduit Bodies: NEMA FB 1.
 - 1. Indenter and die-cast set screw types are not acceptable.
 - 2. Wet or Damp Locations: Steel or die-cast compression type.
 - 3. Concealed Dry Locations: Steel compression, die cast compression type, or steel set screw type.

2.08 SURFACE METAL RACEWAY

- A. Product Description: ANSI/UL 5 sheet metal channel with fitted cover, suitable for use as surface metal raceway.
- B. Size: As indicated on the Drawings.
- C. Finish: Gray enamel.
- D. Fittings, Boxes and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway. Furnish all fittings and accessories required to provide a complete and working system.

2.09 SURFACE NON-METAL RACEWAY

- A. Product Description: ANSI/UL 5A plastic channel with fitted cover, suitable for use as surface metal raceway.
- B. Size: As indicated on the Drawings.
- C. Finish: IVORY.
- D. Fittings, Boxes and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway. Furnish all fittings and accessories required to provide a complete and working system.

2.10 WIREWAY

- A. Product Description: General purpose or NEMA 3R type wireway suitable for installation conditions.
- B. Knockouts: None; provide in field as required.
- C. Size: As indicated on Drawings or as required to meet NEC fill requirements.
- D. Cover: Screw cover.
- E. Fittings: Lay-in type with captive screws.
- F. Finish: Galvanized in mechanical rooms and unfinished areas; gray powder coated in finished areas and outdoors.

2.11 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
 - 1. 4" square by 2 1/4" deep minimum size. Provide plaster rings of required depth at recessed locations. Provide compatible industrial device covers and blank covers at other locations.
 - 2. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch (13 mm) male fixture studs where required.

- 3. Ceiling Boxes imbedded in concrete: Concrete ring type with top cover
- 4. Outlet boxes in masonry walls or embedded in concrete: Steel masonry type box.
- B. Cast Boxes: NEMA FB 1, material as specified in articles above. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

2.12 PULL AND JUNCTION BOXES

- A. Above Ground: Sheet Metal Boxes: NEMA OS 1, galvanized steel, NEMA Type 1 or 3R as required by installation location.
- B. In Ground: Fiberglass polymer concrete handhole with concrete polymer composite weatherproof cover with nonskid finish

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.02 EXISTING WORK

- A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.
- B. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.
- C. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.
- D. Extend existing raceway and box installations using materials and methods as specified.
- E. Clean and repair existing raceway and boxes to remain or to be re-installed.

3.03 INSTALLATION

- A. Ground and bond raceway and boxes in accordance with Section 26 05 26.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.
- C. Identify raceway and boxes in accordance with Section 26 05 53.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.04 INSTALLATION – RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- D. Group related raceways; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29 and provide space on each for 25 percent additional raceways.
- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports.
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Route exposed raceway parallel and perpendicular to walls.
- H. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- I. Route raceways in and under slab from point-to-point.
- J. Maintain clearance between raceway and piping for maintenance purposes.
- K. Maintain 12 inch (300 mm) clearance between raceway and surfaces with temperatures exceeding 104 degrees F (40 degrees C).
- L. Cut raceways square using saw or pipe cutter; de-burr cut ends.
- M. Bring raceways to shoulder of fittings; fasten securely.
- N. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe non-metallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- O. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in wet locations.
- P. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender to fabricate or provide factory elbows for bends in metal conduit larger than 1" size.
- Q. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- R. Install fittings to accommodate expansion and deflection where raceway crosses expansion joints.
- S. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- T. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

- U. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
- V. Close ends and unused openings in wireway.
- W. Outdoor Below Grade Locations: Burial depth per NEC requirements.
 - 1. Where crossing under or through exterior grade beams utilize only Schedule 80 conduit within 5' of either side of beam.
 - 2. Provide rigid steel or intermediate metal conduit (IMC) elbows at all changes of direction exceeding 30 degrees, including transitions to outdoor above grade locations. Wrap metal conduit with one application, half-lapped, of Minnesota Mining and Manufacturing Company "Scotchwrap" No. 51, Plymouth Rubber Co. "Plywrap 20" or Westape, Inc. 20 mil. Extend tape wrap to a minimum of 6" above grade.
 - 3. Where penetrating exterior walls into basements or finished spaces transition to rigid steel or intermediate metal conduit (IMC) before penetrating wall. Provide an OZ Gedney series "FSK," Link Seal "LS-200" series, or approved equal seal at each penetration location.
- X. Within or Under Concrete Construction Located On or Below Grade:
 - 1. For trade sizes 1" and smaller, transitions to concealed areas above slab may be made with non-metallic elbows and riser nipples. Convert to metallic conduit or tubing within maximum of 18" above slab.
 - 2. For trade sizes 1 1/4" and larger, and all transitions to exposed locations, provide rigid steel or intermediate metal conduit (IMC) elbows.
- Y. Interior Dry Locations (as defined by the NEC): Do not use EMT for exposed work within 48" above finished floor. Do not use EMT for medium voltage cables.
- Z. Lighting Fixtures:
 - 1. Conduit size shall be 1/2" minimum and shall not exceed six feet (1.8 M) maximum length. Conduit shall be long enough to allow movement of lay-in type fixtures for maintenance purposes.
 - 2. Conduit shall run directly from a junction box to a single fixture. Direct connections between fixtures utilizing flexible metal conduit is not acceptable.
- AA. Flexible metal conduit:
 - 1. Use only in dry locations and only where flexibility is necessary for connections to equipment or fixtures.
 - 2. Do not install aluminum type in locations less than 6' above finished floor or working surface.
- BB. Liquid-tight flexible metal conduit: Use in wet or dry locations where flexibility is

necessary for connections to equipment or for connections to lighting fixtures.

3.05 INSTALLATION – BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings.
- B. Adjust box location up to 10 feet (3 m) prior to rough-in to accommodate intended purpose.
- C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 05 27.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches (150 mm) horizontally from ceiling access panel or from removable recessed luminaire.
- F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches (150 mm) separation. Install with minimum 24 inches (600 mm) separation in acoustic rated walls.
- H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- I. Install stamped steel bridges to fasten flush mounting outlet box between studs.
- J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- K. Install adjustable steel channel fasteners for hung ceiling outlet box.
- L. Do not fasten boxes to ceiling support wires or other piping systems.
- M. Support boxes independently of conduit.
- N. Install gang box where more than one device is mounted together. Do not use sectional box.
- O. Install gang box with plaster ring for single device outlets.
- P. Outdoor Above Grade Locations and other Wet Locations (as defined by the NEC): Provide malleable cast iron outlet boxes, “FS” or “FD” series where recessed mounting of outlets is not feasible and for junction boxes in trade sizes 1” and smaller. Utilize malleable iron conduit bodies (condulets) at changes of direction and pull points. Galvanized NEMA 3R steel boxes may be used only at locations where specifically called for on the Drawings, or as approved by the Engineer.
- Q. Damp Locations: Provide malleable cast iron outlet boxes, “FS” or “FD” series where recessed mounting of outlets is not feasible and for junction boxes in trade sizes 1” and smaller. Utilize malleable iron conduit bodies (condulets) at changes of direction and pull

points. Galvanized steel boxes may be used only at locations where specifically called for on the Drawings.

3.06 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Section 07 84 00.
- B. Locate outlet boxes to allow luminaires to be positioned as indicated on the Drawings.
- C. Align adjacent wall mounted outlet boxes for switches, thermostats and similar devices.

3.07 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting and balancing.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused openings in boxes.

3.08 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean interior of boxes to remove dust, debris, and other material.
- C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Nameplates.
2. Labels.
3. Wire markers.
4. Conduit markers.
5. Underground Warning Tape.
6. Lockout Devices.
7. Panelboard Directories

B. Related Sections:

1. Section 09 90 00 - Painting and Coating: Execution requirements for painting specified by this section.
2. Section 26 05 19 – 600-Volt Building Wire and Cable
3. Division 27 – Communications.

1.02 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures.

B. Product Data:

1. Submit manufacturer's catalog literature for each product required.
2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location and function.

1.03 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

1.04 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing and protecting products.
- B. Accept identification products on site in original containers. Inspect for damage.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Install labels and nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.01 NAMEPLATES

- A. Furnish materials in accordance with referenced standards and authority having jurisdiction.
- B. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color. Use red lettering on nameplates for emergency system components.
- C. Letter Size:
 - 1. Panelboards, Switchboards and Motor Control Centers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify voltage rating, source and room location of the source.
 - 2. Equipment Enclosures: 1 inch (25 mm); identify equipment designation.
 - 3. Circuit Breakers, Switches, and Motor Starters in Panelboards or Switchboards or Motor Control Centers: 1/2 inch (13 mm); identify circuit and load served, including location.
 - 4. Individual Circuit Breakers, Disconnect Switches, Enclosed Switches, and Motor Starters: 1/2 inch (13 mm); identify source and load served.
 - 5. Transformers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify primary and secondary voltages, primary source, and secondary load and location.
- D. Minimum nameplate thickness: 1/8 inch.

2.02 LABELS

- A. Furnish materials in accordance with referenced standards and authority having jurisdiction.
- B. Labels: All labels shall be permanent, and machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS ARE ALLOWED. Exception: back side of device plates and junction boxes smaller than 8" X 8" may use handwritten, legible labeling on box covers,

unless specifically prohibited by other specification sections.

- C. Embossed tape will not be permitted for any application.

2.03 WIRE MARKERS

- A. Furnish materials in accordance with referenced standards.
- B. Description: Cable label size shall be appropriate for the conductor or cable size(s), outlet faceplate layout and patch panel design. All labels shall be self-laminating, machine generated and be wrapped around the cable or sheath. Flag type labels are not acceptable. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminate over the full extent of the printed area of the label.
- C. Legend:
 - 1. Control Circuits: Control wire number as indicated on schematic and interconnection diagrams.
- D. Tape (phase identification only): Scotch #35 tape in appropriate colors for system voltage and phase.

2.04 CONDUIT AND RACEWAY MARKERS

- A. Furnish materials in accordance with referenced standards.
- B. Description: Nameplate fastened with adhesive, labels fastened with adhesive and stencils.
- C. Color:
 - 1. Medium Voltage System: Black lettering on white background.
 - 2. 480 Volt System: Black lettering on white background.
 - 3. 208 Volt System: Black lettering on white background.
- D. Legend:
 - 1. Medium Voltage System: HIGH VOLTAGE.
 - 2. 480 Volt System: 480 VOLTS.
 - 3. 208 Volt System: 208 VOLTS.

2.05 UNDERGROUND WARNING TAPE

- A. Provide detectable underground warning tape, yellow background, black letters, 6" width, equal to Ideal #42-251, with suitable warning legend describing buried electrical lines.

2.06 LOCKOUT DEVICES

- A. Lockout Hasps:

1. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

2.07 PANELBOARD DIRECTORIES

- A. Typed directories for panels must be covered with clear plastic, have a metal frame. Room number on directories shall be Owner's numbers, not Plan numbers unless Owner so specifies.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.02 EXISTING WORK

- A. Install identification on existing equipment to remain in accordance with this section.
- B. Install identification on unmarked existing equipment.
- C. Replace lost nameplates, labels and markers.
- D. Re-stencil existing equipment.

3.03 INSTALLATION

- A. Install identifying devices after completion of painting.
- B. Nameplate Installation:
 1. Install nameplate parallel to equipment lines.
 2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
 4. Secure nameplate to equipment front using adhesive.
 5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
 6. Install nameplates for the following:
 - a. Switchboards.
 - b. Panelboards.
 - c. Transformers.
 - d. Service Disconnects.

- e. Motor Control Centers
 - 7. Nameplates shall include equipment designation, supply voltage, secondary voltage (for transformers) and feeder source designation.
- C. Label Installation:
 - 1. Install label parallel to equipment lines.
 - 2. Install label for identification of individual control device stations.
 - 3. Install labels for permanent adhesion and seal with clear lacquer.
- D. Wire Marker Installation:
 - 1. Install wire marker for each conductor at panelboard gutters, pull boxes, outlet and junction boxes.
 - 2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
 - 3. Install label for identification of health care facilities receptacles per NEC Article 517.
 - 4. Install labels at data outlets identifying patch panel and port designation.
- E. Underground Warning Tape Installation:
 - 1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION

SECTION 26 24 16 – PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Distribution and branch circuit panelboards.
2. Electronic grade branch circuit panelboards.
3. Load centers.

1.02 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:

1. NEMA PB 1 - Panelboards.
2. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

B. National Fire Protection Association:

1. NFPA 70 - National Electrical Code.

C. Underwriters Laboratories Inc.:

1. UL 50 - Cabinets and Boxes.
2. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
3. UL 1283 - Electromagnetic Interference Filters.
4. UL 1449 - Transient Voltage Surge Suppressors.
5. UL 1699 - Arc-Fault Circuit Interrupters.

1.03 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit catalog data showing specified features of standard products.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

D. Field Quality Control Submittals: Indicate results of Contractor furnished tests and inspections.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.
- C. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance products.

1.06 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years of experience.

PART 2 PRODUCTS

2.01 PANELBOARDS

- A. Acceptable Manufacturer List: Manufacturers are listed alphabetically:
 - 1. Cutler-Hammer.
 - 2. Square D.
- B. Substitution Limitations:
 - 1. Section 01 60 00 - Product Requirements: Requirements for substitutions for other manufacturers and products.
- C. Description: NEMA PB 1, panelboard.
- D. Operation:
 - 1. Service Conditions:
 - a. Temperature: <105 degrees F
 - b. Altitude: <6000 feet above sea level.
 - 2. Minimum integrated short circuit rating: as scheduled.
- E. Materials:
 - 1. Panelboard Bus: Aluminum, current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard.

2. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Furnish interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses unless otherwise scheduled.
 3. Molded Case Circuit Breakers: UL 489, circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide electronic trip units when specifically scheduled in lieu of thermal type. Furnish circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.
 4. Molded Case Circuit Breakers with Current Limiters: UL 489, circuit breakers with replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole. Provide electronic trip units when specifically scheduled in lieu of thermal type.
 5. Current Limiting Molded Case Circuit Breakers: UL 489, circuit breakers with integral overcurrent and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size NEMA FU 1, Class RK-5 fuse.
 6. Circuit Breaker Accessories: Trip units and auxiliary switches as scheduled.
 7. Enclosure: NEMA PB 1, Type as scheduled.
 8. Cabinet Front: Surface hinged trim type, fastened with screws.
 9. Contractor shall determine feed arrangement, top or bottom, to match installation. Where specific feed arrangements are shown on the drawings, the contractor shall adhere to those requirements.
 10. Furnish circuit directory inside door.
- F. Finishes:
1. Covers, trim and doors: Manufacturer's standard gray enamel. Provide full height side-hinged trim type covers. Door-in-door type construction is not acceptable.
 2. Enclosure: Galvanized.

2.02 ELECTRONIC GRADE PANELBOARD

- A. Description:
1. Integral Surge Suppressor: Component recognized in accordance with UL 1449 and UL 1283.
 2. Panelboard: UL 67 listed and TVSS device UL 1449 Component Recognized. TVSS device meets UL 1449. Furnish panelboard markings with clamp voltage at TVSS terminals and clamp voltage at panelboard line terminals.
- B. Performance:

1. Integral Surge Suppressers:
 - a. Meet or exceed the following criteria:
 - 1) Maximum single impulse current rating 80 kA, 120 kA, 160 kA, or 200 kA as scheduled for each phase.
 - 2) Pulse Lift Test: Capable of protecting against and surviving 5000 IEEE C62.41 Category C transients without failure or degradation.
 - 3) Clamping voltage not exceeding the following:

Voltage	L-N	N-G	L-G
208Y/120	500 V	500 V	500 V
480Y/277	1000 V	1000 V	1000 V

C. Fabrication:

1. Integral Surge Suppressor:
 - a. Furnish copper bus bars for surge current path.
 - b. Construct using surge current modules (MOV based). Each module fused with user replaceable 200,000 AIR rated fuses. Status of each module monitored on front cover of panelboard enclosure and on module.
 - c. Furnish with audible alarm activated when one of surge current modules has failed. Furnish alarm on/off to silence alarm and alarm push-to-test switch to test alarm. Locate switches and alarm on front cover of panelboard enclosure.
 - d. Furnish response time no greater than five nanoseconds for individual protection modes.
 - e. Designed to withstand maximum continuous operating voltage (MCOV) of not less than 115 percent of nominal RMS voltage.
 - f. Furnish visible indication of proper suppressor connection and operation. Lights indicate operable phase and module.
 - g. Furnish minimum EFI/RFI filtering of 34 dB at 100 kHz with insertion loss ratio of 50: 1 using Mil Std. 220A methodology.
2. Panelboards:
 - a. Furnish one circuit breaker, rating as recommended by manufacturer with appropriate number of poles, as dedicated disconnect for TVSS.
 - b. Furnish 200 percent rated neutral assembly with aluminum neutral bus.
 - c. Furnish with insulated ground bus and non-insulated equipment grounding bus.
 - d. Remainder of specification requirements shall be per Article 2.1.

2.03 SOURCE QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.
- B. Independently test integral surge suppressors with category C3 high exposure waveform (20 kV-1.2/50us, 10kA-8/20 us) per IEEE C62.41.

PART 3 EXECUTION

3.01 DEMOLITION

- A. Disconnect abandoned panelboards and load centers. Install blank cover for abandoned panelboards and load centers where specifically indicated on the Drawings.
- B. Maintain access to existing panelboard and load centers remaining active and requiring access. Modify installation or provide access panel.

3.02 INSTALLATION

- A. Install panelboards and load centers plumb.
- B. Install recessed panelboards flush with wall finishes.
- C. Height: Where height of panelboard permits, 6' above finished floor or working surface. Otherwise, mount higher but to remain in compliance with NEC Article 404.8(A) requirements.
- D. Install filler plates for unused spaces in panelboards.
- E. Provide typed circuit directory for each branch circuit panelboard. Identify each circuit as to its clear, evident and specific purpose of use.
- F. Install engraved plastic nameplates in accordance with Section 26 05 53.
- G. Install spare conduits out of each recessed panelboard to accessible location above ceiling. Minimum spare conduits: 3 empty 1 inch (DN27). Identify each as SPARE.
- H. Ground and bond panelboard enclosure according to Section 26 05 26. Connect equipment ground bars of panels in accordance with NFPA 70.

3.03 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

3.04 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.
- B. Measure and record steady state load currents at each panelboard feeder. Submit results to Engineer as part of close-out documents.

3.05 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean existing panelboards [and load centers] to remain or to be reinstalled.

END OF SECTION

SECTION 26 28 13 – 250 & 600 VOLT FUSES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes 250 and 600 volt fuses and spare fuse cabinet.

1.02 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures.
- B. Product Data: Submit data sheets showing electrical characteristics, including time-current curves.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual sizes, ratings and locations of fuses.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years of experience.

1.06 MAINTENANCE MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two fuse pullers.

1.07 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for extra materials.
- B. Furnish three spare fuses of each class, size and rating installed.

