

Project Manual

UTHSC - MSB 1st Floor Infill LRC 3 & 4

Issue for Construction

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PWP Project No. 214-198

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SEALS PAGE



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END OF SECTION

SECTION 01 10 00
SUMMARY

PART 1 GENERAL

1.01 PROJECT

- A. Project Name: UT Health MSB LRC Infill
- B. Owner's Name: The University of Texas Health Science Center at Houston.
- C. Architect's Name: PhiloWilke Partners, LLP.

1.02 CONTRACT DESCRIPTION

- A. Contract Type: A single prime contract based on a Stipulated Price as described in Document 00 52 00 - Agreement Form.

1.03 DESCRIPTION OF ALTERATIONS WORK

- A. Scope of demolition and removal work is shown on drawings and specified in Section 02 41 00.

1.04 WORK BY OWNER

- A. Items noted NIC (Not in Contract) will be supplied and installed by Owner before Substantial Completion. Some items include:
 - 1. Movable cabinets.
 - 2. Furnishings.
 - 3. Small equipment.
 - 4. Artwork.
- B. Owner will supply the following for installation by Contractor:
 - 1. Equipment indicated on the Equipment Schedule to be Owner-Furnished and Contractor Installed (OFCl)..

1.05 OWNER OCCUPANCY

- A. Owner intends to continue to occupy adjacent portions of the existing building during the entire construction period.
- B. Owner intends to occupy the Project upon Substantial Completion.
- C. Owner intends to occupy a certain portion of the Project prior to the completion date for the conduct of normal operations.
- D. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
- E. Schedule the Work to accommodate Owner occupancy.

1.06 CONTRACTOR USE OF SITE AND PREMISES

- A. Construction Operations: Limited to areas noted on Drawings.
- B. Arrange use of site and premises to allow:
 - 1. Owner occupancy.
 - 2. Work by Others.
 - 3. Work by Owner.
 - 4. Use of site and premises by the public.
- C. Provide access to and from site as required by law and by Owner:
 - 1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
 - 2. Do not obstruct roadways, sidewalks, or other public ways without permit.
- D. Existing building spaces may not be used for storage.
- E. Utility Outages and Shutdown:
 - 1. Limit shutdown of utility services to agreed hours at a time, arranged at least 24 hours in advance with Owner.

2. Prevent accidental disruption of utility services to other facilities.

1.07 WORK SEQUENCE

- A. Construct Work in phases during the construction period:
 1. _____ Refer to the Drawings for proposed phasing sequence..
- B. Coordinate construction schedule and operations with 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. Procedures for preparation and submittal of applications for progress payments.
- B. Documentation of changes in Contract Sum and Contract Time.
- C. Change procedures.
- D. Correlation of Contractor submittals based on changes.
- E. Procedures for preparation and submittal of application for final payment.

1.02 RELATED REQUIREMENTS

1.03 SCHEDULE OF VALUES

- A. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit draft to Architect for approval.
- B. Forms filled out by hand will not be accepted.
- C. Submit a printed schedule on AIA Form G703 - Application and Certificate for Payment Continuation Sheet. Contractor's standard form or electronic media printout will be considered.
- D. Submit Schedule of Values in duplicate within 15 days after date of Owner-Contractor Agreement.
- E. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the specification Section. Identify site mobilization and bonds and insurance.
- F. Revise schedule to list approved Change Orders, with each Application For Payment.

1.04 APPLICATIONS FOR PROGRESS PAYMENTS

- A. Payment Period: Submit at intervals stipulated in the Agreement.
- B. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Architect for approval.
- C. Forms filled out by hand will not be accepted.
- D. For each item, provide a column for listing each of the following:
 - 1. Item Number.
 - 2. Description of work.
 - 3. Scheduled Values.
 - 4. Previous Applications.
 - 5. Work in Place and Stored Materials under this Application.
 - 6. Authorized Change Orders.
 - 7. Total Completed and Stored to Date of Application.
 - 8. Percentage of Completion.
 - 9. Balance to Finish.
 - 10. Retainage.
- E. Execute certification by signature of authorized officer.
- F. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored products.
- G. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of Work.
- H. Submit _____ copies of each Application for Payment.
- I. Include the following with the application:
 - 1. Transmittal letter as specified for Submittals in Section 01 30 00.