PART 2 PRODUCTS

2.01 FUSES

- A. Manufacturers:

1. Bussman.
 2. Littlefuse.
 3. Shawmut.
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Dimensions and Performance: NEMA FU 1, class as specified or as indicated on Drawings.
- C. Voltage: Rating suitable for circuit phase-to-phase voltage.
- D. Interrupting Rating for all Fuses: 200,000 rms amperes minimum.
- 2.02 CLASS RK1 FUSES
- A. Bussman Type LPN-RK__SP (250V), LPS-RK__SP (600V) or equivalent
 - B. Dimensions and Performance: UL Class RK1, NEMA FU 1, current limiting.
 - C. Time Delay: 10 seconds minimum at 500% rated current.
 - D. Voltage: Rating suitable for circuit phase-to-phase voltage.
- 2.03 CLASS RK5 FUSES
- A. Bussman Type FRN-R (250V), FRS-R (600V), or equivalent
 - B. Dimensions and Performance: UL Class RK1, NEMA FU 1, moderate current limiting.
 - C. Time Delay: 10 seconds minimum at 500% rated current.
 - D. Voltage: Rating suitable for circuit phase-to-phase voltage.
- 2.04 CLASS L (TIME DELAY) FUSES
- A. Bussman Type KRP-C__SP or equivalent
 - B. Construction: silver links with sand filler.
 - C. Dimensions and Performance: UL Class L, NEMA FU 1.
 - D. Time Delay: 4 seconds minimum at 500% rated current.
 - E. Interrupting Rating: 300,000 RMS symmetrical.
- 2.05 CLASS J (TIME DELAY) FUSES
- A. Bussman Type LPJ__SP, or equivalent
 - B. Time Delay: 10 seconds minimum at 500% rated current.

- C. Dimensions and Performance: UL Class J, NEMA FU 1.
- D. Interrupting Rating: 200,000 RMS symmetrical minimum.

PART 3 EXECUTION

3.01 EXISTING WORK

- A. Remove fuses from abandoned circuits.
- B. Maintain access to existing fuses and other installations remaining active and requiring access. Modify installation or provide access panel.

3.02 INSTALLATION

- A. Install fuse with label oriented so manufacturer, type and size are easily read.

END OF SECTION

SECTION 26 28 16 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes fusible switches, non-fusible switches, and molded case and insulated case circuit breakers in individual enclosures.
- B. Related Sections:
 - 1. Section 26 28 13 - Fuses.

1.02 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - 2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
 - 3. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures.
- B. Product Data: Submit switch ratings and enclosure dimensions.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of enclosed switches and circuit breakers with ratings of installed fuses.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section.

PART 2 PRODUCTS

2.01 FUSIBLE SWITCH ASSEMBLIES

- A. Manufacturers:
 - 1. Cutler Hammer.
 - 2. GE Electrical.

3. Siemens.
 4. Square D.
 5. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: NEMA KS 1, heavy-duty enclosed load interrupter knife switch. Handle lockable in OFF position.
 - C. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses.
 - D. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 1. Interior Dry Locations: Type 1.
 2. Exterior Locations: Type 3R or 4 as noted on plans.
 - E. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.
 - F. Furnish switches with entirely copper current carrying parts.

2.02 NON-FUSIBLE SWITCH ASSEMBLIES

- A. Manufacturers:
 1. Cutler Hammer.
 2. GE Electrical.
 3. Siemens.
 4. Square D.
 5. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: NEMA KS 1, heavy-duty enclosed load interrupter knife switch. Handle lockable in OFF position.
- C. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 1. Interior Dry Locations: Type 1.
 2. Exterior Locations: Type 3R or 4 as noted on plans.
- D. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.
- E. Furnish switches with entirely copper current carrying parts.

2.03 SWITCH RATINGS

- A. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.
- B. Short Circuit Current Rating: UL listed for 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes). 200,000 rms symmetrical amperes when used with or protected by Class L fuses (800-1200 ampere).

2.04 MOLDED CASE CIRCUIT BREAKER

- A. Manufacturers:
 - 1. Cutler Hammer.
 - 2. GE Electrical.
 - 3. Siemens.
 - 4. Square D.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Enclosed, molded-case circuit breaker conforming to NEMA AB 1, suitable for use as service entrance equipment where applied.
- C. Service Conditions:
 - 1. Temperature: 104 degrees F maximum.
 - 2. Altitude: 6,000 feet maximum.
- D. Field-Adjustable Trip Circuit Breaker: Circuit breakers with frame sizes 200 amperes and larger have mechanism for adjustment as noted on Drawings.
- E. Current Limiting Circuit Breaker: Circuit breaker indicated as current-limiting have automatically-resetting current limiting elements in each pole. Let-through Current and Energy: Less than permitted for same size Class RK-5 fuse.
- F. Solid-State Circuit Breaker: Electronic sensing, timing, and tripping circuits for adjustable current settings; and delays as noted on Drawings.
- H. Current Limiter: Designed for application with molded case circuit breaker.
 - 1. Coordinate limiter size with trip rating of circuit breaker to prevent nuisance tripping and to achieve interrupting current rating specified for circuit breaker.
 - 2. Interlocks trip circuit breaker and prevent closing circuit breaker when limiter compartment cover is removed or when one or more limiter is not in place or has operated.

- I. Accessories: As indicated on Drawings. Conform to NEMA AB 1. Typical devices include breaker locks, pad lock provisions, auxiliary switch, shunt-trip operators, and others as indicated.
- J. Enclosure: NEMA AB 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R or 4 or as noted on Drawings.
- K. Service Entrance: Circuit breakers identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

PART 3 EXECUTION

3.01 EXISTING WORK

- A. Disconnect and remove abandoned enclosed switches and circuit breakers.
- B. Maintain access to existing enclosed switches and circuit breakers and other installations remaining active and requiring access. Modify installation or provide access panel.
- C. Clean and repair existing enclosed switches to remain or to be reinstalled.

3.02 INSTALLATION

- A. Install enclosed switches and circuit breakers plumb. Provide supports in accordance with Section 26 05 29.
- B. Height: 5 feet to operating handle.
- C. Install fuses for fusible disconnect switches. Refer to Section 26 28 13 for product requirements.
- D. Install engraved plastic nameplates in accordance with Section 26 05 53.
- E. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.03 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing and adjusting.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.

3.04 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting and balancing.
- B. Adjust trip settings to coordinate circuit breakers with other overcurrent protective devices in circuit.
- C. Adjust trip settings to provide adequate protection from overcurrent and fault currents

END OF SECTION

SECTION 26 51 16 – INTERIOR LIGHTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes interior luminaires, lamps, ballasts and accessories.

1.02 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C82.1 – American National Standard for Lamp Ballast-Line Frequency Fluorescent Lamp Ballast.
 - 2. ANSI C82.4 – American National Standard for Ballasts-for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).

1.03 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings: Indicate dimensions and components for each luminaire not standard product of manufacturer.
- C. Product Data: Submit dimensions, ratings, and performance data.
- D. Samples: Submit two color chips 3 by 3 inch in size illustrating luminaire finish color where indicated in luminaire schedule.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of experience.

PART 2 PRODUCTS

2.01 INTERIOR LUMINAIRES

- A. Product Description: Complete interior luminaire assemblies, with features, options and accessories as scheduled on Drawings.
- B. Refer to Section 01 60 00 – Product Requirements for product options.

2.02 LED LIGHTING

- A. Screw-In Retrofit Lamps:
 - 1. Shall meet DOE's Energy Star or Design Light Consortium performance criteria for qualified screw-in or pin-based LED lamps.

2. Shall have Lamp CCTs conforming to ANSI C78.377A color binning and utilize a 4-step MacAdam Ellipse Algorithm binning process (Philips Optibin or equal) within each retrofit lamp for greater CCT consistency.
3. The CCT shall be 4000K unless otherwise approved. The CRI shall be ≥ 80 .
4. Each lamp shall have a power factor $\geq 90\%$.
5. Each lamp shall have total harmonic distortion (THD) $< 10\%$.
6. Shall be tested in accordance with LM-79-08 electrical and photometric measurements. Provide test results of each unique lamp.
7. Shall be tested in accordance with LM-80 lumen depreciation test. Provide test results of each unique lamp. The L70 rated life result shall be a minimum of 25,000 hours for MR11, 16 and candelabra lamps; 40,000 hours for PAR 20, 30, 38 and BR30 lamps.
8. Shall carry a 3-year minimum product warranty covering failure of ALL electrical components.

B. Luminaires

1. The luminaire manufacturer shall be registered as a DOE Quality Advocate.
2. Shall meet DOE's Energy Star or Design Light Consortium performance criteria.
3. The luminaire manufacturer shall provide the manufacturer's name of the LED being used in the luminaire.
4. Shall be UL or ETL listed and be furnished complete with LEDs and power supplies.
5. LED light source packages, arrays or modules used in the luminaire shall be tested in accordance with LM-80 lumen depreciation test. Provide test results of each unique package, array or module. The L70 rated life result shall be a minimum of 50,000 hours.
6. Shall be tested in accordance with LM-79-08 electrical and photometric measurements. Provide test results of each unique luminaire.
7. The CCT shall be 4000K unless otherwise approved. The CRI shall be ≥ 80 .
8. Each luminaire shall have a power factor ≥ 90 percent.
9. In instances where the LED sources are to be mounted directly into the architecture, such as installing a strip LED by using an adhesive tape, the LED manufacturer shall provide a recommended heat sink volume adequate to achieve rated life at L70.
10. Each luminaire shall carry a 3-year minimum product warranty covering failure of ALL electrical components.

C. Power Supplies

1. LED power supplies shall operate LEDs within the current limit specification of the manufacturer.
2. Shall operate from 60Hz input source and have input power factor >90 percent and a minimum efficiency of 70 percent at full rated load of the driver.
3. Shall have short circuit and overload protection.
4. Shall have a minimum starting temperature of 0 degrees F and a maximum case temperature rating of at least 70 degrees C.
5. Power supply output shall be regulated to +/-5 percent across published load range.
6. Shall have a Class A sound rating.
7. Shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47CFR part 15, non-consumer (Class A) for EMI/RFI.
8. Shall contain no PCBs.
9. Shall carry a 3-year minimum warranty from date of manufacturer against defects in material or workmanship, including a replacement, for operation at or below the maximum case temperature specification. (For LED lamps and internal power regulation components for defects resulting in a fixture lumen depreciation >30 percent.)
10. Dimmable power supplies shall allow the light output to be maintained at the lowest control setting (prior to off) without dropping out.

PART 3 EXECUTION

3.01 EXISTING WORK

- A. Disconnect and remove abandoned luminaires, lamps and accessories.
- B. Extend existing interior luminaire installations using materials and methods compatible with existing installations or as specified.
- C. Clean and repair existing interior luminaires to remain or to be reinstalled.

3.02 INSTALLATION

- A. Install suspended luminaires using pendants supported from swivel hangers. Install pendant length required to suspend luminaire at indicated height.
- B. Support luminaires 2 x 2 foot size and larger independent of ceiling framing.
- C. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

- D. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- E. Exposed Grid Ceilings: Support surface-mounted luminaires on grid ceiling directly from building structure.
- F. Install recessed luminaires to permit removal from below.
- G. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- H. Install clips to secure recessed grid-supported luminaires in place.
- I. Install wall-mounted luminaires at height as indicated on Drawings or as scheduled.
- J. Install accessories furnished with each luminaire.
- K. Connect luminaires to branch circuit outlets provided under Section 26 05 33 using 1/2" min. x 6'-0" max. flexible conduit, or type MC cable where allowed under other sections of this specification.
- L. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- M. Install specified lamps in each luminaire.
- N. Interface with air handling accessories furnished and installed under Section 23 37 00.
- O. Ground and bond interior luminaires in accordance with Section 26 05 26.

3.03 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Quality Requirements and Section 01 70 00 – Execution and Closeout Requirements: Field inspecting, testing, adjusting and balancing.
- B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.04 ADJUSTING

- A. Section 01 70 00 – Execution and Closeout Requirements: Testing, adjusting and balancing.
- B. Aim and adjust luminaires [as indicated on Drawings].

3.05 CLEANING

- A. Section 01 70 00 – Execution and Closeout Requirements: Final cleaning.
- B. Remove dirt and debris from enclosures.
- C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

3.06 PROTECTION OF FINISHED WORK

A. Section 01 70 00 – Execution and Closeout Requirements: Protecting finished work.

B. Relamp luminaires [having failed lamps] at Substantial Completion.

END OF SECTION

SECTION 26 56 16 – EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes exterior luminaires, poles and accessories.

1.02 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C82.1 - American National Standard for Lamp Ballast-Line Frequency Fluorescent Lamp Ballast.
 - 2. ANSI C82.4 - American National Standard for Ballasts-for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures.
- B. Shop Drawings: Indicate dimensions and components for each luminaire not standard Product of manufacturer.
- C. Product Data: Submit dimensions, ratings, and performance data.
- D. Samples: Submit two color chips 3 x 3 inch in size illustrating luminaire finish color where indicated in luminaire schedule.
- E. Light Layout: Provide a computer generated factory point to point foot-candle layout of the project for each area involved.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of experience.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

1.06 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

PART 2 PRODUCTS

2.01 LUMINAIRES

- A. Product Description: Complete exterior luminaire assemblies, with features, options and accessories as scheduled on Drawings.
- B. Refer to Section 01 60 00 - Product Requirements for product options.

2.02 LED LUMINAIRES

A. LED Pole Luminaires

1. Construction: Single-piece die-cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convective cooling. The LED drivers are mounted in direct contact with the casting to promote low operating temperature and long life. Housing is completely sealed against moisture and environmental contaminants (IP65). Finish: Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish. Minimum 3 mils thickness.
2. Optics: Precision-molded acrylic lenses are engineered for superior area lighting distribution, uniformity, and pole spacing. Light engine is standard 4000K zero upright and qualifies as a Nighttime Friendly™ product.
3. Electrical: High-efficacy LEDs mounted to a metal-core circuit board to maximize heat dissipation and promote long life (L87/100,000 hrs at 40°C). Class 1 electronic drivers have a power factor >90%, THD <20%, and an expected life of 100,000 hours with <1% failure rate.
4. Hardware: Stainless steel bolts fasten the mounting block securely to poles and walls.

B. LED Wall Luminaires

1. Construction: Two-piece die-cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convective cooling. The LED driver is mounted to the door to thermally isolate it from the light engines for low operating temperature and long life. Housing is completely sealed against moisture and environmental contaminants (IP65). Housing weep holes for wet location listing in the face-up orientation; this permits safe drainage while maintaining the luminaire's IP65 rating.
2. Finish: Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish. Minimum 3 mils thickness.
3. Optics: Precision-molded proprietary acrylic lenses with photometric distributions tailored specifically to building mounted applications. Light engines are 4000K (70 min.CRI), and qualifies as a Nighttime Friendly™ product when not mounted under a canopy or similar covering.
4. Electrical: High-efficacy LEDs mounted to a metal-core circuit board to maximize heat dissipation and promote long life. Class 1 electronic driver has a power factor >90%, THD <20%, and has an expected life of 100,000 hours with <1% failure rate.

5. Hardware: Universal mounting plate with integral mounting support arms.

2.03 METAL POLES

- A. Manufacturers:
 1. Millerbernd.
 2. Spaulding.
 3. Valmont.
- B. Substitutions: Section 01 60 00 - Product Requirements.
- C. Material and Finish: Steel, Bronze Polyester Powder Coat finish, unless noted otherwise on fixture schedule.
- D. Shape and Dimensions: Square straight, length per fixture schedule.
- E. Base: Non-Breakaway type, provide with bolt covers.
- F. Accessories:
 1. Anchor Bolts.
 2. Handhole.
- G. Loading Capacity Ratings:
 1. Luminaire Weight: Per Luminaire Supplier
 2. Luminaire EPA: Per Luminaire Supplier
 3. Wind Load Design: 90 mph steady wind, 1.3 gust factor.

2.04 POLE FOUNDATIONS

- A. Construct from reinforced concrete in sizes as shown on Drawings.
- B. The exposed surface area of the foundation shall have the forms removed and the concrete rubbed out to a smooth finish.

2.05 FUSES

- A. Furnish and install a fuse holder and fuse in each ungrounded leg of the electrical circuit supplying the outdoor luminaire. For pole-mounted fixture located behind handhole cover Bussman HCB series fuse holders with type FNM fuses or equal. Every luminaire shall be separately fused with a waterproof fuse holder. Size the fuse for the amperage of the luminaire. Tap the circuit conductors with a minimum #10 AWG conductor to serve the luminaire. The fuse and holder shall be accessible through the handhole. Provide sufficient wire to bring fuse holder outside of handhole.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and Project conditions.
- B. Verify foundations are ready to receive fixtures.

3.02 EXISTING WORK

- A. Disconnect and remove abandoned exterior luminaries.
- B. Extend existing exterior luminaire installations using materials and methods compatible with existing installations or as specified.
- C. Clean and repair existing exterior luminaries to remain or to be reinstalled.

3.03 INSTALLATION

- A. Install concrete bases for lighting poles at locations as indicated on Drawings in accordance with Section 03 30 00.
- B. Install poles plumb. Install double nuts to adjust plumb. Grout around each base.
- C. Install lamps in each luminaire.
- D. Bond and ground luminaries, metal accessories and metal poles in accordance with Section 26 05 26. Install supplementary grounding electrode at each pole.
- E. For wall mounted fixtures on exterior walls with metal wall panels, provide junction box mounted to structural wall with required extension ring brought out flush with face of metal panel. Install fixture mounting plate to face of panel with gasketing to seal around extension ring and wall panel. Coordinate installation with wall panel contractor. Ground fixture to equipment ground conductor for circuit.

3.04 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting and balancing.
- B. Operate each luminaire after installation and connection. Inspect for improper connections and operation.
- C. Measure illumination levels to verify conformance with performance requirements.
- D. Take measurements during night sky, without moon or with heavy overcast clouds effectively obscuring moon.

3.05 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting and balancing.

- B. Aim and adjust luminaries to provide illumination levels and distribution as indicated on Drawings and Submittals.

3.06 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean photometric control surfaces as recommended by manufacturer.
- C. Clean lens, finishes and touch up damage.

3.07 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.
- B. Relamp luminaries having failed lamps at Substantial Completion.

END OF SECTION

SECTION 31 10 00 - SITE CLEARING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes specifications for the removal and disposal of all trees, stumps, brush, roots, shrubs, vegetation, logs, rubbish and other objectionable material.
- B. Construction within public rights-of-way shall be governed by the City of Austin (COA), Standard Specifications Manual, current edition, unless otherwise noted.
- C. Related Sections:
 - 1. Section 015713 "Temporary Erosion and Sedimentation Control".
 - 2. Section 312000 "Earth Moving" for subgrade preparation, excavation, and backfill.

1.03 SUBMITTALS

- A. General
 - 1. A permit when utility adjustments are made in the right-of-way
 - 2. A plan for removal and deposition of all clearing and grubbing materials and debris

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

2.01 GENERAL

- A. Prior to commencement of this work, all required erosion control and tree protection measures indicated on the Drawings shall be in place. The existing utilities shall be located and protected as specified in the General and Supplementary Conditions and Division 01 Specification Sections and/or indicated on the Drawings. A permit shall be required when utility adjustments are to be made in preparation for construction in the right-of-way.
- B. Areas within the construction limits indicated on the Drawings shall be cleared of all trees, stumps, brush, etc.; except trees or shrubs scheduled for preservation which shall be carefully trimmed as directed, and shall be protected from scarring, barking or other injuries during construction operations. All exposed cuts over 2 inches (50 millimeters) in diameter, exposed ends of pruned limbs or scarred bark shall be treated with an approved asphalt material within 24 hours of the pruning or injury.
- C. Construction equipment shall not be operated, nor construction materials stockpiled, under the canopies of trees, unless otherwise indicated on the Drawings and/or specified in the

Contract Documents. Excavation or embankment materials shall not be placed within the drip line of trees until tree wells are constructed.

- D. Within the construction limits or areas indicated, all obstructions, stumps, roots, vegetation, abandoned structures, rubbish and objectionable material shall be removed to the following depths:
1. Any foundations from existing structures (such as light poles) should be demolished and completely removed from all proposed construction areas, to a depth of at least 24 inches below final grade.
 2. Roots of trees to be removed within construction areas should be grubbed to full depths, including the dry soil around the roots.
 3. All utilities and associated bedding materials that are planned to be abandoned/demolished should be removed from within the construction areas. If not possible, the abandoned utility lines should be thoroughly grouted and plugged with flowable fill.
- E. Holes remaining after removal of all obstructions, objectionable material, trees, stumps, etc. shall be backfilled with select embankment material and compacted by approved methods. All cleared and grubbed material shall be disposed of in a manner satisfactory to the Engineer. Unless otherwise provided, all materials as described above shall become the property of the Contractor and removed from the site and disposed of at a permitted disposal site.
- F. Burning materials at the site shall conform to General and Supplementary Conditions and Division 01 Specification Sections.

END OF SECTION

SECTION 31 20 00 - EARTH MOVING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Texas Department of Transportation (TxDOT) Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, adopted November 1, 2014.
- C. City of Austin (COA), Standard Specifications Manual, current edition.

1.02 SUMMARY

- A. Section includes specifications for the following:
 - 1. Excavation
 - 2. Subgrade preparation
 - 3. Borrow
 - 4. Embankment
 - 5. Proof rolling
- B. Construction within public rights-of-way shall be governed by the City of Austin (COA), Standard Specifications Manual, current edition, unless otherwise noted.
- C. Related Sections:
 - 1. Section 015713 "Temporary Erosion and Sedimentation Control"
 - 2. Section 311000 "Site Clearing"

1.03 SUBMITTALS

- A. General
 - 1. Plan for removal and deposition of all waste materials
 - 2. Blasting permit if blasting is required and allowed on the project
 - 3. Plan identifying source, material type, classification and characteristics (P.I., optimum moisture-density, etc.) of embankment layers, in-situ subgrade soils, proposed borrow material
 - 4. Type and size of equipment proposed to produce the required compaction
 - 5. The manufacturer, model and description of the proposed dust control equipment
 - 6. The sprinkling plan including application rate, pattern of sprinkling and scheduled times of application
 - 7. Source, gradation, and test results for the crushed limestone material
 - 8. Field density test results for in-place compacted subgrade, embankment, and base

PART 2 PRODUCTS

2.01 BORROW

- A. Borrow will be used only when indicated on the Drawings or directed by the Engineer and shall only be acquired from approved sources.

- B. Borrow for paving areas shall have a PI less than 30.

2.02 EMBANKMENT

- A. General
 - 1. Excavated on-site processed limestone and Stratum Ia/I/II soils, if free of organics, debris, and rocks larger than 4 inches, may be considered for use as fill in pavement, landscape, or other general areas.
- B. Rock Embankments
 - 1. The maximum dimension of any rock used in embankment shall be less than the thickness of the embankment layer and in no case shall any rock over 2 feet (600 mm) in its greatest dimension be placed in the embankment, unless otherwise approved by the Engineer.
 - 2. All oversized rocks, which are otherwise suitable for construction, shall be broken to the required dimension and utilized in embankment construction where indicated. When preferred by the Contractor and acceptable to the Engineer, oversized rocks may be placed at other locations where the embankment layer is of greater depth, thus requiring less breakage.

PART 3 EXECUTION

3.01 GENERAL

- A. Prior to commencement of this work, all required erosion control and tree protection measures shall be in place. The existing utilities shall be located and shall be protected as specified in the General and Supplementary Conditions and Division 01 Specification Sections and/or indicated on the Drawings. A permit shall be required when utility adjustments are to be made in preparation for construction in the right-of-way.
- B. Construction equipment shall not be operated, nor construction materials stockpiled, under the canopies of trees, unless otherwise indicated on the Drawings. Excavation or embankment materials shall not be placed within the drip line of trees until tree wells are constructed.
- C. No material shall be stockpiled within the banks of a waterway.

3.02 DUST CONTROL

- A. Materials
 - 1. Water shall be furnished by the Contractor and shall be clean and free from industrial wastes and other objectionable matter.
- B. General
 - 1. It shall be the Contractor's continuous responsibility at all times, including nights, holidays and weekends until acceptance of the project by the Owner, to maintain the specified areas relatively free of dust in a manner that will cause the least inconvenience to the public.

3.03 EXCAVATION

- A. General

1. All excavation shall be unclassified and shall include all materials encountered regardless of their nature or the manner in which they are removed.
2. All excavation shall be performed as specified herein and shall conform to the established alignment, grades and cross sections indicated on the Drawings. Suitable excavated materials shall be utilized, insofar as practical, in constructing required embankments.
3. Unsuitable excavated materials or excavation in excess of that needed for construction shall be known as "Waste" and shall become the property of the Contractor. Unsuitable material encountered below the subgrade elevation in pavement cuts, when declared "Waste" by the Engineer, shall be replaced with material from the pavement excavation or with other suitable material as approved by the Engineer. It shall become the Contractor's responsibility to dispose of this material in an environmentally sound manner at a permitted disposal site.
4. All blasting shall conform to the Provisions of the General and Supplementary Conditions and Division 01 Specification Sections. In all cases, a Blasting Permit must be obtained in advance from the regulating authority.
5. Adequate dewatering and drainage of excavation shall be maintained throughout the time required to complete the excavation work.
6. Stump holes or other small excavations encountered within the limits of the embankments shall be backfilled with suitable material and thoroughly tamped by approved methods before commencement of the embankment construction.

3.04 SUBGRADE PREPARATION

A. General

1. The subgrade shall be prepared sufficiently in advance to ensure satisfactory prosecution of the Work.
2. The Contractor shall set blue tops for the subgrade at maximum intervals of 50 feet (15 meters) in each direction.
3. The surface of the subgrade shall be scarified and shaped in conformity with the typical sections and the lines and grades indicated on the Drawings; by the removal of existing material or addition of approved material as established by the Engineer. Any deviation in the subgrade cross section which exceeds $\frac{1}{2}$ inch in a length of 10 feet (12 mm in a length of 3 meters), measured longitudinally, shall be corrected by loosening, adding or removing material, and then reshaping and compacting by sprinkling and rolling.

B. Proofrolling

1. Once final subgrade elevations have been achieved, the exposed subgrade shall be carefully proofrolled with a 20-ton (minimum weight) pneumatic roller or a fully loaded dump truck to detect weak zones in the subgrade, in accordance with the requirements in this Section.
2. All unsuitable material shall be removed and replaced with soils exhibiting similar classification, moisture content, and density as the adjacent in-situ soils.

C. Density

1. It is the intent of this specification to provide the required density and moisture control for the subgrade based on the plasticity characteristics of the approved materials. The subgrade materials shall be sprinkled as required and compacted to the extent necessary to provide the density specified below, unless otherwise indicated on the Drawings. The Plasticity Index (P.I.) will be established in accordance with TxDOT Test Methods Tex-104-E, Tex-105-E and Tex-106-E. The density determination will be made in accordance with TxDOT Test Method Tex-114-E and field density measurements will be made in accordance with TxDOT Test Method Tex-115-E.

Description	PI	Density, Percent	Range or Moisture Contents for Compaction
Subgrade and Paving Fill	Less than 25	Not less than 95	-3% minimum +3% maximum
Subgrade and Paving Fill	Greater than 25	Not less than 95	Optimum minimum +4% maximum
Crushed Limestone Base		Not less than 95	-3% minimum +3% maximum

2. Subgrade materials on which planting or turf will be established shall be compacted to a minimum of 85 percent of the density as determined in accordance with TxDOT Test Method Tex-114-E. Field tests for density in accordance with TxDOT Test Method Tex-115-E will be made as soon as possible after compaction operations are completed. If the material fails to meet the density specified, it shall be reworked as necessary to obtain the density required.
3. Prior to placement of any base materials, the in-place density and moisture content of the top 6 inches (150 mm) of compacted subgrade shall be checked. If the tests indicate that the relative density and moisture do not meet the limits specified in the table above, the subgrade shall be reworked as necessary to obtain the specified compaction and moisture content. All initial testing will be paid for by the Owner. All retesting shall be paid for by the Contractor.

3.05 BORROW

A. General

1. The Contractor shall arrange for borrow from one of the following sources:
 - a. Existing borrow pit
 - b. New borrow pit
 - c. Surplus excavated material from a site, with a site development permit
2. The Contractor shall notify the Engineer 3 weeks prior to opening a pit or any other borrow source to allow necessary testing for approval of materials. All borrow sites shall comply with the requirements of the site development permit.
3. During construction, borrow sources shall be kept drained to permit final cross sections to be measured, when required.
4. Borrow sites shall be managed and maintained to minimize the impact of the appearance of the natural topographic features and at no time create a potential hazard to the public.

3.06 EMBANKMENT

A. General

1. The area of embankment placement shall be proof rolled and any unstable or spongy areas shall be undercut and backfilled with suitable material or otherwise mechanically manipulated and compacted by approved methods. Where shown on the Drawings or required by the Engineer, the ground surface thus prepared shall be compacted by sprinkling and rolling. The surface of the ground, including those plowed and loosened or roughened by small washes, shall be restored to approximately its original slope and the ground surface thus prepared shall be compacted by sprinkling and rolling.
2. Unless otherwise indicated on the Drawings and with the exception of rock, the surface of the ground of all unpaved areas, which are to receive embankment, shall be loosened by scarifying or plowing to a depth of not less than 4 inches (100 mm). The loosened material shall be re-compacted with the new embankment as hereinafter specified.

3. The surface of hillsides, which are to receive embankment, shall be loosened, by scarifying or plowing, to a depth of not less than 4 inches (100 mm) and benches constructed before the embankment materials are placed. The embankment shall then be placed in layers, as hereinafter specified, beginning at the low side with partial width layers and increasing the widths of the layers as the embankment is raised. The material, which has been loosened during preparation of the original ground surface, shall be re-compacted simultaneously with the embankment material placed at the same elevation.
 4. Where embankments are to be placed adjacent to or over existing pavements, the pavement slopes shall be plowed or scarified to a depth of not less than 6 inches (150 mm) and the embankment along the pavement slopes shall be built up in successive layers, as hereinafter specified, to the elevation of the old pavement. Then, if specified, the top surface of the old pavement shall be scarified to a minimum depth of 6 inches (150 mm) and re-compacted along with the next layer of the new embankment. The total depth of the scarified and added material shall not exceed the permissible layer depth, specified hereinafter.
 5. Trees, stumps, roots, vegetation or other unsuitable materials shall not be placed in embankment.
 6. All embankment shall be constructed in layers approximately parallel to the finished grade.
 7. The embankment shall be continuously maintained at its finished section and grade until that portion of the work is accepted. After completion of the embankment to the finished section and grade, the Contractor shall proof roll the subgrade or finished grade. Any unstable or spongy areas shall be undercut and backfilled with suitable material or otherwise mechanically manipulated and compacted by approved methods. After acceptance of the embankment, re-vegetation activities shall commence immediately to minimize the soil loss and air pollution.
- B. Rolling
1. The embankment layer shall be sprinkled.
 2. Rolling with a power roller shall start longitudinally at the sides of the designated area and proceed towards the center, overlapping on successive trips by at least 1/2 the width of the rear wheel of the power roller.
 3. The rollers, unless otherwise directed by the Engineer or designated representative, shall be operated at a speed between 2 and 3 miles (3 and 5 kilometers) per hour.
- C. Earth Embankment
1. Earth embankments shall be defined as embankments composed of soil material other than rock and shall be constructed of acceptable material from approved sources.
 2. Unless directed otherwise, earth embankments shall be constructed in successive layers, with a thickness of 8 inches (200 mm) or less in loose measure, for the full width of the individual cross section and in a length that is best suited to the sprinkling and compaction methods utilized.
 3. Minor quantities of rocks with a maximum dimension of 4 inches (100 mm) may be incorporated in the earth embankment layers, provided that the rock is not placed immediately adjacent to structures.
 4. Each layer of embankment shall be uniform as to material type and classification, density and moisture content before beginning compaction.
 5. Where layers of unlike materials abut each other, each layer shall be feathered on a slope of 1:20 or the materials shall be so mixed as to prevent abrupt changes in the soil.
 6. Any material placed in the embankment by dumping in a pile or windrows shall not be incorporated in a layer in that position. All such piles or windrows shall be incorporated in an embankment layer by blading and mixing or by similar methods.
 7. Clods or lumps of material shall be broken down into smaller sizes and the embankment material in a layer shall be mixed by blading, harrowing, discing or similar methods to ensure that a uniform material of uniform density is secured in each layer.
 8. The water required in sprinkling the layers, to obtain the moisture content necessary for optimum compaction, shall be evenly applied. It shall be the responsibility of the Contractor

to secure uniform moisture content throughout the layer by such methods as may be necessary.

9. All earth cuts, whether full width or partial width side hill cuts and which are not required to be excavated below the subgrade elevation, shall be scarified to a uniform depth of at least 6 inches (150 mm) below grade. The material shall be mixed and reshaped by blading, sprinkled and rolled in accordance with the requirements outlined above for earth embankments to the same density required for the adjacent embankment.
10. Each layer shall be compacted to the required density by any method, and/or type and size of equipment, which will produce the required compaction. Prior to and in conjunction with the rolling operation, each layer shall be brought to the moisture content necessary to obtain the required density and shall be kept leveled with suitable equipment to insure uniform compaction over the entire layer.
11. It is the intent of this specification to provide the required density and moisture control for each layer of earth embankment and select material based on the plasticity characteristics of the embankment soil. Each layer shall be sprinkled as required and compacted to the extent necessary to provide the density specified below, unless otherwise indicated.

Description	PI	Density, Percent	Range or Moisture Contents for Compaction
Subgrade and Paving Fill	Less than 25	Not less than 95	-3% minimum +3% maximum
Subgrade and Paving Fill	Greater than 25	Not less than 95	Optimum minimum +4% maximum
Crushed Limestone Base		Not less than 95	-3% minimum +3% maximum

12. The Plasticity Index (PI) will be established in accordance with TxDOT Test Methods Tex-104-E, Tex-105-E and Tex-106-E and the density determination will be made in accordance with TxDOT Test Method Tex-114-E, "Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade and Embankment Soil". Field density measurements will be made in accordance with TxDOT Test Method Tex-115-E, "Field Method for Determination of In-Place Density of Soils and Base Materials".
13. After each layer of earth embankment or select material is complete, tests, as necessary, will be conducted as directed by the Engineer. If the material fails to meet the density specified, the course shall be reworked as necessary to obtain the specified compaction.

D. Rock Embankments

1. Rock embankments shall be defined as those composed principally of rock and shall be constructed of accepted material from approved sources. Rock embankments shall not be placed immediately adjacent to structures.
2. Except as otherwise indicated on the Drawings, rock embankments shall be constructed in successive layers of 18 inches (450 mm) or less in thickness for the full width of the cross section. When, in the opinion of the Engineer, the rock sizes necessitate a greater thickness of layer than specified, the layer thickness may be increased as necessary, but in no case shall the thickness of layer exceed 2½ feet (750 mm).
3. Each layer shall be constructed by starting at one end and dumping the rock on top of the layer being constructed then pushing the material ahead with a bulldozer in such a manner that the larger rock will be placed on either the ground or the preceding embankment layer. Each layer shall be constructed in such a manner that the interstices between the larger stones are filled with small stones and spalls which have been created by this operation and from the placement of succeeding layers of material.

4. Each layer shall be compacted to the required density as outlined for "Earth Embankments", above, except in those layers where rock will make density testing difficult, the Engineer may accept the layer by visual inspection or proof rolling.
5. Unless otherwise indicated, the upper 3 feet (1 meter) of the embankment shall not contain stones larger than 4 inches (100 mm) in their greatest dimension and shall be composed of material so graded that the density and uniformity of the surface layer may be secured in accordance with TxDOT Test Method Tex-114-E.
6. Exposed oversize material shall be broken up or removed.

3.07 PROOF ROLLING

A. Equipment

1. The proof rolling equipment shall have a loading platform or body suitable for ballast loading that is supported on a minimum of two (2) axles with not more than two (2) pneumatic tired wheels per axle. All wheels shall be arranged so that they will carry approximately equal loads when operating on uneven surfaces. Pneumatic proof rolling equipment with multiple pivotal axles and more than two tires along the front or rear axle axis shall have articulating axle supports to equally distribute the load to all tires over uneven surfaces.
2. The proof roller unit, under working conditions, shall have a minimum contact width of 7½ feet (2.3 meters) and shall be so designed that the gross roller weight may be varied uniformly from 25 tons to 50 tons (23 megagrams to 45 megagrams) by ballast loading. The tires shall be capable of operating under various loads with variable air pressures up to 145 psi (up to 1000 kiloPascals). The tires shall be smooth tread and shall impart a minimum ground contact pressure of 75 pounds per square inch (520 kiloPascals). Tires shall be practically full of liquid (i.e. when liquid will flow from the valve stem of a fully inflated tire with the stem in the uppermost position). The operating load and tire pressure shall be within the range of the manufacturer's chart as directed by the Engineer.
3. The proof roller shall be drawn by a power train of adequate tractive effort or may be of a self-propelled type. The proof rolling equipment shall be equipped with a reverse mode transmission or be capable of turning 180 degrees in a street width. When a separate power train is used to draw the proof roller, the power train weight shall not be considered in the weight of the proof roller. The power train shall be rubber-tired when rolling subgrade and base materials. A cleated or track-type power train may be used on earth and rock embankments.

B. Execution

1. The entirety of prepared surfaces to be tested shall be proof rolled by a minimum of two passes of the proof roller tires. Each succeeding trip of the proof roller shall be offset by not greater than one tire width.
2. Proof rollers shall be operated at speeds between 2 and 6 miles per hour (3 and 10 kilometers per hour) or as directed by the Engineer.
3. Acceptable limits of elastic and plastic deformation of prepared subgrade courses shall be established by proof rolling test sections of representative soil conditions, previously tested and approved for density and moisture requirements of the governing subgrade and earth embankment items. Proof rolling of first course base over a plastic subgrade may be waived by the Engineer if it is determined that the prepared first course base will be damaged by the proof roller.

C. Subgrade

1. The subgrade shall be tested by proof rolling prior to placement of the first course of base material. Any unstable or spongy subgrade areas identified by proof rolling shall be corrected either by additional re-working, drying and compaction, or by removal and replacement of unsuitable materials. When specifically directed by the Engineer, the Contractor shall re-work the subgrade as follows:

- a. Remove the unstable subgrade to the full depth of the unstable insitu material or to a minimum depth of 6 inches (150 mm), whichever is greater.
 - b. Spread the material over a sufficient area to allow reworking of the excavated material.
 - c. Disc, scarify or otherwise breakup the excavated material and allow to dry (Note: If approved by the Engineer, the addition of lime or other additive may be used to aid in the drying process or to stabilize the unstable material).
 - d. Fill the excavated area with the re-worked material and compact to specified densities.
 - e. Proof roll the re-worked area.
2. Unstable organic subgrade soils shall not be reworked but shall be permanently removed and replaced with materials approved by the Engineer.
 3. All suitable material removed by excavation may be utilized in the subgrade with the approval of the Engineer. All other material required for completion of the Subgrade, shall also be subject to approval by the Engineer.
- D. Embankment Construction
1. All embankment courses shall be proof rolled, unless otherwise directed by the Engineer.
 2. If required by the Engineer, stability testing of embankments constructed to the finished elevation shall either be conducted with a standard proof roller or alternate equipment, which can be proven to impart a horizontal and vertical pressure distributions equivalent to or greater than those induced by a standard proof roller.