2. Current construction photographs specified in Section 01 30 00.
 3. Partial release of liens from major Subcontractors and vendors.
 4. Affidavits attesting to off-site stored products.
 5. Maintenance and Operations manuals and other pertinent information for equipment and systems prior to installation and payment request for equipment.
- J. When Architect requires substantiating information, submit data justifying dollar amounts in question. Provide one copy of data with cover letter for each copy of submittal. Show application number and date, and line item by number and description.

1.05 MODIFICATION PROCEDURES

- A. Submit name of the individual authorized to receive change documents and who will be responsible for informing others in Contractor's employ or subcontractors of changes to the Contract Documents.
- B. For minor changes not involving an adjustment to the Contract Sum or Contract Time, Architect will issue instructions directly to Contractor.
- C. Architect's Supplemental Instructions (ASI): Architect will advise of minor changes in the Work not involving an adjustment to Contract Sum or Contract Time as authorized by the Conditions of the Contract by issuing supplemental instructions on AIA Form G710, or a similar form.
- D. For other required changes, Architect will issue a document signed by Owner instructing Contractor to proceed with the change, for subsequent inclusion in a Change Order.
 1. The document will describe the required changes and will designate method of determining any change in Contract Sum or Contract Time.
 2. Promptly execute the change.
- E. For changes for which advance pricing is desired, Architect will issue a document that includes a detailed description of a proposed change with supplementary or revised drawings and specifications, a change in Contract Time for executing the change and the period of time during which the requested price will be considered valid. Contractor shall prepare and submit a fixed price quotation within ten (10) days.
- F. Contractor may propose a change by submitting a request for change to Architect, describing the proposed change and its full effect on the Work, with a statement describing the reason for the change, and the effect on the Contract Sum and Contract Time with full documentation and a statement describing the effect on Work by separate or other contractors. Document any requested substitutions in accordance with Section 01 60 00.
- G. Computation of Change in Contract Amount: As specified in the Agreement and Conditions of the Contract.
 1. For change requested by Architect for work falling under a fixed price contract, the amount will be based on Contractor's price quotation.
 2. For change requested by Contractor, the amount will be based on the Contractor's request for a Change Order as approved by Architect.
 3. For change ordered by Architect without a quotation from Contractor, the amount will be determined by Architect based on the Contractor's substantiation of costs as specified for Time and Material work.
- H. Substantiation of Costs: Provide full information required for evaluation.
 1. On request, provide the following data:
 - a. Quantities of products, labor, and equipment.
 - b. Taxes, insurance, and bonds.
 - c. Overhead and profit.
 - d. Justification for any change in Contract Time.
 - e. Credit for deletions from Contract, similarly documented.
 2. Support each claim for additional costs with additional information:
 - a. Origin and date of claim.
 - b. Dates and times work was performed, and by whom.

- c. Time records and wage rates paid.
- d. Invoices and receipts for products, equipment, and subcontracts, similarly documented.
- 3. For Time and Material work, submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract.
- I. Execution of Change Orders: Architect will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.
- J. After execution of Change Order, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum.
- K. Promptly revise progress schedules to reflect any change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.
- L. Promptly enter changes in Project Record Documents.

1.06 APPLICATION FOR FINAL PAYMENT

- A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- B. Application for Final Payment will not be considered until the following have been accomplished:
 - 1. All closeout procedures specified in Section 01 70 00.

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. Electronic document submittal service.
- B. Preconstruction meeting.
- C. Progress meetings.
- D. Progress photographs.
- E. Submittals for review, information, and project closeout.
- F. Number of copies of submittals.
- G. Submittal procedures.