END OF SECTION

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Texas Department of Transportation (TxDOT) Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, adopted November 1, 2014.
- C. City of Austin (COA), Standard Specifications Manual, current edition.

1.2 SUMMARY

- A. Section includes specifications for construction of the following, except when constructed within public rights-of-way, or within 5 feet of any building:
 - 1. Concrete pavement for drives and parking
 - 2. Concrete curbs and gutters
 - 3. Concrete sidewalks and ramps
 - 4. Precast concrete bumper curbs
 - 5. Concrete paver units
 - 6. Miscellaneous concrete site slabs
- B. Construction within public rights-of-way shall be governed by the City of Austin (COA), Standard Specifications Manual, current edition, unless otherwise noted, including the following:
 - 1. Clayton Lane
 - 2. Wilhelmina Delco Drive
- C. Related Sections:
 - 1. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
 - 2. Section 033053 "Miscellaneous Cast-in-Place Concrete" for miscellaneous site concrete structures.
 - 3. Section 312000 "Earth Moving" for subgrade preparation, excavation, and backfill.
 - 4. Section 321316 "Decorative Concrete Paving" for stamped concrete other than detectable warnings.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

- A. Concrete
 - 1. Mix design for each class of concrete required on the project

2. Supplier and type of mixing equipment
 3. Supplier current TCEQ and EPA authorizations to operate the facility.
 4. Appropriate mortar and grout mix designs
 5. Admixtures:
 - a. Type of admixtures to be used with the concrete mixes
 - b. Certification that proposed admixture meet the requirements of this specification, ASTM C260 and ASTM C494
 6. Evaporation retardants:
 - a. Type and manufacturer of proposed evaporation retardant
 - b. Confirmation that the evaporation retardant meets the requirements of test results for TxDOT DMS-4650
 7. Epoxies and/or adhesives:
 - a. Type and manufacturer of proposed epoxy and/or adhesives
 - b. Confirmation that it meets the requirements of test results for TxDOT DMS-6100
- B. Reinforcing Steel
1. Evidence that the steel reinforcement producer is included on the TxDOT list of approved producing mills
 2. Listing of the size, grade, type and quantity of reinforcing steel proposed for the project
 3. If welding of reinforcing steel is proposed:
 - a. Evidence that carbon equivalent (C.E.) of the proposed steel is at least 0.55% with a report of chemical analysis showing the percentages of elements necessary to establish C.E.
 4. When mechanical splices are proposed:
 - a. The types of couplers proposed for use
- C. Fibrous Concrete
1. Concrete Type, Supplier and Design
 2. Fiber Type, Supplier and product properties
 3. Proposed proportioning of material, including adjustment for slump requirements
 4. Fiber documentation of compliance with applicable building codes, this specification item, and ASTM C 1116/C 1116 M-08
- D. Joints and Joint Sealant
1. Type and manufacturer of all joint materials proposed for use
 2. Technical data indicating that proposed products meet the requirements specified herein
 3. Sealant Type (Rubber-Asphalt, Polymer Modified Emulsion, Low Modulus Silicone or Polyurethane), Class and method of application (crack sealing, joint sealing, etc)
 4. Manufacturer recommendations concerning the use of primer and backer rod
 5. Manufacturer recommended equipment and procedures for preparation, dispensing, application, curing etc of the sealant
 6. Manufacturer certification that the product to be supplied meets or exceeds the specifications
- E. Curing
1. Proposed curing methods and procedures
 2. Type and manufacturer for all membrane curing materials proposed
 3. Type and manufacturer for all polyethylene firm curing materials proposed
- F. Concrete paver units
1. Samples for initial selection from manufacturer color charts showing the full range of colors, textures and patterns for each type of paving unit indicated on the Drawings
 2. Shop drawings indicating pattern orientation and cross section details
 3. Manufacturer Certification that the Interlocking Paving Units meet or exceed all the requirements of ASTM C-936 and this specification item

PART 2 - PRODUCTS

2.1 BASE

A. General

1. Subbase or base materials shall be per the Drawings and in accordance with Section 312000, "Earth Moving".

2.2 FORMS

A. General

1. Forms shall be of metal, well-seasoned wood or other approved material of a section satisfactory to the Engineer.
2. Wood forms shall not be less than 2 inches (50 mm) nominal thickness for straight runs and 1-inch (25-mm) nominal thickness for curved runs. Forms shall be clean, straight, free from warp and of a depth equal to the thickness of the finished work.
3. Metal forms shall be as required to maintain the true shape without warping or bulging. All bolt and rivet heads on the facing sides shall be countersunk. Clamps, pins or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms, which do not present a smooth surface or line up properly, shall not be used. Metal shall be kept free from rust, grease or other foreign materials.
4. Flexible or curved forms shall be used for curves of 100-foot (30 meter) radius or less.
5. Form or form lumber that will be reused shall be maintained clean and in good condition. Lumber that is split, warped, bulged, or marred or that has defects that will produce inferior forms shall not be used but shall be removed from the work.

2.3 REINFORCEMENT

A. General

1. Steel reinforcing shall be open-hearth, basic oxygen or electric-furnace new billet steel.
2. Unless indicated otherwise on the drawings, bar reinforcement shall be Grade 60 and must conform to ASTM A615/615M.
3. The nominal deformed bar size of reinforcing steel bars shall be designated in 1/8 inches.
4. Smooth, round bars shall be designated by size number through a No. 4. Smooth bars above No. 4 shall be designated by diameter in inches.

B. Welded Wire Fabric

1. Welded wire fabric shall conform to ASTM A 185 or A 497.
2. Where deformed wire is required, the size number shall be preceded by D and for smooth wire the prefix W shall be shown.
3. Welded wire fabric shall be designated in 1/100 inches, and specified as follows: 6 x 12 - W16 x W8, which indicates a 6 in. (150 mm) longitudinal wire spacing and 12-in (300 mm) transverse wire spacing with smooth No. 16 (103) wire longitudinally and smooth no. 8 (52) wire transversely.
4. Longitudinal and transverse wires shall be electrically welded together at all points of intersection and the welds shall be of sufficient strength that they will not be broken during handling or placing. All welding and fabrication of fabric sheets shall conform to the requirements of ASTM A 185.
5. Mats that have been bent or wires dislocated or parted during shipping or project handling shall be realigned to within 1/2 inch (13 mm) of original horizontal plane of the mat. Mats with any portion of the wires out of vertical alignment more than 1/2 inch (13 mm) after

realignment and/or wires dislocated or mutilated so that, in the opinion of the Engineer, they do not represent the original mat, shall be rejected.

6. Welded steel wire fabric shall be furnished in sheets as indicated and steel having been previously bundled into rolls will not be accepted. An approved hinge will be permitted in each sheet to provide for each sheet longitudinally. When wire fabric is used, it will replace only the longitudinal and transverse bars. The tie bars and load transmission units at joints will not be affected.
7. Tightly adhered scale or rust which resists removal by vigorous wire brushing need not be removed except that excessive loss of section to the reinforcement due to rust shall be cause for rejection. Excessive loss of section shall be defined as loss of section to the extent that the reinforcement will no longer meet the physical requirements for the size and grade of steel specified.

C. Chairs and Supports

1. Chairs and Supports shall be steel, precast mortar or concrete blocks cast in molds of sufficient strength to position the reinforcement as indicated on the drawings when supporting the dead load of the reinforcement, the weight of the workers placing concrete and the weight of the concrete bearing on the steel. Chairs shall be plastic coated when indicated on the drawings.
2. Steel chairs shall have a base with 9 inch² (58 cm²) minimum area or sufficient area to prevent the chair from sinking into fill or subgrade. Precast mortar or concrete blocks meeting the requirements of this item may be used.

D. Bending

1. The reinforcement shall be bent cold, true to the shapes indicated on the drawings. Bending shall preferably be done in the shop. Irregularities in bending shall be cause for rejection. Improperly fabricated, damaged or broken bars shall be replaced at no additional expense to the Owner. Damaged or broken bars embedded in a previous concrete placement shall be repaired using a method approved by the Engineer.
2. Unless otherwise indicated on the drawings, the inside diameter of bar bends, in terms of the nominal bar diameter (d), shall be as follows:

Bar Number in 1/8 inches (mm)	Diameter
3, 4, 5 (10, 13, 16)	4d
6, 7, 8	6d
9, 10, 11 (29, 32, 36)	8d
14, 18 (43, 57)	10d

E. Tolerances

1. Fabricating tolerances for bars shall not be greater than as follows:
 - a. Bar length, 1 inch
 - b. Any bend, 1/2 inch
 - c. Spiral or circular tie, 1/2 inch
 - d. Stirrup or tie, 1/2 inch

F. Splices

1. Splicing of bars, except when indicated on the drawings or specified herein, will not be permitted without written approval of the Engineer.
2. Any splicing shall conform to the requirements in the Table below.

Minimum Lap Requirements		
Bar Number in 1/8 inches (mm)	Uncoated Lap Length	Coated Lap Length
3 (10)	1 foot 4 inches (0.4 meters)	2 foot 0 inches (0.610 meters)
4 (13)	1 foot 9 inches (0.533 meters)	2 foot 8 inches (0.813 meters)
5 (16)	2 foot 2 inches (0.660 meters)	3 feet 3 inches (0.991meters)
6 (19)	2 foot 7 inches (0.787 meters)	3 feet 11 inches (1.194 meters)
7 (22)	3 feet 5 inches (1.041 meters)	5 feet 2 inches (1.575 meters)
No. 8 (25)	4 feet 6 inches (1.372 meters)	6 feet 9 inches (2.057 meters)
No. 9 (29)	5 feet 8 inches (1.727 meters)	8 feet 6 inches (2.591 meters)
No. 10 (32)	7 feet 3 inches (2.210 meters)	10 feet 11 inches (3.327 meters)
No. 11 (36)	8 feet 11 inches (2.718 meters)	13 feet 5 inches (4.089 meters)

3. Welded wire fabric shall be spliced using a lap length that includes an overlap of at least 2 cross wires plus 2 inches (50 mm) on each sheet or roll. No splice of less than 6 inches (150 mm) will be permitted. Splices in the #3 (10M) bars shall have a minimum lap of 12 inches (300 mm).
4. End preparation for butt-welding reinforcing bars shall be done in the field, except Bar No. 6 and larger shall be done in the shop. Delivered bars shall be of sufficient length to permit this practice.
5. Unless otherwise indicated on the drawings, dowel bars transferring tensile stresses shall have a minimum embedment equal to the minimum lap requirements shown in the table above. Shear transfer dowels shall have a minimum embedment of 12 inches (300 mm).

G. Mechanical Couplers

1. When mechanical splices in reinforcing steel bars are indicated on the drawings, the following types of couplers may be used:
 - a. Sleeve-filler
 - b. Sleeve-threaded
 - c. Sleeve-swaged
 - d. Sleeve-wedge

H. Storage of Materials

1. Steel reinforcement shall be stored above the surface of the ground upon platforms, skids or other supports and shall be protected as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcement shall be free from dirt, paint, grease, oil or other foreign materials. Reinforcement shall be free from injurious defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scale will not be cause for rejection, provided the minimum dimensions, cross sectional area and tensile properties of a hand wire brushed specimen meets the physical requirements for the size and grade of steel indicated on the drawings.

I. Fiber Reinforcement

1. Reinforcement shall be in accordance with ASTM C 1116/C 1116 M-08. Fibers shall conform to section 4.1.2 Type 2 Glass Fiber-Reinforced Concrete, or 4.1.3 Type 3 Synthetic Fiber-Reinforced Concrete, or 4.1.4 Natural Fiber-Reinforced Concrete.
2. Reinforcement shall be 100% virgin polypropylene fibrillated fibers specially manufactured for use as concrete reinforcement and meeting the requirements of ASTM C-1116 (Fiber-Reinforced Concrete and Shotcrete). The fibrous material shall not contain reprocessed

- olefin. Each container of fibrous material shall bear the manufacturer's name and/or trademark and the net weight (mass) of fibrous material in the package.
3. The fiber manufacturer shall provide documentation of a minimum of 5-year performance history of the fiber and confirm compliance with applicable building codes, this specification item and ASTM C-1116.
 4. The specific gravity of the fibrous material shall be 0.91 plus or minus .05. The tensile strength shall be 80 to 110 ksi (550 to 750 MPa). The lengths of the fibrous material shall be ½, ¾, 1½ and 2 inches (12.7, 19, 38 and 51 mm) in length.
 5. Unless otherwise shown on the drawings, each cubic yard of concrete shall contain no less than 1½ pounds of fibrous material (0.9 kg per cubic meter). The fibrous material shall be added to the concrete mix at the time the mix is batched.

2.4 JOINTS

A. Asphalt Board

1. Preformed asphalt board shall be formed from cane or other suitable fibers of a cellular nature securely bound together and uniformly impregnated with a suitable asphaltic binder and meeting the requirements of the Standard Specifications for Preformed Expansion Joint Filler for Concrete (Bituminous Type), ASTM D 994.
2. Boards shall be smooth, flat and straight throughout and shall be sufficiently rigid to permit easy installation.
3. Boards that crack or shatter during installing and finishing operations will not be acceptable.
4. When tested in accordance with TxDOT Test Method Tex-524-C the asphalt boards shall not deflect from the horizontal more than ¾ inch in 3½ inches (19.3 cm in 90 cm).

B. Non-bituminous Fiber Material

1. Preformed non-bituminous fiber material shall meet the requirements of the Standard Specifications for the Preformed Expansion Joint Filler for Concrete Paving and Structural Construction, ASTM D 1751, except that the requirements pertaining to bitumen content, density and water absorption shall be voided.

C. Boards

1. Board shall be obtained from Redwood, Cypress, Gum, Southern Yellow Pine or Douglas Fir timber. They shall be solid heartwood and shall be free from sapwood, knots, clustered birdseye, checks and splits. Occasional sound or hollow birdseye, when not in clusters, will be permitted provided the board is free from any other defects that will impair its usefulness as a joint filler.
2. With the exception of Redwood and Cypress, all boards shall have a creosote or pentachlorophenol treatment of 6 pounds per cubic foot (96 kg/m³).
3. When oven dried at 230°F (110°C) to a constant weight, the weight of the board per cubic foot (minus treatment), shall not be less than 20 pounds nor more than 35 pounds (not less than 320 nor more than 561 kgs per cubic meter).

D. Joint Sealer

1. Unless otherwise indicated on the drawings a Class 4, 5 or 7 low-modulus silicone sealant shall be provided that conforms to the requirements of TxDOT DMS-6310, "Joint Sealants and Fillers".
2. The joint sealer shall adhere to the sides of the concrete joint or crack and shall be an effective seal against infiltration of water and incompressibles. The material shall not crack or break when exposed to low temperature.

E. Backer Rod

1. Backer Rod shall be expanded closed cell polyethylene foam compatible with sealant. No bond or reaction shall occur between rod and sealant. Backer Rod shall be of sufficient width to be in compression after placement and shall be used with joint sealer.

- F. Rebonded Recycled Tire Rubber
 1. This material shall consist of granular particles of rubber, made by grinding automobile and truck tires, securely bound together by a synthetic resin or plastic binder. The filler must be molded into sheets of the required dimensions, which meet the testing requirements of both ASTM D 1751 and ASTM D 1752, except that the requirements for asphalt content and expansion are waived. The density of the material must be at least 30 lb/ft³ (440kg/m³).

- G. Load Transmission Devices for Expansion and Control Joints
 1. When indicated, one end of each dowel bar shall be encased in an approved cap having an inside diameter of 1/16 inch (16 mm) greater than the diameter of the dowel bar. The cap shall be of such strength, durability and design as to provide free movement of the dowel bar and shall be approved by the Engineer prior to use. One end of the cap shall be filled with a soft felt plug or shall be void in order to permit free movement of the dowel bar for a distance equivalent to 150 percent of the width of the expansion joint used. The dowel caps and dowel bars shall be held securely in place by bar ties as indicated on the drawings. Mechanical methods of implanting dowel bars in the plastic concrete may be used when approved by the Engineer.
 2. Where required, dowel bars shall be coated with a plastic material meeting the requirements indicated.
 3. Where red lead and oil bar coating is indicated, the red lead may be of any standard commercial grade and the oil shall be clean and no lighter than Standard No. 30 SAE grade. Approved thinner and dryer may be added to the red lead, but the material upon application shall be of such consistency that will provide a uniform and heavy coating on the bar. Where asphalt bar coating is indicated, the material may be any standard grade of oil asphalt and shall be applied hot. Cutback asphalt will not be permitted for bar coating.

- H. Cleaning and Sealing Joints and Cracks in Concrete Pavement
 1. Joints and/or cracks shall be sealed with the type and/or class of materials indicated on the Drawings.
 2. The materials shall conform to the requirements of TxDOT Departmental Materials Specification No. DMS-6310, "Joint Sealants and Seals".
 3. Primers, if required, shall be as recommended by the manufacturer of the sealant. Backer rods, when required, shall be compatible with the sealant and shall not react with or bond to the sealant.
 4. The sealing compound shall be delivered in the manufacturer's original sealed containers. Each container shall be legibly marked with the name of the manufacturer, the trade name of the sealer, the manufacturer's batch number or lot, the pouring temperature, and the safe heating temperature.
 5. All equipment shall be in accordance with the sealant manufacturer's recommendations. Air compressors shall be equipped with appropriate filters for removing oil and water from the air.
 6. Any equipment, that damages dowels, reinforcing steel, concrete, base, subbase or subgrade in the process of cleaning the joints and/or cracks, shall be discontinued and the joint and/or crack shall be cleaned by other methods approved by the Engineer, which do not cause such damage.

2.5 CONCRETE

- A. General
 1. Concrete shall be composed of hydraulic cement or hydraulic cement and supplementary cementing materials, water, aggregates (fine and coarse), and admixtures proportioned and mixed as hereinafter provided to achieve specified results.
 2. Fine and coarse aggregates, mineral filler, bulk cement and fly ash shall be weighed separately. Allowances shall be made in the water volume and aggregate weights during

batching for moisture content of aggregates and admixtures. Measurement of materials in non-volumetric and volumetric mixers shall conform to Section 421.4.D of TxDOT Specification Item 421, "Hydraulic Cement Concrete".

B. Cementitious Materials

1. Portland cement shall conform to ASTM C 150, Type I (General Purpose) or Type III (High Early Strength).
2. If the use of high early cement is not specified on the Drawings and the Contractor desires to use it, the Contractor shall obtain written permission from the Engineer prior to its use and shall assume all additional costs incurred by the use of such cement. All cement shall be of the same type and from the same source for a project unless written permission is first received from the Engineer.
3. Bulk or sacked cement may be used and a bag shall contain 94 pounds (42.6 KG) net. All bags shall be in good condition at the time of inspection.
4. Fly ash (denoted by Texas DOT designations Type A and Type B) may replace 20 to 35 percent of a mix design's Portland cement content by absolute volume. Fly ash shall not be used in mix designs with less than 5 sacks of portland cement per cubic yard.

C. Admixtures

1. General
 - a. Concrete admixtures conforming to the requirements below may be used when approved by the Engineer to minimize segregation, improve workability, reduce the amount of mixing water and to provide normal hot weather concreting provisions. The use of admixtures shall not alter the approved mix designs, except for water content.
 - b. The Contractor shall submit the name of the admixture proposed and manufacturer's certification that the selected admixtures meet the requirements of this item and of ASTM C 260 and C 494 as applicable. Admixtures for a mix design shall be of the same brand. If more than one admixture is proposed in the concrete mix, a statement of compatibility of components shall accompany certification. Manufacturer's product literature shall specify when in the batching/mixing operation the admixture must be added.
 - c. No admixture shall be chloride-based or have chloride(s) added in the manufacturing process.
 - d. Admixtures must be pretested by the Texas Department of Transportation (TXDOT) Materials and Tests Engineer and be included in the State's current approved admixture list.
2. Air Entraining Admixture:
 - a. An "Air Entraining Admixture" is defined as a material which, when added to a concrete mixture in the proper quantity, will entrain uniformly dispersed microscopic air bubbles in the concrete mix.
 - b. The admixture shall meet the requirements of ASTM Designation: C 260 modified as follows:
 - 1) The cement used in any series of test shall be either the cement proposed for the specific work or a "reference" Type I cement from one mill.
 - 2) The air entraining admixture used in the reference concrete shall be Neutralized Vinsol Resin.
3. Water-reducing Admixture:
 - a. A "Water-reducing Admixture" is defined as a material which, when added to a concrete mixture in the correct quantity, will reduce the quantity of mixing water required to produce concrete of a given consistency and required strength.
 - b. This admixture shall conform to ASTM C 494, Type A.
4. Accelerating Admixture:
 - a. An "Accelerating Admixture" is defined as an admixture that accelerates the setting time and the early strength development of concrete.

- b. This admixture shall conform to ASTM C 494, Type C. The accelerating admixture will contain no chlorides.
5. Water-reducing, Retarding Admixture:
 - a. A "Water-reducing, Retarding Admixture" is defined as a material which, when added to a concrete mixture in the correct quantity, will reduce the quantity of mixing water required to produce concrete of a given consistency and retard the initial set of the concrete.
 - b. This admixture shall conform to ASTM C 494, Type D.
6. High-range Water Reducing Admixtures:
 - a. A "High-range Water Reducing Admixture", referred to as a superplasticizer, is defined as a synthetic polymer material which, when added to a low slump concrete mixture increases the slump without adversely affecting segregation, impermeability or durability of the mix.
 - b. This admixture shall conform to ASTM C 494, Type F or G.
7. Fly Ash:
 - a. Fly ash used in Portland cement concrete as a substitute for Portland cement or as a mineral filler shall comply with TXDOT Materials Specification D-9-8900 and be listed on TXDOT's current list of approved fly ash sources. Fly ash obtained from a source using a process fueled by hazardous waste (30 Texas Administrative Code, Section 335.1) shall be prohibited. This applies to any other specification concerning the use of fly ash. Contractor shall maintain a record of source for each batch. Supplier shall certify that no hazardous waste is used in the fuel mix or raw materials.

D. Coarse Aggregate

1. Coarse aggregate shall consist of durable particles of crushed or uncrushed gravel, crushed blast furnace slag, crushed stone or combinations thereof; free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material either free or as an adherent coating. Quality shall be reasonably uniform throughout.
2. When white hydraulic cement is specified, the coarse aggregates used in the concrete shall be light colored.
3. The coarse aggregate from each source shall not contain more than 0.25 percent by weight of clay lumps, nor more than 1.0 percent by weight of shale nor more than 5 percent by weight of laminated and/or friable particles when tested in accordance with TXDOT Test Method TEX-413-A.
4. The coarse aggregate from each source shall have a wear of not more than 40 percent when tested in accordance with TXDOT Test Method TEX-410-A.
5. Unless otherwise indicated on the drawings, the coarse aggregate from each source shall be subjected to 5 cycles of the soundness test conforming to TXDOT Test Method TEX-411-A. The loss shall not be greater than 12 percent when sodium sulfate is used or 18 percent when magnesium sulfate is used.
6. Coarse aggregate shall be washed. The Loss by Decantation (TXDOT Test Method TEX-406-A), plus allowable weight of clay lumps, shall not exceed 1 percent or the value indicated on the drawings or in the project manual, whichever is less. If material finer than the # 200 (75 micrometer) sieve is definitely established to be dust of fracture of aggregates made primarily from crushing of stone, essentially free from clay or shale as established by Part III of TXDOT Test Method TEX-406-A, the percent may be increased to 1.5. When crushed limestone coarse aggregate is used in concrete pavements, the decant may exceed 1% but not more than 3% if the material finer than the #200 (75 micrometer) sieve is determined to be at least 67% calcium carbonate in accordance with TxDoT Test Method Tex-406-A, Part III.
7. The coarse aggregate factor may not be more than 0.82; however, when voids in the coarse aggregate exceed 48 percent of the total rodded volume, the coarse aggregate factor shall not exceed 0.85. The coarse aggregate factor may not be less than 0.68 except for a Class I machine extruded mix that shall not have a coarse aggregate factor lower than 0.61.

8. When exposed aggregate surfaces are required, the coarse aggregate shall consist of particles with at least 40 percent crushed faces. Uncrushed gravel, polished aggregates and clear resilient coatings are not acceptable for exposed aggregate finishes.
9. Recycled crushed concrete fine aggregate shall be limited to a maximum of 20% of the fine aggregate.
10. The use of recycled crushed hydraulic cement concrete as a coarse aggregate shall be limited to Concrete Classes A, B and D.
11. When tested by approved methods, the coarse aggregate including combinations of aggregates when used, shall conform to the grading requirements shown in the table below.

Coarse Aggregate Gradation Chart (Percent Passing)										
Grade	Nom. Size	2½" (62.5mm)	2" (50mm)	1½" (37.5mm)	1" (25mm)	¾" (19mm)	½" (12.5mm)	3/8" (9.5mm)	No. 4 (4.75mm)	No. 8 (2.36mm)
1	2" (50 mm)	100	80—100	50—85		20—40			0—5	
2 (467)*	1½" (37.5 mm)		100	95—100		35—70		10—30	0—5	
3	1" (50 mm)		100	95—100		60—90	25—60		0—5	
4 (57)*	1" (50 mm)			100	95—100		25—60		0—10	0—5
5 (67)*	¾" (19 mm)				100	90—100		20—55	0—10	0—5
6 (7)*	½" (12.5 mm)					100	90—100	40—70	0—15	0—5
7	3/8" (9.5 mm)						100	70—95	0—25	
8	3/8" (9.5 mm)						100	95—100	20—65	0—10

E. Fine Aggregate

1. Fine aggregate shall be washed and consist of clean, hard, durable and uncoated particles of natural or manufactured sand or a combination thereof, with or without a mineral filler. Quality shall be reasonably uniform throughout.
2. When white hydraulic cement is specified, the fine aggregates used in the concrete shall be light colored.
3. It shall be free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material and it shall not contain more than 0.5 percent by weight of clay lumps in accordance with TEX-413-A. When subjected to color test for organic impurities per TXDOT Test Method TEX-408-A, it shall not show a color darker than standard.
4. Unless indicated otherwise on the drawings the acid insoluble residue of fine aggregate used in slab concrete subject to direct traffic shall not be less than 60 percent by weight (mass) when tested conforming to TXDOT Test Method TEX-612-J.
5. Unless indicated otherwise on the Drawings, fine aggregate shall be blended, when necessary, to meet the acid insoluble residue requirement.
6. Recycled crushed concrete fine aggregate shall be limited to a maximum of 20% of the fine aggregate.
7. The use of recycled crushed hydraulic cement concrete as a fine aggregate shall be limited to Concrete Classes A, B and D.

8. When tested in accordance with TxDoT Test Method Tex-401-A, the fine aggregate, including mineral filler and combinations of aggregates, when used, shall conform to the grading requirements shown in the table below.

Fine Aggregate Gradation Chart (Grade 1 - Percent Passing)							
3/8 (9.5 mm)	No. 4 (4.75 mm)	No. 8 (2.36 mm)	No. 16 (1.18mm)	No. 30 (600 µm)	No. 50 (300 µm)	No. 100 (150 µm)	No. 200 (75 µm)
100	95—100	80—100	50—85	25—65	10—35 ¹	0—10	0—3 ²
<ol style="list-style-type: none"> 1. 6 to 35 when sand equivalent value is greater than 85. 2. 0 to 6 for manufactured sand. 							

9. Sand equivalent per TXDOT Test Method TEX-203-F shall not be less than 80 nor less than otherwise indicated on the drawings, whichever is greater.
10. The fineness modulus will be determined by adding the percentages by weight retained on sieve Nos. 4, 8, 16, 30, 50 and 100 (4.75 mm, 2.36 mm, 1.18mm, 600 µm, 300 µm, and 150 µm) and dividing the sum of the six sieves by 100. For all classes of concrete, the fineness modulus shall be between 2.30 and 3.10.

F. Mineral Filler

1. Mineral filler shall consist of stone dust, clean crushed sand or other approved inert material. When tested in accordance with TxDoT Test Method Tex-401-A, it shall conform to the following gradation:

Passing the No. 30 (600 µm) Sieve	100 percent
Passing the No. 200 (75 µm) Sieve	65 to 100 percent

G. Mixing Water

1. Water for use in concrete and for curing shall be potable water free of oils, acids, organic matter or other deleterious substances and shall not contain more than 1,000 parts per million of chlorides as Cl or sulfates as SO₄.
2. Water from municipal supplies approved by the State Health Department will not require testing. Contractor shall sample and test water from other sources and submit test results to the Engineer for approval 10 days prior to proposed use. Tests shall be made in accordance with "Standard Method of Test for Quality of Water to be used in Concrete," AASHTO Method T-26.
3. Water shall be accurately metered.

H. Evaporation Retardants

1. Evaporation retardants shall conform to the requirements of TxDoT DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants". The evaporation retardant must be a commercially available monomolecular film compound. The evaporation retardant shall have no adverse effect on the cement hydration process or the concrete and shall reduce surface moisture evaporation from the concrete when performing concrete operations in direct sun, wind, high temperatures, or low relative humidity. The producer of the evaporation retardant shall certify that it meets these specified requirements.

I. Air Entrainment

1. Unless indicated otherwise on the drawings, all concrete classes with the exception of Class B shall be air entrained in accordance with the table below. If the air content is more than 1½ percentage points below or 3 percentage points above the required air, the load

of concrete will be rejected. If the air content is more than 1½ but less than 3 percentage points above the required air, the concrete may be accepted based on strength test results.

Air Entrainment		
Nominal Maximum Aggregate Size, Inches (mm)	% Air Entrainment	
	Moderate Exposure	Severe Exposure
3/8 (9.5)- Grades 7 & 8	6	7½
½ (12.5)- Grades 6	5½	7
¾ (19)- Grades 5	5	6
1 (25)- Grades 4	4½	6
1½ (37.5)- Grades 2 & 3	4½	5½
2 (50)- Grades 2	4	5

- J. Epoxy
 - 1. Unless indicated otherwise on the drawings, epoxy materials shall conform to TxDOT DMS-6100, "Epoxy and Adhesives".

- K. Mortar and Grout
 - 1. Mortar and grout shall consist of 1 part hydraulic cement and 2 parts sand with sufficient water to provide the desired consistency.
 - 2. Mortar shall be provided with a consistency that can be handled easily and spread by a trowel.
 - 3. Grout shall be provided with a consistency that will flow into and completely fill all voids.

- L. Precast Bumper Curbs
 - 1. Bumper curbs shall be composed of precast concrete.
 - 2. All reinforcing steel shall be #3 (10M) bar.

- M. Paver Units
 - 1. Paving units shall be modular concrete pavers conforming to ASTM Designation: C 936, "Solid Concrete Interlocking Paving Units" and the requirements specified in this Item. The paver units shall be made using normal weight aggregates conforming to ASTM C-33.
 - 2. Pigments used in concrete paver units shall be synthetic iron oxide and shall be alkali-resistant, light fast, water insoluble, chemically inert and weather resistant.
 - 3. When required in conjunction with a bedding layer for the concrete paver units or with paver closure units, the grout mix shall be composed of one part portland cement, one part masonry cement (or ¼ part hydrated lime), parts of concrete sand equal to 2½ to 3 times the sum of the volumes of the cement and lime used, and sufficient water to make the mixture plastic.

- N. Storage of Materials
 - 1. Cement, Supplementary Cementing Materials and Mineral Filler
 - a. All cement, supplementary cementing materials and mineral filler shall be stored in separate and well ventilated, weatherproof buildings or approved bins, which will protect the material from dampness or absorption of moisture. Storage facilities shall be easily accessible and each shipment of packaged cement shall be kept separated to provide for identification and inspection.
 - b. The Engineer may permit small quantities of sacked cement to be stored in the open for a maximum of 48 hours on a raised platform and under waterproof covering.
 - 2. Admixtures

- a. Admixtures shall be stored in accordance with manufacturer's recommendations and shall be protected against freezing.
3. Aggregates
 - a. The method of handling and storing concrete aggregates shall prevent contamination with foreign materials. If the aggregates are stored on the ground, the sites for the stockpiles shall be clear of all vegetation and shall be level. Aggregates shall be stockpiled in sizes to facilitate blending. If the aggregate is not stockpiled on a hard, non-contaminant base, the bottom 6-inch (150 mm) layer of the stockpile shall not be used without recleaning the aggregate.
 - b. When conditions require the use of 2 or more grades of coarse aggregates, separate stockpiles shall be maintained to prevent intermixing. Where space is limited, stockpiles shall be separated by walls or other appropriate barriers.
 - c. Aggregate shall be stockpiled and protected from the weather a minimum of 24 hours prior to use to minimize free moisture content. When stockpiles are too large to protect from the weather, accurate and continuous means acceptable to the Engineer shall be provided to monitor aggregate temperature and moisture. Aggregates shall be stockpiled and handled such that segregation and contamination are minimized.
 - d. The stockpiles shall be sprinkled to control moisture and temperature as necessary. A reasonably uniform moisture content shall be maintained in aggregate stockpiles.

2.6 CONCRETE MIX

A. Mix Design

1. The Contractor shall furnish a mix design acceptable to the Engineer for the class of concrete required in accordance with the table below. The mix shall be designed by a qualified commercial laboratory and signed/sealed by a registered Professional Engineer, licensed in the state of Texas to conform with requirements contained herein, to ACI 211.1 or TXDOT Bulletin C-11 (and supplements thereto). The maximum water-to-cementitious material ratio identified in the table for specific classes of concrete shall not be exceeded.

Classes of Concrete						
Class	Cement Sacks Per CY	Minimum Strength, psi (MPa)		Maximum W/C Ratio, by weight	Coarse Aggr. Grade	Air Entrain.
		28 Days	7 Days			
A	5.0 (280 kg/m ³)	3000 (20.6)	2100 (14.5)	0.6	2,3,4,8	Yes
B	4.0 (225 kg/m ³)	2000 (13.8)	1400 (9.7)	0.6	2,3,4,5,6,7	No
C	6.0 (335 kg/m ³)	3600(24.8)	2520 (17.4)	0.45	2,3,4,5,6	Yes
D	4.5 (252 kg/m ³)	2500 (17.2)	1750 (12.1)	0.6	2,3,4,5,6,7	No
J	2.0 (112 kg/m ³)	800 (5.5)	560 (3.9)	N/A	2,3,4,5	No
S	6.0 (335 kg/m ³)	4000 (27.6)	2800 (19.3)	0.45	2,3,4,5	Yes

2. A higher-strength class of concrete with equal or lower water-to-cementitious-material ratio may be substituted for the specified class of concrete.
3. The mix design shall be over-designed in order to account for production variability and to ensure minimum compressive strength requirements are met.
4. The Contractor shall perform, at the Contractor's expense, the work required to substantiate the design, including testing of strength specimens.
5. Approved admixtures that are included in the prequalified concrete admixtures list maintained by TxDOT's Construction Division may be used with all classes of concrete at

the option of the Contractor provided that specific requirements of the governing concrete structure specification are met.

6. Water reducing and retarding agents shall be required for hot weather, large mass, and continuous slab placements.
7. Air entraining agents may be used in all mixes but must be used in the classes indicated. Unless approved by the Engineer, mix designs shall not exceed air contents for extreme exposure conditions as recommended by ACI 211.1 for the various aggregate grades.

B. Mix Design Options

1. For class of concrete designed using more than 520 lbs. of cementitious material per cubic yard (310 kgs per cubic meter), one of the mix design options presented below shall be used.
2. For class of concrete designed using less than 520 lbs. of cementitious material per cubic yard (310 kgs per cubic meter), one of the mix design options presented below will be used, except that Class C fly ash may be used instead of Class F fly ash for Options 1, 3 and 4 unless a sulfate-resistant concrete is required.
 - a. Option 1: Twenty (20) to thirty-five (35) percent of the cement may be replaced with Class F fly ash.
 - b. Option 2: Thirty-five (35) to fifty (50) percent of the cement may be replaced with ground granulated blast-furnace slag.
 - c. Option 3: Thirty-five (35) to fifty (50) percent of the cement may be replaced with a combination of Class F fly ash, ground granulated blast-furnace slag or silica fume. The combination may not include more than thirty-five (35) percent fly ash and no more than ten (10) percent silica fume.
 - d. Option 4: Type IP or Type IS will be used and up to ten (10) percent of the cement may be replaced with Class F fly ash, ground granulated blast-furnace slag or silica fume.
 - e. Option 5: Thirty-five (35) to fifty (50) percent of the cement may be replaced with a combination of Class C fly ash and at least six (6) percent of silica fume, ultra fine fly ash or metakaolin. The combination may not include more than thirty-five (35) percent fly ash and no more than ten (10) percent silica fume.
 - f. Option 6: A lithium nitrate admixture will be added at a minimum dosage of 0.55 gal. of thirty (30) percent lithium nitrate solution per pound of alkalis present in the hydraulic cement.
 - g. Option 7: When hydraulic cement only is used in the design, the total alkali contribution from the cement in the concrete does not exceed 4.0 lbs. per cubic yard.

C. Consistency

1. Concrete shall be workable, cohesive, possess satisfactory finishing qualities and of stiffest consistency that can be placed and vibrated into a homogeneous mass within slump requirements specified in the table below without the development of segregation or honeycombing. No concrete will be permitted with a slump in excess of the maximums shown unless water-reducing admixtures have been previously approved. Concrete that exceeds the maximum acceptable placement slump at time of delivery will be rejected. Slump values shall be conducted in accordance with TXDOT Test Method TEX-415-A.

Slump Requirements		
Type of Construction	Slump, inches (mm)	
	Maximum	Minimum
Heavy Duty Pavements and Driveways	6½ (165)	4 (100)
Sidewalks and Medium Duty Pavement and Driveways	4 (100)	2 (50)
Curbs and Gutters, Hand-vibrated	3 (75)	1 (25)

Slump Requirements		
Type of Construction	Slump, inches (mm)	
	Maximum	Minimum
Curbs and Gutters, Hand-tamped or spaded	4 (100)	2 (50)
High Strength Concrete	4 (100)	3 (75)

2. Consistency and quality of concrete should allow efficient placement and completion of finishing operations before initial set. Re-tempering (i.e. addition of water and reworking concrete after initial set) shall not be allowed. When field conditions are such that additional moisture is needed for final concrete surface finishing operation, the required water shall be applied to surface by fog spray only and shall be held to a minimum. Excessive bleeding shall be avoided and in no case will it be permissible to expedite finishing and drying by sprinkling the surface with cement powder.
3. Since the slump of a fiber-reinforced concrete is less than the slump of an otherwise identical concrete without fiber and since the magnitude of difference depends upon the amount and type of fibers, trial mixtures representing the amount and type of fibers to be used for the work shall be prepared and tested to ensure that the specified slump requirements are met.