1.02 RELATED REQUIREMENTS

- A. Section 01 32 16 - Construction Progress Schedule: Form, content, and administration of schedules.
- B. Section 01 30 10 - Internet-Based Collaboration System: Requirements for documentation required in this section to be stored on a Project Website.
- C. Section 01 70 00 - Execution and Closeout Requirements: Additional coordination requirements.
- D. Section 01 78 00 - Closeout Submittals: Project record documents.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 ELECTRONIC DOCUMENT SUBMITTAL SERVICE

- A. All documents transmitted for purposes of administration of the contract are to be in electronic (PDF) format and transmitted via an Internet-based submittal service that receives, logs and stores documents, provides electronic stamping and signatures, and notifies addressees via email.
 - 1. Besides submittals for review, information, and closeout, this procedure applies to requests for information (RFIs), progress documentation, contract modification documents (e.g. supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, Contractor's correction punchlist, and any other document any participant wishes to make part of the project record.
 - 2. Contractor and Architect are required to use this service.
 - 3. It is Contractor's responsibility to submit documents in PDF format.
 - 4. Subcontractors, suppliers, and Architect's consultants will be permitted to use the service at no extra charge.
 - 5. Users of the service need an email address, Internet access, and PDF review software that includes ability to mark up and apply electronic stamps (such as Adobe Acrobat, www.adobe.com, or Bluebeam PDF Revu, www.bluebeam.com), unless such software capability is provided by the service provider.
 - 6. Paper document transmittals will not be reviewed; emailed PDF documents will not be reviewed.
 - 7. All other specified submittal and document transmission procedures apply, except that electronic document requirements do not apply to samples or color selection charts.
- B. Cost: The cost of the service will be paid by Owner.
- C. Submittal Service: The selected service is:

1. Electronic document submittals will be processed utilizing the Internet-based collaboration system employed for the project. See section 01 30 10 - Internet-Based Collaboration System for additional requirements..
- D. Training: One, one-hour, web-based training session will be arranged for all participants, with representatives of Architect and Contractor participating; further training is the responsibility of the user of the service.
- E. Project Closeout: Architect will determine when to terminate the service for the project and is responsible for obtaining archive copies of files for Owner.

3.02 PRECONSTRUCTION MEETING

- A. Schedule meeting after Notice of Award.
- B. Attendance Required:
 1. Owner.
 2. Architect.
 3. Contractor.
 4. Contractor's superintendent..
 5. All Major Subcontractors..
- 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, list of Products, schedule of values, and progress schedule.
 5. Designation of personnel representing the parties to Contract and Architect.
 6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 7. Scheduling.
 8. Critical work sequencing.
 9. Use of premises/temporary facilities.
 10. Equipment deliveries and priorities.
 11. Coordination with Owner supplied equipment / suppliers.
 12. Safety procedures and first aid.
 13. Security.
 14. Housekeeping and waste disposal.
 15. Provisions for temporary egress, dust protection, and infection control.
 16. Procedures for testing.
 17. Procedures for maintaining record documents.
 18. Progress meeting schedule.
- D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.03 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the Work at maximum monthly intervals.
- B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.
- C. Attendance Required:
 1. Contractor.
 2. Owner.
 3. Architect.
 4. Contractor's Superintendent.
 5. Major Subcontractors and suppliers.

- D. Agenda:
1. Review minutes of previous meetings.
 2. Review of Work progress.
 3. Field observations, problems, and decisions.
 4. Identification of problems that impede, or will impede, planned progress.
 5. Review of outstanding Requests for Information.
 6. Review of submittals schedule and status of submittals.
 7. Maintenance of progress schedule.
 8. Corrective measures to regain projected schedules.
 9. Planned progress during succeeding work period.
 10. Maintenance of quality and work standards.
 11. Effect of proposed changes on progress schedule and coordination.
 12. Other business relating to Work.
- E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.
1. Distribution may be made via posting to the Internet-based collaboration system employed for the Project.

3.04 CONSTRUCTION PROGRESS SCHEDULE - SEE SECTION 01 32 16

- A. Within 10 days after date of the Agreement, submit preliminary schedule defining planned operations for the first 60 days of Work, with a general outline for remainder of Work.

3.05 PROGRESS PHOTOGRAPHS

- A. Submit photographs with each application for payment, taken not more than 3 days prior to submission of application for payment.
- B. Photography Type: Digital; electronic files.
- C. Provide photographs of site and construction throughout progress of Work produced by an experienced photographer, acceptable to Architect, using a digital camera with a minimum resolution of five mega-pixels.
- D. In addition to periodic, recurring views, take photographs of each of the following events:
- E. Take photographs as evidence of existing project conditions as follows:
1. Foundations in progress and upon completion..
 2. Structural framing in progress and upon completion.
 3. Enclosure of building, upon completion.
 4. Final completion, minimum of ten (10) photos..
- F. Views:
1. Provide non-aerial photographs from four cardinal views at each specified time, until Date of Substantial Completion.
 2. Consult with Architect for instructions on views required.
 3. Provide factual presentation.
 4. Provide correct exposure and focus, high resolution and sharpness, maximum depth of field, and minimum distortion.
- G. Digital Photographs: 24 bit color, minimum resolution of 1024 by 768, in JPG format; provide files unaltered by photo editing software.
1. Delivery Medium: via posting on the Internet-based collaboration system employed for the Project..
 2. File Naming: Include project identification, date and time of view, and view identification.
 3. Hard Copy: Printed hardcopy (grayscale) of PDF file and point of view sketch.

3.06 SUBMITTALS FOR REVIEW

- A. When the following are specified in individual sections, submit them for review:
1. Product data.

2. Shop drawings.
 3. Samples for selection.
 4. Samples for verification.
- B. Submit to Architect for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
- C. Samples will be reviewed only for aesthetic, color, or finish selection.
- D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 78 00 - Closeout Submittals.

3.07 SUBMITTALS FOR INFORMATION

- A. When the following are specified in individual sections, submit them for information:
1. Design data.
 2. Certificates.
 3. Test reports.
 4. Inspection reports.
 5. Manufacturer's instructions.
 6. Manufacturer's field reports.
 7. Other types indicated.
- B. Submit for Architect's knowledge as contract administrator or for Owner. No action will be taken.

3.08 SUBMITTALS FOR PROJECT CLOSEOUT

- A. When the following are specified in individual sections, submit them at project closeout:
1. Project record documents.
 2. Operation and maintenance data.
 3. Warranties.
 4. Bonds.
 5. Other types as indicated.
- B. Submit for Owner's benefit during and after project completion.

3.09 NUMBER OF COPIES OF SUBMITTALS

- A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.
- B. Documents for Project Closeout: Make one reproduction of submittal originally reviewed. Submit one extra of submittals for information.
- C. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.
1. After review, produce duplicates.
 2. Retained samples will not be returned to Contractor unless specifically so stated.

3.10 SUBMITTAL PROCEDURES

- A. Transmit each submittal with a copy of approved submittal form.
- B. Identify the submittal with an identification number comprised of:
1. The specification section number pertaining to the submittal.
 2. A sequential number, beginning at the number 1 for each specification section.
 3. If the submittal is a resubmission, a sequential alphabetic suffix, beginning with the letter 'A' for the first resubmission, 'B' for the second, and so-on.
- C. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate on each copy.

- D. 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 the requirements of the Work and Contract Documents.
- E. Schedule submittals to expedite the Project, and coordinate submission of related items.
- F. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.
- G. Identify variations from Contract Documents and Product or system limitations that may be detrimental to successful performance of the completed Work.
- H. Provide space for Contractor and Architect review stamps.
- I. When revised for resubmission, identify all changes made since previous submission.
- J. Distribute reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.
- K. Submittals not requested will not be recognized or processed.

END OF SECTION

SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preliminary schedule.
- B. Construction progress schedule, bar chart type.

1.02 RELATED SECTIONS

- A. Section 01 10 00 - Summary: Work sequence.

1.03 REFERENCES

- A. AGC (CPSM) - Construction Planning and Scheduling Manual; Associated General Contractors of America; 2004.
- B. M-H (CPM) - CPM in Construction Management - Project Management with CPM, O'Brien, McGraw-Hill Book Company; 2006.

1.04 SUBMITTALS

- A. Within 10 days after date of Agreement, submit preliminary schedule defining planned operations for the first 60 days of Work, with a general outline for remainder of Work.
- B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
- C. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
- D. Within 10 days after joint review, submit complete schedule.
- E. Submit under transmittal letter form specified in Section 01 30 00 - Administrative Requirements.

1.05 QUALITY ASSURANCE

- A. Scheduler: Contractor's personnel or specialist Consultant specializing in CPM scheduling with one years minimum experience in scheduling construction work of a complexity comparable to this Project, and having use of computer facilities capable of delivering a detailed graphic printout within 48 hours of request.