2.7 CONCRETE MIXING

A. General

1. Concrete may be provided by one of the following:
 - a. Batched and/or mixed at a plant and delivered by a transit-mix truck
 - b. Batched and mixed by a mobile volumetric batching and mixing unit
 - c. Batched and mixed by hand
2. All equipment necessary for construction of this item shall be on the Project and shall be approved by the Engineer before the Contractor will be permitted to begin construction operations on which the equipment is to be used.
3. All equipment, tools and machinery used for hauling materials and performing any part of the work shall be maintained in such condition to insure completion of the work without excessive delays for repairs and replacement.
4. Mixing equipment shall be capable of producing sufficient concrete to provide required quantities.
5. Improperly mixed concrete shall not be placed.
6. An adequate water supply and an accurate method of measuring the water shall be provided.

B. Transit-Mix (Ready-Mix) Concrete

1. The central batching plant and mixer trucks meet the requirements of ASTM C 94, Ready-mixed Concrete.
2. Mixing shall be done in a mixer that will produce uniform distribution of material throughout the mass and shall be capable of producing concrete meeting. The concrete shall be delivered to the project in a thoroughly mixed and uniform mass and shall be discharged with a satisfactory degree of uniformity. Additional mixing at the job site, at the mixing speed designated by the manufacturer, may be allowed by the Engineer as long as the concrete is discharged before the drum has revolved a total of 300 revolutions after the introduction of the mixing water to the cement and the aggregates.
3. Additional mortar (1 sack cement, 3 parts sand and sufficient water) shall be added to each batch to coat the mixer drum. This shall be required for every load of concrete. The mixing speed shall be attained as soon as all ingredients are in the mixer.

4. A ticket system will be used that includes a copy for the Inspector. Ticket will have machine stamped time/date of concrete batch, a mix design designation, weight of cement, fly ash, sand and aggregates; exact nomenclature and written quantities of admixtures and water. Any item missing or incomplete on ticket may be cause for rejection of concrete.
5. Sufficient trucks will be available to support continuous placements.
6. When the concrete contains silica fume, mixing times and batching operations shall be adjusted as necessary to ensure that the material is completely and uniformly dispersed in the mix. The dispersion of the silica fume within the mix shall be verified in trial batches.
7. Mixing and agitating speed shall be as designated by the mixer manufacturer. All revolutions after prescribed mixing shall be at agitating speed. Except for short periods of time during discharge, the drum shall be kept in continuous motion from the time the mixing is started until the discharge is completed.
8. A portion of mixing water required by the mix design to produce the specified slump may be withheld and added at the job site, but only with permission of the Engineer and under the Inspector's observation. When water is added under these conditions, the drum or blades shall be turned at least 30 additional revolutions at mixing speed to ensure thorough and uniform mixing of the concrete. When water is added, the mix design water-cementitious-material ratio shall not be exceeded. Water or chemical admixtures shall not be added to the batch after any concrete has been discharged.
9. Additional cement shall not be added at the job site to otherwise unacceptable mixes.
10. A metal plate shall be attached in a prominent place on each truck mixer plainly showing the various uses for which it was designed. The data shall include the drum's speed of rotation for mixing and for agitating and the capacity for complete mixing and/or agitating only.
11. The loading of the transit mixers shall not exceed capacity as shown on the manufacturer's plate attached to the mixer or 63 percent of the drum volume, whichever is the lesser volume. The loading of transit mixers to the extent of causing spill-out in route to delivery will not be acceptable.
12. Excess concrete remaining in the drum after delivery and wash water after delivery shall not be dumped on the project site unless approval of the dump location is first secured from the Engineer.

C. Volumetric Batching and Mixing Concrete

1. The batching and continuous mixing operations shall conform to ASTM C 685, "Concrete Made by Volumetric Batching and Continuous Mixing". This type concrete shall be made from materials continuously batched by volume, mixed in a continuous mixer and delivered to the site in a freshly mixed and unhardened state. Tests and criteria for batching accuracy and mixing efficiency shall be as specified in ASTM C 685.
2. These mixers shall be designed to receive all the concrete ingredients, including admixtures, required by the mix design in a continuous uniform rate and mix them to the required consistency before discharging.
3. For continuous volumetric mixers, the materials delivered during a revolution of the driving mechanism or in a selected interval, will be considered a batch and the proportion of each ingredient will be calculated in the same manner as for a batch type plant.
4. Mixing time shall conform to recommendations of manufacturer of mixer unless otherwise directed by Engineer.
5. A ticket system will be used that includes a copy for the Inspector. The ticket will have machine stamped time/date of concrete batch, a mix design designation, weight of cement, fly ash, sand and aggregates; exact nomenclature and written quantities of admixtures and water. Any item missing or incomplete on ticket may be cause for rejection of concrete.
6. Each batching or mixing unit, or both, shall carry in a prominent place a metal plate or plates on which are plainly marked the gross volume of the unit in terms of mixed concrete, discharge speed and the weight-calibrated constant of the machine in terms of a revolution counter or other output indicator. The mixer shall produce a thoroughly mixed and uniform concrete.

7. The batcher-mixer unit shall contain in separate compartments all the necessary ingredients needed for the manufacture of concrete. The unit shall be equipped with calibrated proportioning devices to vary the mix proportions and it shall produce concrete as required by the Work and ASTM C 685.
8. Entire contents of the drum shall be discharged before any materials are placed therein for a succeeding batch.

D. Hand-Mixed Concrete

1. Hand mixing of concrete may be permitted for small placements or in case of an emergency and then only on authorization of the Engineer.
2. Hand-mixed batches shall not exceed a 4 cubic foot (0.113 cubic meters) batch in volume.
3. Material volume ratios shall not be leaner than 1 part cement, 2 parts large aggregate, 1 part fine aggregate and enough water to produce a consistent mix with a slump not to exceed 4 inches (100 mm).
4. Admixtures shall not be used unless specifically approved by the Engineer.

E. Admixtures

1. All admixtures used shall be liquid except high-range water reducers which may be a powder. Liquid admixtures shall be agitated as needed to prevent separation or sedimentation of solids; however, air agitation of Neutralized Vinsol Resin will not be allowed.
2. No admixture shall be dispensed on dry aggregates. Admixtures shall be dispensed at the batching site separately, but at the same time as the mixing water. Only high range water reducers may be introduced into the mix at the job site.
3. When other admixtures are used with fly ash, the amount of the other admixture to be used shall be based on the amount of Portland cement only and not the amount of Portland cement and fly ash.
4. When high-range water reducers are to be added at the job site, transit mixers shall be used. Admixture manufacturer literature shall indicate recommended mixing methods and time for the specific equipment and mix design used. The transit mix equipment shall not be loaded in excess of 63 percent of its rated capacity to ensure proper mixing of the admixture at the site. If during discharging of concrete a change in slump in excess of 30% is noted, the remaining concrete shall be rejected unless prior approval was given by the Engineer to retemper a load with a second charge of admixture. Retempering with water shall not be allowed.
5. All mixes with air entrainment shall have a minimum relative durability factor of 80 in accordance with ASTM C 260. Dosage of air entrainment admixtures may be adjusted by the Contractor to stay within the specified tolerances for air entrainment of Standard Specification Item No. 403S, "Concrete for Structures".

F. Transporting Time

1. The maximum time interval between the addition of cement to the batch and the placing of concrete in the forms shall not exceed the following:

Allowable Transportation Times		
Air or Concrete Temperature whichever is higher	Maximum Time w/o Retarder	Maximum Time with Retarder
Non-agitated Concrete		
35°F to 79°F (2°C to 26°C)	45 minutes	45 minutes
Over 80°F (Over 25°C)	30 minutes	45 minutes
Agitated Concrete		
90°F (32°C) or above	45 minutes	105 minutes

Allowable Transportation Times		
75°F to 89°F (24°C to 32°C)	60 minutes	120 minutes
35°F to 74°F (2°C to 23°C)	90 minutes	150 minutes

2.8 CURING

A. Liquid Membrane

1. The liquid forming membrane curing compound shall comply with the "Standard Specification for Liquid Membrane-forming Compounds for Curing Concrete", ASTM C 309, Type 1-D clear or translucent, with fugitive dye or Type 2 white pigmented. The material shall have a minimum flash point of 80°F (26.7°C) when tested by the "Pensky-Martin Closed Cup Tester", ASTM D 93.
2. It shall be of such consistency that it can be satisfactorily applied as a fine mist through an atomizing nozzle by means of approved pressure spraying equipment at atmospheric temperatures above 40°F (4.4°C).
3. It shall be of such nature that it will not produce permanent discoloration of concrete surfaces nor react deleteriously with the concrete or its components. Type 1 compound shall contain a fugitive dye that will be distinctly visible not less than 4 hours nor more than 7 days after application.
4. Type 2 compound shall not settle out excessively or cake in the container and shall be capable of being mixed to a uniform consistency by moderate stirring and shall exhibit a daylight reflectance of not less than 60 percent of that of magnesium oxide when tested as indicated.
5. The compound shall produce a firm, continuous, uniform moisture impermeable film, free from pinholes and shall adhere satisfactorily to the surfaces of damp concrete. When applied to the damp concrete surface at the rate of coverage indicated, the compound shall dry to the touch in not more than 4 hours and shall not be tacky or track off concrete after 12 hours.
6. It shall adhere to horizontal and vertical surfaces in a tenacious film and shall not run off or show an appreciable sag, disintegrate, check, peel or crack during the required curing period.
7. Under traffic, the compound shall not pick up or peel and shall gradually disintegrate from the surface.
8. The compound shall be delivered to the job only in the manufacturer's original containers, which shall be clearly labeled with the manufacturer's name, the trade name of the material and a batch number or symbol with which test samples may be correlated.
9. The water retention test shall be in accordance with the following table. Percentage loss shall be defined as the water lost after the application of the curing material was applied. The permissible percent moisture loss shall not exceed 2 percent after 24 hours and 4 percent after 72 hours.

B. Polyethylene Film

1. Polyethylene film shall be opaque pigmented white in color and shall be manufactured from virgin resin without additives or scrap. It shall be sufficiently strong and tough to permit its use under the conditions existing on street paving work without being torn or otherwise rendered unfit for the purpose during the curing period.
2. The film shall have a minimum thickness of 4 mils (0.004 inch), shall have a minimum tensile strength of 1,700 psi at 77°F (11,720 kPa at 25°C) in the longitudinal direction and 1,200 psi at 77°F (8,275 kPa at 25°C) in the transverse direction and shall have a minimum elongation of 200 percent at 77°F (25°C) in the longitudinal direction and 150 percent at 77°F (25°C) in the transverse direction.

3. The permissible percent moisture loss shall not exceed 2 percent after 24 hours and 4 percent after 72 hours. Tests for tensile strength and elongation will be conducted in accordance with ASTM Designation: D 882, Method A. Tests for moisture retention will be conducted in accordance with ASTM Designation: C 156.

C. Cotton Mats

1. Cotton mats shall consist of a filling material of cotton "bat" or "bats" [at least 12 oz. Per square yard (400 grams per square meter)] completely covered with unsized cloth [at least 6 oz. Per square yard (200 grams per square meter)] stitched longitudinally with continuous parallel rows of stitching spaced at less than 4 in. (100 mm), or tuft both longitudinally and transversely at intervals less than 3 in. (75 mm).
2. The cotton mats shall be free from tears and in good general condition. A flap at least 6 in. (150 mm) wide with two (2) thicknesses of the covering that extends along one side of the mat shall be provided.

D. Burlap-Polyethylene Mats

1. The burlap-polyethylene mats shall be made from burlap impregnated on 1 side with a film of opaque white-pigmented polyethylene, free from visible defects. The laminated mats shall have at least 1 layer of an impervious material such as polyethylene, vinyl plastic, or other acceptable material (either as a solid sheet or impregnated into another fabric) and shall be free of visible defects.

PART 3 - EXECUTION

3.1 PREPARATION

A. General

1. The subgrade, subbase or base course shall be shaped to the lines, grades and cross sections as indicated on the Drawings and shall be thoroughly compacted in accordance with Section 312000, "Earth Moving".
2. No equipment or hauling shall be permitted on the prepared subgrade, except by special permission of the Engineer.
3. Any unsuitable material encountered in the subgrade shall be removed and replaced by a suitable material and compacted to a uniform grade.
4. If the subgrade is undercut or natural ground is located below the top of subgrade, the necessary backfill material shall conform with Section 312000, "Earth Moving", and shall be compacted with a mechanical tamper. Hand tamping will not be permitted.
5. The subgrade or foundation shall be moist before placing on grade. If dry the subgrade shall be lightly sprinkled.

B. Curbs and Gutters

1. Subgrade for curb and gutter shall be excavated and prepared to depth and width requirements indicated on the Drawings, including a minimum of 12 inches (300 mm) behind the curb, unless a greater width is indicated on the Drawings.
2. A minimum of 4 inches (100 mm) of crushed limestone base shall be spread, wetted and thoroughly compacted under curb and gutter as specified in Section 312000, "Earth Moving". If dry, the base shall be sprinkled lightly with water before concrete is deposited thereon.

C. Sidewalks

1. A granular cushion of a minimum thickness of 2 inches (50 mm) but maximum thickness of 5 inches (125 mm), composed of crusher screenings, gravel and sand, crushed rock or coarse sand, shall be spread, wetted thoroughly, tamped and leveled. The granular

cushion shall be moist at the time the concrete is placed. Where the subgrade is rock or gravel, 70% of which is rock; the 2-inch (50 mm) cushion need not be used.

D. Driveways

1. A 2-inch (50-mm) minimum compacted thickness cushion shall be spread, wetted thoroughly, tamped and leveled. The cushion shall be moist at the time the concrete is placed. Where the subgrade material consists of gravel or includes 70 percent of rock, the 2-inch (50-mm) cushion layer may not be required.

3.2 FORMS

A. Placing Forms

1. Permission to place concrete will not be given until all work is complete to the satisfaction of the Engineer.
2. The subgrade under the forms shall be firm and cut true to grade so that each form section when placed will be firmly in contact for its whole length and base width and exactly at the established grade. Any subgrade under the forms below established grade shall be corrected, using suitable material, placed, sprinkled and rolled as directed.
3. All forms areas shall be cleaned of any extraneous matter before placing concrete. Forms shall be cleaned and oiled each time they are used.
4. Forms shall be staked with at least 3 pins for each 10-foot (3-meter) section. A pin shall be placed at each side of every joint. Form sections shall be tightly joined and keyed to prevent relative displacement.
5. All forms on which concrete will be placed shall be thoroughly wetted before the placement of concrete. Puddles of excess water shall be removed before placing the concrete. The various surfaces shall be in a moist, saturated surface dry condition when concrete is placed on or against them.
6. If, at any stage of the work, the forms show signs of bulging or sagging, the portion of the concrete causing such condition shall be removed immediately, if necessary and the forms shall be reset and securely braced against further movement.

B. Removing Forms

1. Unless otherwise indicated on the drawing, forms for vertical surfaces may be removed when the concrete has aged 12 hours after initial set, provided it can be done without damage to the concrete.
2. Forms for inside curb faces may be removed in approximately 3 hours provided it can be done without damage to the curb.
3. If all test cylinders made for the purpose of form removal have been broken without attaining the required strength, forms shall remain in place for a total of 14 curing days.
4. All metal appliances used inside forms for alignment shall be removed to a depth of at least $\frac{1}{2}$ in. (13 mm) from the concrete surface. The appliances shall be manufactured to allow the removal without undue chipping or spalling of the concrete, and so that it leaves a smooth opening in the concrete surface when removed. Rods, bolts and ties shall not be burned-off.
5. All forms shall be removed unless indicated otherwise on the drawings.

3.3 STEEL REINFORCEMENT

A. Placement

1. Reinforcement shall be placed as near as possible in the position indicated on the drawings. Unless otherwise indicated on the drawings, dimensions shown for reinforcement are to the centers of the bars. In the plane of the steel parallel to the nearest surface of concrete, bars shall not vary from plan placement by more than $\frac{1}{12}$ of the spacing between bars. In the plane of the steel perpendicular to the nearest surface of

concrete, bars shall not vary from plan placement by more than ¼ inch (6 mm). Cover of concrete to the nearest surface of steel shall be as follows:

Condition	Minimum Cover, Inches (mm)
Concrete cast against and permanently exposed to earth, all sizes	3 (76 mm)
Concrete exposed to earth or weather, bar No. 6 (19) through No. 18 bars (57)	2 (51 mm)
Concrete exposed to earth or weather, bar No. 5 (16), W31 (W200) or D31 (D200) wire and smaller	1½ (38 mm)

2. All reinforcement shall be accurately placed at slab mid-depth, equidistant from the top and bottom of the concrete and held firmly in place by means of bar supports of adequate strength and number that will prevent displacement and keep the steel at its proper position during the placement of the concrete. In no instance shall the steel be placed directly on the subgrade or sand cushion layer.
3. All reinforcing steel shall be tied at all intersections, except that where spacing is less than 1 foot (300 mm) in each direction, alternate intersections only need be tied. Mats of wire fabric shall overlap each other 1 full space as a minimum to maintain a uniform strength and shall be tied at the ends and edges.
4. Where prefabricated deformed wire mats are specified or if the Contractor requests, welded wire fabric may be substituted for a comparable area of steel reinforcing bar plan, subject to the approval of the Engineer.
5. Individual bar supports shall be placed in rows at 4-ft (1.22 meters) maximum spacing in each direction. Continuous type bar supports shall be placed at 4-ft (1.22 meters) maximum spacing.
6. Prior to placement of the concrete, the reinforcement installation shall be inspected by the Engineer to ensure conformance with the drawings, specifications and this item.
7. Care shall be exercised to keep all steel in its proper position during placement of the concrete. If during placement of the concrete, the reinforcement is observed to lose bar support, float upward or move in any direction, the placement shall be stopped until corrective action is taken.

B. Sidewalks

1. Reinforcement for sidewalks shall consist either of polypropylene fibrillated fibers or 6" x 6" x W1.4 x W1.4 (150mm x 150mm x MW9 x MW9) welded wire fabric or one layer #3 (10M) reinforcing bars, placed no more than 18 inches (450 mm) on center both directions.
2. Where driveways cross sidewalks, additional reinforcing shall be placed in the sidewalk as indicated on the Drawings.

C. Driveways

1. Reinforcement for medium-duty driveways shall consist of 1 layer of 6 x 6 by W 1.4 x W 1.4 (150 x 150 by MW9 x MW9) wire fabric or No. 3 (10 M) bars placed not more than 18 inches (450 mm) on center, both directions. Reinforcement for heavy-duty driveways shall consist of 1 layer of No. 4 (13 M) bars placed no more than 18 inches (450 mm) on center, both directions.