1.06 SCHEDULE FORMAT

- A. Listings: In chronological order according to the start date for each activity. Identify each activity with the applicable specification section number.
- B. Diagram Sheet Size: Maximum 22 x 17 inches or width required.
- C. Scale and Spacing: To allow for notations and revisions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRELIMINARY SCHEDULE

- A. Prepare preliminary schedule in the form of a horizontal bar chart.

3.02 CONTENT

- A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
- B. Identify each item by specification section number.
- C. Identify work of separate stages and other logically grouped activities.
- D. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.

- E. Provide separate schedule of submittal dates for shop drawings, product data, and samples, owner-furnished products, Products identified under Allowances, and dates reviewed submittals will be required from Architect. Indicate decision dates for selection of finishes.
- F. Indicate delivery dates for owner-furnished products.
- G. Coordinate content with schedule of values specified in Section 01 20 00 - Price and Payment Procedures.
- H. Provide legend for symbols and abbreviations used.

3.03 BAR CHARTS

- A. Include a separate bar for each major portion of Work or operation.
- B. Identify the first work day of each week.

3.04 REVIEW AND EVALUATION OF SCHEDULE

- A. Participate in joint review and evaluation of schedule with Architect at each submittal.
- B. Evaluate project status to determine work behind schedule and work ahead of schedule.
- C. After review, revise as necessary as result of review, and resubmit within 10 days.

3.05 UPDATING SCHEDULE

- A. Maintain schedules to record actual start and finish dates of completed activities.
- B. Indicate progress of each activity to date of revision, with projected completion date of each activity.
- C. Annotate diagrams to graphically depict current status of Work.
- D. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.
- E. Indicate changes required to maintain Date of Substantial Completion.
- F. Submit reports required to support recommended changes.
- G. Provide narrative report to define problem areas, anticipated delays, and impact on the schedule. Report corrective action taken or proposed and its effect including the effects of changes on schedules of separate contractors.

3.06 DISTRIBUTION OF SCHEDULE

- A. Distribute copies of updated schedules to Contractor's project site file, to Subcontractors, suppliers, Architect, Owner, and other concerned parties.
- B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

END OF SECTION

SECTION 01 35 53
SECURITY PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Security measures including formal security program, entry control, personnel identification, and miscellaneous restrictions.

1.02 RELATED REQUIREMENTS

- A. Section 01 10 00 - Summary: use of premises and occupancy.
- B. Section 01 50 00 - Temporary Facilities and Controls: Temporary lighting.

1.03 SECURITY PROGRAM

- A. Protect Work, existing premises and Owner's operations from theft, vandalism, and unauthorized entry.
- B. Initiate program in coordination with Owner's existing security system at project mobilization.
- C. Maintain program throughout construction period until Owner acceptance precludes the need for Contractor security.

1.04 ENTRY CONTROL

- A. Restrict entrance of persons and vehicles into Project site and existing facilities.
- B. Allow entrance only to authorized persons with proper identification.
- C. Maintain log of workers and visitors, make available to Owner on request.
- D. Contractor shall control entrance of persons and vehicles related to Owner's operations.
- E. Coordinate access of Owner's personnel to site in coordination with Owner's security forces.

1.05 PERSONNEL IDENTIFICATION

- A. Provide identification badge to each person authorized to enter premises.
- B. Badge To Include: Personal photograph, name, assigned number, expiration date and employer.
- C. Maintain a list of accredited persons, submit copy to Owner on request.
- D. Require return of badges at expiration of their employment on the Work.

1.06 RESTRICTIONS

- A. Do not allow cameras on site or photographs taken except by written approval of Owner.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 40 00
QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Submittals.
- B. Testing and inspection agencies and services.
- C. Control of installation.
- D. Mock-ups.
- E. Tolerances.
- F. Testing and inspection services.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Submittal procedures.
- B. Section 01 42 16 - Definitions.
- C. Section 01 42 19 - Reference Standards.
- D. Section 01 60 00 - Product Requirements: Requirements for material and product quality.

1.03 REFERENCE STANDARDS

- A. ASTM C1021 - Standard Practice for Laboratories Engaged in Testing of Building Sealants; 2008 (Reapproved 2014).
- B. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation; 2014.
- C. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction; 2012a.
- D. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing; 2013.