3.4 JOINTS

A. General

1. The Contractor shall install concrete joint materials which will function as a compatible system.

2. Care shall be exercised during the construction of all joints to ensure that the concrete sections are completely separated by an open joint or by the joint materials and to ensure that the joints will be true to the outline indicated on the drawings.
 3. Joint sealer shall not be placed where a bond breaker is present.
 4. Asphalt, Redwood board or other materials used shall extend the full depth of the concrete and shall be perpendicular to the exposed face.
 5. All joints shall be shaped to conform to the contour of the finished section in which they are installed.
- B. Expansion Joints
1. All open joints and joints to be filled with expansion joint material shall be constructed using forms adaptable to loosening or early removal.
 2. The expansion joint material shall be placed vertically and shall extend the full depth of the concrete.
 3. Where preformed fiber joint material is used, it shall be anchored to the concrete on one side of the joint by light wire or nails to prevent the material from falling out.
 4. Finished joints shall conform to the drawing details with the concrete sections completely separated by the specified opening or joint material.
 5. Soon after form removal and where necessary after surface finishing, all projecting concrete shall be removed along exposed edges to secure full effectiveness of the expansion joints.
- C. Control Joints
1. Control joints shall be formed or sawed joints perpendicular to the surface of the pavement.
 2. Where sawed joints are used, controls joints shall be sawed as soon as sawing can be accomplished without damage to the pavement, and within 24 hours of concrete placement. All joints shall be completed before permitting traffic to use the pavement.
 3. Concrete saws shall be power driven, shall be manufactured especially for the purpose of sawing concrete and shall be capable of performing the work. Saw blades shall be as indicated. Tracks adequately anchored, chalk, string line or other approved methods shall be used to provide true alignment of the joints. The concrete saw shall be maintained in good operating condition and the Contractor shall keep a standby power saw on the project at all times when concrete operations are under way.
 4. If membrane curing is used, the portion of the seal which has been disturbed by sawing operations shall be restored by the Contractor by spraying the areas with additional curing seal.
- D. Construction Joints
1. Intentional stoppage of the placing of the concrete shall be at either an expansion joint or at a control joint.
 2. Construction joints shall be square and normal to the forms.
 3. Bulkheads shall be provided in the forms for all joints, of sufficient cross-sectional area to prevent deflection, accurately notched to receive the load transmission devices or dowels, and shaped accurately to the cross section of the pavement.
 4. The hardened concrete surface shall be thoroughly cleaned of all loose material, laitance, dirt or foreign matter and saturated with water so it is moist when placing fresh concrete against it. Remove all free water and moisten the surface before concrete or bonding grout is placed against it. Forms shall be drawn tight against the existing concrete and the joint surface flushed with grout just prior to placing the fresh concrete.
 5. The joint surface shall be coated with bonding mortar, grout, epoxy or other material as indicated on the drawings or other items. A Type V epoxy shall be provided in accordance with TxDoT DMS-6100, "Epoxies and Adhesives" for bonding fresh concrete to hardened concrete. The epoxy shall be placed on a clean dry surface and the fresh concrete shall be placed while the epoxy is still tacky. Bonding mortar or grout shall be placed on a surface that is saturated surface dry and the concrete shall be placed before the bonding mortar or

grout dries. Other bonding agents shall be placed in accordance with the manufacturer's recommendations.

6. Immediately upon any unintended stoppage of the placing of concrete, the Contractor shall place the available concrete to a line and install the above-described bulkhead at right angles to the centerline of the pavement, perpendicular to the surface and at the required elevation. Concrete shall be placed and finished to this bulkhead. Any concrete remaining on the subgrade ahead shall be removed and disposed of as directed by the Engineer. When placing of concrete is resumed before the concrete has set to the extent that the concrete will stand on removal of the bulkhead, the new concrete shall be rodded with the first. An edge created by a construction joint of this type shall have a joint seal space and shall be sealed as required for control joints. The joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set shall be deemed a construction joint. The term monolithic placement shall be interpreted to mean that the manner and sequence of concrete placing shall not create construction joints.

E. Installation of Dowels and Anchor Bolts

1. Dowels and anchor bolts shall be installed by casting them in place or by grouting with grout, epoxy, or epoxy mortar unless indicated otherwise on the drawings.
2. Holes for grouting shall be formed or drilled. Holes for anchor bolts shall be drilled to accommodate the bolt embedment required on the drawings. Holes for dowels shall be made at least 12 in. (300 mm) deep unless indicated otherwise on the drawings. When grout or epoxy mortar is specified the diameter of the hole shall be at least twice the dowel or bolt diameter but shall not exceed the dowel or bolt diameter plus 1 ½ in (38 mm). When epoxy is specified the hole diameter should be 1/16 to ¼ in. (1.6 to 6.35 mm) greater than the dowel or bolt diameter.
3. The holes shall be thoroughly cleaned of all loose material, oil, grease or other bond-breaking substance and blow them clean with filtered compressed air. When an epoxy type material is used the holes shall be in a surface dry condition. When hydraulic cement grout is used the holes shall be in a surface moist condition. The void space between the hole and the dowel or bolt shall be completely filled with grouting material. The requirements for cleaning outlined in the product specification for prepackaged systems shall be followed exactly.

F. Curbs and Gutters

1. Expansion joint material, ¾ inch (19 mm) in thickness, shall be provided at intervals not to exceed 40 feet (12 meters) and shall extend the full width and depth of the concrete.
2. Control joints shall be made ¾ inch (19 mm) deep at 10-foot (3 meters) intervals.
3. All joint headers shall be braced perpendicular and at right angles to the curb.
4. Two round smooth dowel bars, ½ inch (12.5 mm) in diameter and 24 inches (600 mm) in length, shall be installed at each expansion joint. Sixteen inches (400 mm) of one end of each dowel shall be thoroughly coated with hot oil, asphalt or red lead, so that it will not bond to the concrete. The dowels shall be installed with a dowel sleeve on the coated end as indicated on the Drawings.

G. Sidewalks

1. Expansion joint material ¾ inch (19 mm) thick, shall be provided where the new construction abuts an existing structure, sidewalk or driveway. Similar expansion material shall be placed around all obstructions protruding through the sidewalk. The expansion joint material shall be placed vertically and shall extend the full depth of the concrete.
2. Maximum spacing of expansion joints shall be 40 feet (12 meters) as indicated on the Drawings or as directed by the Engineer.
3. Control joints shall be spaced at 5 feet (1.5 meters) on center. Normal dimensions of the control joints shall be ¼ inch wide and ¾ inch deep (6 mm wide and 19 mm deep).
4. All joints shall be constructed perpendicular (90 degrees) to the centerline of walk and shall match any previously placed concrete joints.

5. For sidewalks with widths exceeding 6 feet (1.83 meters), longitudinal control joints shall be provided as indicated on the Drawings or as directed by the Engineer.
- H. Driveways
1. Expansion joint material, $\frac{3}{4}$ inch (19 mm) thick, shall be provided where the new construction abuts the existing sidewalks or driveways or as directed by the Engineer.
 2. Similar expansion material shall be placed around all obstructions protruding through the driveway.
 3. Control joints shall be located on 10-foot (3-meter) centers or as directed by the Engineer. Normal dimensions of the control joints shall be $\frac{1}{4}$ -inch (6.25-mm) wide and $\frac{3}{4}$ -inch (19 mm) deep.
- I. Valley Gutters
1. Expansion joint material $\frac{3}{4}$ inch (19 mm) thick shall be provided as indicated on the Drawings or as directed by the Engineer.
 2. The expansion joint material shall be placed vertically and shall extend the full depth of the concrete.
 3. Weakened plane joints shall be provided on 10-foot (3 meter) centers or as directed by the Engineer. Normal dimensions of the weakened plane joints shall be $\frac{1}{4}$ inch (6.3 mm) wide and $\frac{3}{4}$ inch (19 mm) deep.
- J. Cleaning and Sealing Joints and Cracks
1. General
 - a. Equipment, tools and machinery recommended for proper prosecution of the Work shall be on the project and shall be approved by the Engineer prior to the initiation of the joint and/or crack cleaning and sealing operations.
 2. Joint and Crack Preparation
 - a. The bonding surface of cracks and joints shall be cleaned of infiltrated material, saw cuttings or other foreign material. All material removed from joints and cracks shall be removed.
 - b. No sealing of any joints or cracks shall be done when the joints or cracks are damp, unless drying of the joints and cracks with compressed air can be demonstrated.
 - c. Joints shall be cleaned with filtered compressed air.
 - d. Hand tools, air guns, power routers, abrasive equipment or other equipment may be used to clean the joints. The joint sealant space shall be resized by sawing to the width and depth shown on the Drawings to accommodate the type of sealant specified.
 - e. Cracks shall be grooved initially at the surface so that a reservoir of rectangular cross section is provided for the sealant. The grooves shall be cut to the dimensions shown on the Drawings. The devices that are used for grooving, such as diamond blade random cut saws, random-crack grinders, etc., shall be capable of following the path of the crack without causing excessive spalling or other damage to the concrete.
 3. Joint and Crack Sealing
 - a. The sealant shall be installed in accordance with the manufacturer's recommended procedure. The joint and/or crack surfaces shall be surface dry unless recommended otherwise by the manufacturer of the sealant.
 - b. The surface temperature at the time of the sealing operation shall not be less than 40°F (4.5°C).
 - c. The minimum depth of sealant shall be $\frac{1}{2}$ inch (12.5 mm) or a depth recommended by the sealant manufacturer and the top of the sealant shall be located $\frac{1}{8}$ to $\frac{1}{4}$ inch (3 to 6.5 mm) below the adjacent pavement surface.
 - d. If required, the primer shall be applied as soon as possible after cleaning is accomplished. The primer shall be applied uniformly at the rate recommended by the sealant manufacturer. The primer shall be applied to exposed metal surfaces before new corrosion begins and shall be allowed to cure for a minimum of thirty

(30) minutes, but no longer than eight (8) hours prior to the application of the sealant, unless sealant manufacturer recommendations indicate otherwise.

- e. Backer rods shall be used to prevent a fluid type sealant from flowing through the joint and crack and to retain the sealant at its required elevation. The application and use of backer rod shall be as recommended by the sealant manufacturer and approved by the Engineer.

3.5 PLACING CONCRETE

A. General

1. The Contractor shall give the Engineer sufficient advance notice before placing concrete to permit the review of forms, reinforcing steel placement and other preparations. Concrete shall not be placed prior to the completion of formwork and placement of reinforcement therein.
2. When mixing, placing and finishing concrete is scheduled during non-daylight hours; the entire placement site should be illuminated to the satisfaction of the Engineer.

B. Weather Conditions

1. Concrete may be placed when the ambient temperature is not less than 35°F (2°C) in the shade and rising or above 40°F (4°C). Concrete shall not be placed when the ambient temperature in the shade is below 40°F (4°C) and falling unless approved by the Engineer. Concrete shall not be placed in contact with any material coated with frost or having a temperature less than 32°F (0°C).
2. Concrete shall not be placed when impending weather conditions would impair the quality of the finished work.
3. If changes in weather conditions require protective measures after work starts, adequate shelter shall be provided to protect the concrete against damage from rainfall or from freezing temperatures as outlined in this Item. Operations during rainfall shall only be continued if approved by the Engineer.
4. Aggregate stockpiles shall be covered to the extent necessary to control the moisture conditions in the aggregates. Aggregates shall be free from ice, frost and frozen lumps.
5. The Contractor is responsible for the protection of concrete placed under any and all weather conditions and is responsible for producing concrete equal in quality to that placed under normal conditions. Permission given by the Engineer to allow placement of the concrete during adverse weather does not relieve the Contractor of the responsibility for producing concrete equal in quality to that placed under normal conditions. Concrete placed under adverse weather conditions that proves to be unsatisfactory shall be removed and replaced at Contractor' expense.

C. Admixtures

1. All admixtures used shall be liquid except high-range water reducers which may be a powder. Liquid admixtures shall be agitated as needed to prevent separation or sedimentation of solids; however, air agitation of Neutralized Vinsol Resin will not be allowed.
2. No admixture shall be dispensed on dry aggregates. Admixtures shall be dispensed at the batching site separately, but at the same time as the mixing water. Only high range water reducers may be introduced into the mix at the job site.
3. When other admixtures are used with fly ash, the amount of the other admixture to be used shall be based on the amount of Portland cement only and not the amount of Portland cement and fly ash.
4. When high-range water reducers are to be added at the job site, transit mixers shall be used. Admixture manufacturer literature shall indicate recommended mixing methods and time for the specific equipment and mix design used. The transit mix equipment shall not be loaded in excess of 63 percent of its rated capacity to ensure proper mixing of the admixture at the site. If during discharging of concrete a change in slump in excess of 30%

is noted, the remaining concrete shall be rejected unless prior approval was given by the Engineer to retemper a load with a second charge of admixture. Retempering with water shall not be allowed.

5. All mixes with air entrainment shall have a minimum relative durability factor of 80 in accordance with ASTM C 260. Dosage of air entrainment admixtures may be adjusted by the Contractor to stay within the specified tolerances for air entrainment of this specification.

D. Concrete Temperature

1. Minimum Temperature
 - a. The minimum temperature of all concrete at the time of placement shall not be less than 50°F (10°C).
 - b. The aggregate and/or the water may be heated uniformly, so that the temperature of the mixture of aggregates and water is between 50°F(10°C) and 85°F(29°C) before introduction of the cement.
2. Maximum Temperature
 - a. The maximum temperature of any concrete, unless otherwise indicated on the drawings, shall not exceed 95°F (35°C) when placed. The maximum temperature of cast-in-place concrete in curbs and sidewalks, and for precast bumper curbs, shall not exceed 85°F (30°C) when placed.
 - b. If the concrete mix temperature is expected to exceed 90°F (32°C) (or 100°F (38°C) in mixes with high range water reducers) ice may be utilized to lower the concrete mix temperature. Ice may be added to the concrete mix as a portion by weight of the mix water. However, the addition of ice shall not exceed 50% of the total mix water weight.

E. Transporting Time

1. The maximum time interval between the addition of cement to the batch and the placing of concrete in the forms shall not exceed the following:

Allowable Transportation Times		
Air or Concrete Temperature whichever is higher	Maximum Time w/o Retarder	Maximum Time with Retarder
		All others
Non-agitated Concrete		
35°F to 79°F (2°C to 26°C)	45 minutes	45 minutes
Over 80°F (Over 25°C)	30 minutes	45 minutes
Agitated Concrete		
90°F (32°C) or above	45 minutes	105 minutes
75°F to 89°F (24°C to 32°C)	60 minutes	120 minutes
35°F to 74°F (2°C to 23°C)	90 minutes	150 minutes

F. Material Proportions

1. Proportioning of all material components shall be checked prior to discharging. Excluding mortar material for pre-coating of the mixer drum and adjustment for moisture content of admixtures and aggregates, material components shall fall within the range of + 1% for water, + 2% for aggregates, + 3% for cement, +2% for fly ash and within manufacturer recommended dosage rates for admixtures except that air entrainment shall be within + 1½ percentage points of the mix design requirements.

G. Handling and Placing

1. The method of handling, placing and consolidation of concrete shall minimize segregation and displacement of the reinforcement and produce a uniformly dense and compact mass.
2. Concrete shall not have a free fall of more than 5 feet (1.5 meters).
3. Any hardened concrete spatter ahead of the plastic concrete shall be removed.
4. Each part of the forms shall be filled by depositing concrete as near its final position as possible. The coarse aggregate shall be worked back from the face and the concrete forced under and around the reinforcement bars without displacing them. Depositing large quantities at one point and running or working it along the forms will not be allowed.
5. Cold joints in a monolithic placement shall be avoided. The sequence of successive layers or adjacent portions of concrete shall be such that they can be vibrated into a homogeneous mass with the previously placed concrete without a cold joint. Not more than 1 hour (1 ½ hours if a normal dosage of retarding admixture is used) shall elapse between adjacent or successive placements of concrete.

H. Consolidation

1. All concrete shall be carefully consolidated and the mortar flushed to the form surfaces by continuous working with immersion type vibrators. Vibrators which operate by attachment to forms or reinforcement will not be permitted, except on steel forms. At least 1 standby vibrator shall be provided for emergency use in addition to the ones required for placement. For lightweight concrete, vibrators of the high frequency type, which produce a minimum of 7000 impulses per minute, will be required.
2. The concrete shall be vibrated immediately after deposition. Prior to the beginning of work, a systematic spacing of the points of vibration shall be established to insure complete consolidation and thorough working of the concrete around the reinforcement, embedded fixtures and into the corners and angles of the forms. Immersion type vibrators shall be inserted vertically, at points 18 to 30 inches (450 to 750 mm) apart and slowly withdrawn. The vibrator may only be inserted in a sloping or horizontal position in shallow slabs. The vibrator shall not be used to move the concrete to other locations. In addition, the vibrator shall not be dragged through the concrete. Concrete along construction joints shall be thoroughly consolidated by operating the vibrator along and close to but not against the joint surface. The vibration shall continue until thorough consolidation and complete embedment of reinforcement and fixtures is produced, but not long enough to cause segregation. Vibration may be supplemented by hand spading or rodding, if necessary, to insure the flushing of mortar to the surface of all forms.

I. Monolithic Curbs

1. The curb shall be constructed in lengths equal to the adjoining pavement slab lengths and expansion joints shall be provided in the curb opposite each transverse expansion joint in the pavement. Expansion joint material shall be of the same thickness, type and quality as indicated for the pavement and shall be of the section as indicated for the curb. All expansion joints shall be carried through the curb, sidewalk and retaining walls when these items are indicated.
2. When sawed joints are provided for the pavement, the curb placement shall be delayed until all transverse joints have been sawed. To provide bond for the curb, dowel bars shall be placed as indicated on the drawings, while the pavement concrete is still plastic.
3. Weakened plane joints shall be formed in monolithic curbs at a spacing to coincide with the joints in the concrete pavement. The joints shall be formed by inserting in the curb an asphaltic board strip cut to conform to the shape of the curb. When the concrete is sufficiently set, the joint on the top and face of curb shall be grooved with an approved type of grooving tool.
4. A finish coat of mortar shall be applied on the exposed surfaces of the monolithic curbs. The mortar shall be composed of 1 part of Portland Cement and 2 parts of fine aggregate. A mortar coat will not be required for extruded curbs.
5. The curb face, lower radius and top of curb shall be plastered with the sand-cement mortar. The mortar shall be applied with a template or "mule" made to conform to the curb

dimensions as indicated. All exposed surfaces of the curb shall be finished with a steel trowel and brushed to a smooth and uniform surface. The mortar finish as required shall be included in the unit price bid for this item.

J. Concrete Bumper Curbs

1. Concrete bumper curbs shall not be placed monolithically with the concrete pavement.
2. Concrete shall be placed in the forms to the depth indicated and vibrated until thoroughly compacted. Care shall be taken during vibration to ensure that a vibrator is not held too long at one location that segregation is produced.
3. The top surface of the concrete shall be floated and troweled to a uniform smooth surface, and then finished with a camel hair brush or wood float to a gritty texture.
4. The outer edges shall be rounded with approved tools to the radii shown on the Drawings.