1.04 SUBMITTALS

- A. Testing Agency Qualifications:
 - 1. Prior to start of Work, submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.
- B. Design Data: Submit for Architect's knowledge as contract administrator for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents, or for Owner's information.
- C. Test Reports: After each test/inspection, promptly submit two copies of report to Architect and to Contractor.
 - 1. Include:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of inspector.
 - d. Date and time of sampling or inspection.
 - e. Identification of product and specifications section.
 - f. Location in the Project.
 - g. Type of test/inspection.
 - h. Date of test/inspection.
 - i. Results of test/inspection.
 - j. Conformance with Contract Documents.
 - k. When requested by Architect, provide interpretation of results.

2. Test report submittals are for Architect's knowledge as contract administrator for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents, or for Owner's information.
- D. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor or installation/application subcontractor to Architect, in quantities specified for Product Data.
 1. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
 2. Certificates may be recent or previous test results on material or product, but must be acceptable to Architect.
- E. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.05 REFERENCES AND STANDARDS - SEE SECTION 01 42 19

1.06 TESTING AND INSPECTION AGENCIES AND SERVICES

- A. Owner will employ and pay for services of an independent testing agency to perform specified testing.
- B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 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. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect 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. Have Work performed by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 MOCK-UPS

- A. Tests shall be performed under provisions identified in this section and identified in the respective product specification sections.
- B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- C. Accepted mock-ups shall be a comparison standard for the remaining Work.
- D. Where mock-up has been accepted by Architect and is specified in product specification sections to be removed_____, remove mock-up and clear area when directed to do so by Architect.

3.03 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. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

3.04 TESTING AND INSPECTION

- A. See individual specification sections for testing required.
- B. Testing Agency Duties:
 - 1. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
 - 2. Perform specified sampling and testing of products in accordance with specified standards.
 - 3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 - 4. Promptly notify Architect and Contractor of observed irregularities or non-conformance of Work or products.
 - 5. Perform additional tests and inspections required by Architect.
 - 6. Submit reports of all tests/inspections specified.
- C. Limits on Testing/Inspection Agency Authority:
 - 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency may not approve or accept any portion of the Work.
 - 3. Agency may not assume any duties of Contractor.
 - 4. Agency has no authority to stop the Work.
- D. Contractor Responsibilities:
 - 1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
 - 2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
 - 3. Provide incidental labor and facilities:
 - a. To provide access to Work to be tested/inspected.
 - b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
 - c. To facilitate tests/inspections.
 - d. To provide storage and curing of test samples.
 - 4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
 - 5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
 - 6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
- E. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect.
- F. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.
- G. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect. Payment for re testing will be charged to the Contractor by deducting testing charges from the Contract Price.

3.05 DEFECT ASSESSMENT

- A. Replace Work or portions of the Work not conforming to specified requirements.

- B. If, in the opinion of Architect, it is not practical to remove and replace the Work, Architect will direct an appropriate remedy or adjust payment.

END OF SECTION

SECTION 01 42 16
DEFINITIONS

PART 1 GENERAL

1.01 SUMMARY

- A. This section supplements the definitions contained in the General Conditions.
- B. Other definitions are included in individual specification sections.

1.02 DEFINITIONS

- A. Furnish: To supply, deliver, unload, and inspect for damage.
- B. Install: To unpack, assemble, erect, apply, place, finish, cure, protect, clean, start up, and make ready for use.
- C. Product: Material, machinery, components, equipment, fixtures, and systems forming the work result. Not materials or equipment used for preparation, fabrication, conveying, or erection and not incorporated into the work result. Products may be new, never before used, or re-used materials or equipment.
- D. Project Manual: The book-sized volume that includes the procurement requirements (if any), the contracting requirements, and the specifications.
- E. Provide: To furnish and install.
- F. Supply: Same as Furnish.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 42 19
REFERENCE STANDARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Requirements relating to referenced standards.

1.02 QUALITY ASSURANCE

- A. For products or workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard of date of issue specified in the individual specification sections, except where a specific date is established by applicable code.
- C. Obtain copies of standards when required by the Contract Documents.
- D. Should specified reference standards conflict with Contract Documents, request clarification from the Architect before proceeding.
- E. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of the Architect shall be altered by the Contract Documents by mention or inference otherwise in any reference document.