K. Paver Units

1. Concrete paver units shall be bedded in a 1 inch (25 mm) thick mortar bed placed on top of a 3 inch (75-mm) minimum Class A Fibrous Concrete pad.
2. The Contractor shall exercise particular care to maintain the laying pattern throughout the job. Paving units shall be placed to achieve gaps nominally 1/8 inch (3.2 mm) wide between adjacent units to ensure that all joints are correctly aligned.
3. The first row shall abut an edge restraint with a gap of 1/8 inch (3.2 mm) and shall be laid at a suitable angle to the edge restraint to achieve the required visual orientation of paving units in the completed sidewalk.
4. In each row, all full units shall be placed first. Closure units shall be cut and fitted subsequently. In no case shall a closure unit consist of less than 25 percent of a full unit. Areas with closure units less than 25 percent of a full unit shall be filled solid with mortar. Units may be cut using a mechanical or hydraulic cutter or by power sawing. A grout mix shall be used to fill larger edge spaces.
5. Any foot or wheelbarrow traffic during the construction shall use boards overlaying paver units to prevent disturbance of units prior to final set. No other traffic shall be allowed on the pavement at this stage of construction.
6. After placement of the paver units on the uncompacted screeded sand layer, consolidation of the sand bedding and the design levels and profiles of the paver units shall be obtained by not less than two passes of a suitable flat plate compactor. Any grouted concrete paver units that are damaged or displaced during the compaction process shall be replaced and regouted.
7. The compactor shall be a high frequency, low-amplitude mechanical flat plate vibrator with a plate area sufficient to cover a minimum of 12 paver units. The compactor shall be capable of producing 3,500 to 5,000 pounds (15.5 to 22.2 kiloNewton) centrifugal compaction force. The flat plate compactor shall be equivalent to Model P-22 manufactured by Koehring, Master Division of Dayton, Ohio.
8. Compaction shall proceed as closely as possible following placement and shall be completed prior to the acceptance of any construction traffic.
9. Compaction shall not be attempted, however, within 3 feet (.9 meter) of the laying face of the paver units. Compaction shall continue until lipping has been eliminated between adjoining units. Joints shall be filled and compacted again as herein described.
10. All work extending to within 3 feet (.9 meter) of the laying face must be left fully compacted at the completion of each day's placement. Compaction of the remaining surface will be completed after sufficient units are laid in place.
11. As soon as practical after placement of pavers in the mortar bed, and in any case prior to the termination of work on that day, and prior to the acceptance of construction traffic, bedding sand for joint-filling shall be spread over the sidewalk and allowed to dry. When dry, the filling sand shall be swept to fill the joints. At least one pass of the plate vibrator will be used to achieve compaction of the joint filling sand.
12. As soon as possible after filling the joints, light construction traffic should be encouraged to use the pavement to assist in the development of the paver unit lockup. Such traffic should traverse the greatest possible area of the pavement. After traffic has been allowed

on the pavers, joints shall be refilled with dry sand periodically until no additional sand will be accepted in the joints.

L. Detectable Warnings

1. Detectable warnings shall be formed in accordance with the requirements of the American Disabilities Act and Texas Accessibility Standards (TAS), including Sections 4.29.2 and A4.29.2.
2. Detectable warning shall consist of raised truncated domes with a diameter of nominal 0.9 inch (23 mm), a height of nominal 0.2 inch (5 mm) and center-to-center spacing of nominal 2.35 inches (60 mm) and shall contrast visually with adjoining surfaces, either light on dark or dark-on-light. The material used to provide contrast shall be an integral part of the walking surface.

3.6 FINISHING

A. Equipment

1. The Contractor shall provide a strike template and a tamping template both of 4 by 10 inch (10 by 25 cm) lumber or equivalent metal section and at least 2 feet longer than the width of the pavement. Both templates to conform to the crown section of the pavement and the tamp, if of wood, shall have a steel face not less than 3/8 inch (9.5 mm) in thickness. The Contractor shall also provide a longitudinal float of approved design and not less than 14 feet (4.25 meters) in length.
2. The Contractor shall furnish and maintain at least two standard 10-foot (3.05 meter) steel straightedges on the work site at all times during the paving operations.
3. The Contractor shall furnish a sufficient number of bridges to ride on the forms and span the pavement for finishing operations and for the installation and finishing of joints. All necessary finishing and edging tools shall be furnished as may be required to complete the pavement as indicated.

B. Fogging

1. The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When conditions are such that additional moisture is needed for finishing, the required water shall be applied to the surface by fog spray only and shall be held to a minimum amount. Fog spray for this purpose may be applied with hand operated fogging equipment.
2. From the time of initial strike off until final finish is completed and required interim curing is in place, the unformed surfaces of concrete slabs shall be kept damp, not wet, to offset the effects of rapid evaporation of mixing water from the concrete due to wind, temperature, low humidity or combinations thereof. Fogging equipment capable of applying water in the form of a fine fog mist, not a spray, will be required. Fogging will be applied at the times and in the manner directed by the Engineer.
3. Fogging equipment may be either water pumped under high pressure or a combination of air and water, either system in combination with a proper atomizing nozzle. The equipment shall be sufficiently portable for use in the direction of any prevailing winds. The equipment shall be adapted for intermittent use to prevent excessive wetting of the surfaces.

C. Floating

1. Concrete shall be struck off with an approved strike off screed to such elevation that when consolidated and finished the surface of the pavement to conform to the required section and grade. The strike template shall be moved forward with a combined transverse and longitudinal motion in the direction work is progressing, maintaining the template in contact with the forms and maintaining a slight excess of material in front of the cutting edge. The concrete shall then be tamped with an approved tamping template to compact the concrete thoroughly and eliminate surface voids and the surface screed to required section.

2. After completion of a strike off, consolidation and transverse screeding, a hand-operated longitudinal float shall be operated to test and level the surface to the required grade.
3. Workers shall operate the float from approved bridges riding on the forms and spanning the pavement. The longitudinal float shall be held in contact with the surface and parallel to the centerline and operated with short longitudinal strokes while being passed from one side of the pavement to the other. If contact with the pavement is not made at all points, additional concrete shall be placed, if required and screed and the float shall be used to produce a satisfactory surface. Care shall be exercised to keep the ends of the float from digging into the surface of the pavement. After a section has been smoothed so that the float maintains contact with the surface at all points in being passed from one side to the other, the bridges may be moved forward half the length of the float and the operations repeated.

D. Broom Finishing

1. The top surface shall be floated and troweled to a uniform smooth surface, then finished with a broom or wood float to a gritty texture unless otherwise indicated on the Drawings.
2. The outer edges and joints shall be rounded with approved tools to a ¼-inch (6.3 mm) radius. Care shall be exercised to prevent loss of dummy joints or rounded edges when applying the broom finish.

E. Curbs and Gutters

1. Within 1 hour after concrete placement, a thin coating, that is no more than ½ inch (12.5 mm) nor less than ¼ inch (6.25 mm) thick of finish mortar, composed of 1 part portland cement to 2 parts fine aggregate, shall be worked into the exposed faces of the curb and gutter by means of a "mule".
2. After the concrete has become sufficiently set, the exposed edges shall be rounded using an edging tool to the radii indicated in the Drawings.
3. The entire exposed surface of the curb and gutter shall be floated to a uniform smooth surface, and then finished with a camel hairbrush to a gritty texture.
4. The forms shall remain in place a minimum of 24 hours unless approved otherwise by the Engineer.
5. After removal of the forms, any minor honeycombed surfaces shall be plastered with a mortar mix as described above. Excessively honeycombed curb and gutter, as determined by the Engineer, shall be completely removed and replaced when directed.

F. Exposed Aggregate

1. When exposed aggregate surfaces are required for sidewalks, driveways and/or medians, the coarse aggregate shall consist of particles with at least 40 percent crushed faces. Uncrushed gravel, polished aggregates and clear resilient coatings are not acceptable. Grade 5 coarse aggregates shall be used for exposed aggregate finishes for sidewalks, driveways and/or medians.

3.7 CURING

A. General

1. At least 1 day of curing shall be allowed after the concrete has achieved initial set before placing strain on projecting reinforcement to prevent damage to the concrete.
2. All concrete pavement shall be cured by protecting it against loss of moisture for a period of not less than 72 hours from the beginning of the curing operations. Immediately after finishing operations have been completed, the entire surface of the newly laid concrete shall be covered and cured in accordance with the requirements specified for whichever of the following methods the Contractor may elect.
3. Failure to provide sufficient cover material of the type the Contractor elects to use, failure to maintain saturation in wet curing methods, lack of water to adequately take care of both

curing and other requirements or other failures to comply with curing requirements shall be cause for immediate suspension of concreting operations.

4. The covering material used in curing shall be removed as necessary to saw joints or to comply with the requirements for "Surface Test."
5. The concrete surface shall be maintained wet with a water spray if indicated and the covering material replaced immediately on completion of sawing and testing and any required surface correction.
6. The storing of reinforcing or structural steel on completed pavement slabs is prohibited.

B. Membrane Curing

1. Immediately after the finishing of pavement has been completed and after the free surface moisture has disappeared, the pavement shall be sprayed uniformly with a Type 2 white pigmented curing compound. Should the film of compound be damaged from any cause before the expiration of 72 hours after original application, the damaged portions shall be repaired with additional compound.

C. Polyethylene Film Curing

1. Immediately after the finishing of the surface has been completed and the concrete has taken its initial set, it shall be wetted with water applied in the form of a fine spray and covered with the polyethylene film so placed and weighted as to cause it to remain in intimate contact with the surface. The polyethylene film covering shall be maintained in place continuously for not less than the specified curing period.
2. The film shall be prepared to form blankets of sufficient width to cover the entire surface and both edges of the pavement slab. All joints in the blankets occasioned by joining film sheets shall lap not less than 12 inches (30.5 cms). All joints shall be sealed in a manner acceptable to the Engineer to provide a moisture-proof lap.
3. The polyethylene film blankets shall be adequately weighted to prevent displacement or billowing due to wind and the film folded down over the side of the pavement shall be secured by a continuous bank of earth. Plowing of this windrow into place not to be permitted.
4. All tears or holes appearing in the polyethylene film during the curing period shall be immediately repaired by placing acceptable moisture proof patches over such defects or by replacing the blankets. It shall be the Contractor's responsibility to prevent damage to the film blankets, which would affect their serviceability and effectiveness as a concrete curing method. Blankets may be rejected by the Engineer at any time if it appears they do not provide an airtight covering.
5. Polyethylene film blankets rejected on account of pinholes or minor tears may be continued in service when repaired to an airtight condition. All polyethylene film blankets rejected by the Engineer shall be immediately marked by the Contractor for identification and then destroyed or stored entirely separate from approved blankets.
6. Should the film blanket be damaged or torn for any cause during the first 72 hours of the curing period such damage shall be repaired immediately.

D. Cotton Mats

1. Wet cotton mats placed in direct contact with the slab shall be maintained for the required curing time. If needed damp burlap blankets made from 9-ounce (255 gm) stock may be placed on the damp concrete surface for temporary protection prior to the application of the cotton mats, which may be placed dry and wetted down after placement.
2. The mats shall be weighted down adequately to provide continuous contact with all concrete surfaces where possible. The surfaces of the concrete shall be kept wet for the required curing time. Surfaces, which cannot be cured by contact, shall be enclosed with mats, anchored positively to the forms or to the ground, so that outside air cannot enter the enclosure. Sufficient moisture shall be provided inside the enclosure to keep all surfaces of the concrete wet.

E. Curbs and Gutters

1. After a minimum of 3 days curing and before placement of the final lift of the base course, the curb shall be backfilled to the full height of the concrete, tamped and sloped as directed by the Engineer.

F. Sidewalks

1. The sides of the concrete shall be cured in the forms. If the forms are removed during the curing process, the curing shall be continued by the placement of fill against the exposed concrete edges.

3.8 PROTECTION

A. Opening to Traffic

1. The pavement shall be closed to traffic, including vehicles of the Contractor, until the concrete is at least 14 days old and has attained an average compressive strength acceptable to the Engineer. This period of closure to traffic may be extended if, in the opinion of the Engineer, weather or other conditions make it advisable to provide an extension of the time of protection.
2. Prior to opening any section of the pavement to traffic, all joints shall be sealed, the pavement cleaned, and topsoil placed against the pavement edges or behind the curb where turf or vegetation is to be established before permitting vehicles thereon.
3. At the end of the 14-day period and as long thereafter as ordered by the Engineer and if so desired by the Contractor, the pavement may be opened for use by vehicles of the Contractor provided the gross weight (vehicle plus load) of such vehicles does not exceed 14,000 pounds (6,350 KGs). Such opening, however, shall in no manner relieve the Contractor from responsibility for the Contractor's work.
4. When High Early Strength Concrete, resulting from the use of Type III cement, is used, the pavement may be opened to all traffic after the concrete is 7 days old or as long thereafter as ordered by the Engineer, subject to the same provisions governing the opening after 14 days as above indicated.

B. Cold Weather

1. The temperature of all concrete placed on or in the ground, shall be maintained above 32°F(0°C) for a period of 72 hours from time of placement.
2. Protection shall consist of providing additional covering, insulated forms or other means and if necessary, supplementing such covering with artificial heating. Avoid applying heat directly to concrete surfaces. Curing shall be provided during this period until all requirements for curing have been satisfied.
3. When impending weather conditions indicate the possibility of the need for such temperature protection, all necessary heating and covering material shall be on hand ready for use before permission is granted to begin placement.
4. Sufficient extra test specimens will be made and cured with the placement to ascertain the condition of the concrete as placed prior to form removal and acceptance.

3.9 FIELD QUALITY CONTROL

A. Testing Agency

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. The Contractor shall provide sufficient notice to the Engineer of each concrete placement to allow for scheduling of tests and inspections, and shall provide access to each concrete placement as needed to perform tests and inspections.

B. Compressive Strength

1. At least one set of test cylinders shall be obtained from each day's concrete placement, or for each 100 cubic yards, whichever is less.
2. A minimum of four test cylinders shall be prepared; two each to be tested at 7 and 28 days. Specimens will be tested conforming to TXDOT Test Method TEX-418-A. A strength test shall be defined as the average breaking strength of 2 cylinders.
3. Test specimens shall be cured using the same methods and under the same conditions as the concrete represented. Design strength cylinders shall be cured conforming to TXDOT Bulletin C-11 (and supplements thereto).
4. When control of concrete quality is by 28-day compressive tests, job control testing will be by 7-day compressive strength tests. The minimum strength requirement for seven (7) day test will be 70 percent of the specified minimum 28-day compressive strength. If the required 7-day strength is not obtained, changes in the mix design shall be made and resubmitted for approval. For an occasional failure of the seven-day compressive test, the concrete may be tested at 28 days for final evaluation.

C. Slump

1. At least one slump test will be performed for each day's concrete placement.
2. Slump tests will be performed in accordance with TxDoT Test Method Tex-415-A.

D. Entrained Air

1. At least one entrained air test shall be performed for each day's concrete placement.
2. Entrained air tests will be performed in accordance with TxDoT Test Method Tex-416-A.

E. Temperature

1. At least one temperature test shall be performed hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above.
2. Temperature tests will be performed in accordance with ASTM C 1064/C 1064M.

F. Pavement Surface Testing

1. After the concrete has been placed 12 hours or more, the Engineer will test the surface of the pavement with a 10-foot (3.05 meter) straightedge. Unless specified otherwise, the surface shall not vary from the straightedge by more than 1/16 inch per foot (5 mm per meter) from the nearest point of contact and in no case shall the maximum ordinate from a straightedge to the pavement be greater than 1/8 inch (3 mm). Any high spots causing a departure from the straightedge in excess of that specified shall be ground down by the Contractor to meet the surface test requirements.

G. Accessibility

1. Sidewalks, ramps, and pavements designated on the Drawings as accessible routes may be inspected by a Registered Accessibility Specialist (RAS). Any deficiencies noted by the RAS shall be repaired or replaced at the expense of the Contractor.

3.10 REPAIRS AND ACCEPTANCE

A. Defective Work

1. Any defective work discovered after the forms have been removed shall be repaired or replaced as soon as possible at the expense of the Contractor.

B. Cost Adjustments for Pavement

1. It is the intent of this specification that the pavement be constructed in strict conformity with the thickness, strength and typical sections indicated on the drawings. Where any pavement is found not so constructed, the Owner may elect to apply the following rules relative to adjustment of payment in lieu of repair and replacement, based on pavement thickness and compressive strength.

2. Thickness

- a. The pavement will be core drilled after any grinding operations have been completed for surface corrections prior to final acceptance. Locations of core tests may be selected by the Engineer; however, spacing interval for core tests, as specified herein, shall be maintained. The thickness of the pavement will be determined by measurement of the cores in accordance with TxDOT Test Method Tex-424-A.
- b. For the purpose of establishing an adjusted price for pavement, each concrete placement less than 1,000 square yards in area shall be considered a unit. For concrete placements greater than 1,000 square yards in area, the Engineer shall delineate the concrete placements into approximately equivalent units.
- c. One core will be taken at the location selected by the Engineer or at random in each unit.
- d. When the measurement of the core from any unit is not deficient more than 0.2 inches from the plan thickness, full payment will be made.
- e. When the measurement of the core from any unit is deficient more than 0.2 inch but not more than 0.75 inch from the plan thickness, 2 additional cores will be taken from the unit and the average of the 3 cores determined. The 2 additional cores from any unit will be taken at locations such that the pavement in the unit will be well represented. If the average measurement of these 3 cores is not deficient more than 0.2 inches from the plan thickness, full payment will be made. If the average thickness of the 3 cores is deficient by more than 0.2 inch but not more than 0.75 inch from the indicated thickness, an adjusted unit price as provided below will be paid for the areas represented by these cores.

Concrete Pavement Deficiency	
Deficiency in Thickness Determined by Cores, Inches	Proportional Part of Contract Price Allowed
0.00 to 0.20	100 percent
0.21 to 0.30	80 percent
0.31 to 0.40	72 percent
0.41 to 0.50	68 percent
0.51 to 0.75	57 percent

- f. Irrespective of an acceptable overall project average for any or all of the Pay-Adjustment Acceptance Factors, limited substandard portions of the work, as determined by the Engineer, shall be remedied or removed and replaced to the satisfaction thereof.
- g. Any area of pavement found deficient in thickness by more than 0.75 inch but not more than 1 inch or 1/8 of the indicated thickness, whichever is greater, shall be evaluated by the Engineer. If, in the judgment of the Engineer, the area of such deficiency should not be removed and replaced, there will be no payment for the area retained. If, in the judgment of the Engineer, the area of such deficiency warrants removal, the area shall be removed and replaced at the Contractor's entire expense, with concrete of the thickness indicated on the drawings.
- h. Any area of pavement found deficient in thickness by more than 1 inch or more than 1/8 of the indicated thickness, whichever is greater, shall be removed and replaced, at the Contractor's entire expense, with concrete of the thickness indicated on the drawings.
- i. No additional payment over the Contract unit price will be made for any pavement of a thickness exceeding that indicated on the drawings.

3. Compressive Strength

- a. If the average compressive strength based on concrete test cylinders at 28 days is less than the specified minimum strength of the concrete, then payment will be made at an adjusted price as specified in the following table.

Pay Adjustment Factor for Deficient Compressive Strength	
Ratio of Average Strength from Test Cylinders to Specified Minimum Compressive Strength both at 28 Days	Proportional Part of Contract Price Allowed
More than 0.95	100 percent
0.90 to 0.95	85 percent
0.85 to 0.90	70 percent
0.80 to 0.85	60 percent
Less than 0.80	0 percent (Remove & Replace)

- b. When, in the opinion of the Engineer, the compressive strength test results appear unrepresentative, additional testing of field cores may be authorized. To be considered acceptable for consideration the field cores shall be acquired, properly handled and tested in accordance with ASTM C 42/C 42M, "Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete" within 45 days of the original concrete placement date. The retesting will be at the expense of the Contractor and the results of the retesting shall be averaged with the results of the original testing. If the results of retesting indicate that the original test results were erroneous in the opinion of the Engineer, the original test results will be discarded. In the instance of erroneous original test results the subsequent first set of retests will be at the expense of the Owner.
- c. When, in the opinion of the Engineer, the concrete compressive strength is deemed unacceptable for the intended use of the pavement, the concrete shall be removed and replaced to the limits indicated by test results.

3.11 WARRANTY

A. Pavement

1. If cracks develop in the pavement surface within the one-year warranty period, the Contractor shall seal the cracks in accordance with the requirements of this specifications, or perform other corrective measures as directed by the Engineer, at the expense of the Contractor.

END OF SECTION 321313