END OF SECTION

SECTION 01 45 29
STRUCTURAL TESTING AND INSPECTIONS

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 requirements for quality assurance and quality control to be completed by the Testing Laboratory, and Contractor for the following structural items:
1. Concrete Reinforcing.
 2. Structural Steel.
 3. Steel Decking.

1.03 PRICE AND PAYMENT PROCEDURES

- A. Unit Prices:
1. Cost Proposal: The Testing Laboratory's proposal to the Owner shall contain unit price stipulations for specified tests and inspections and on an hourly basis for personnel. A total estimated price shall also be submitted.
- B. Measurement and Payment
1. Payment of the Testing Laboratory: The Owner will pay for the initial Laboratory services for inspection and testing of materials for compliance with the requirements of the Contract Documents.
 2. Payment for Substitution Testing: The Contractor shall arrange for and pay for any additional samples and tests above those required by the Contract Documents as requested by the Contractor for his convenience in performing the work.
 3. Payment for Retesting: When initial tests indicate work does not comply with the requirements of the Contract Documents, the Contractor shall be liable to the Owner for the cost for any additional inspections, sampling, testing, and retesting done by the Testing Laboratory.
 4. Payment by Contractor: The Contractor shall furnish and pay for the following items if required:
 - a. Samples of concrete aggregates and delivery to the Contractor's Testing Laboratory.
 - b. Concrete mix designs as prepared by his concrete supplier.
 - c. Site-situated storage boxes for concrete cylinders
 - d. Concrete coring, tests of below strength concrete, and load tests, if ordered by the Owner, Architect, or Engineer.
 - e. Certification of reinforcing steel mill order.
 - f. Certification of structural steel mill order.
 - g. Certification of portland cement, lime, fly ash.
 - h. Certification of welders and preparation of Welding Procedure Specifications.
 - i. Any other tests when such costs are required by the Contract Documents to be paid by the Contractor.
 5. Payment for Tests of Suspected Deficient Work: If, in the opinion of the Building Official, Owner, Architect, or Engineer, any of the work of the Contractor is not satisfactory, the Contractor shall furnish and pay for all tests that the Owner, Architect, or Engineer deem advisable to determine its proper construction. The Owner shall pay all costs if the tests prove the questioned work to be satisfactory.

1.04 CONTRACTOR RESPONSIBILITIES

- A. The Contractor shall not engage the same Testing Laboratory for construction services as the Owner has for Structural Testing Laboratory Services as defined herein unless agreed to by the Owner.
- B. Furnishing Samples and Certificates: The Contractor shall provide to the laboratory certificates and representative samples of materials proposed for use in the work in quantities sufficient for accurate testing as specified.
- C. Furnishing Casual Labor, Equipment and Facilities: The Contractor shall furnish casual labor, equipment, and facilities as required for sampling and testing by the laboratory and otherwise facilitate the required inspections and tests.

1.05 TESTING LABORATORY RESPONSIBILITIES

- A. The Testing Laboratory shall sample and test materials as they are being installed for compliance with specified acceptance criteria. The Testing Laboratory will report and interpret the test results. The Laboratory shall monitor and report on the installation of construction work and shall perform tests on the completed construction as required to indicate Contractor's compliance with the various material specifications governing this work.
- B. The Testing Laboratory shall provide inspections on the following items:
 - 1. Reinforcing steel placement.
 - 2. Concrete work.
 - 3. Bolts, anchors, and reinforcing bars installed in hardened concrete (post-installed anchors).
 - 4. Inspection of structural steel, bolting, and welding material.
 - 5. Welding of structural steel.
 - 6. High-strength bolting.
- C. Inspections Required by Government Agencies: The Testing Laboratory shall perform inspections and submit reports and certifications as required by government agencies having jurisdiction over the aspects of the project covered by this specification.
- D. Notification of Deficiencies in the Work: The Testing Laboratory shall notify the Architect, Engineer, and Contractor within 24 hours of discovery of observed irregularities and deficiencies of the Work and other conditions not in compliance with the requirements of the Contract Documents. Notification shall be by telephone or e-mail and then in writing.
- E. Accounting: The Testing Laboratory shall be responsible for separating and billing costs attributed to the Owner and costs attributed to the Contractor.
- F. Monitoring Product and Material Certifications: The Testing Laboratory shall be responsible for monitoring the submittals of product and material certifications from manufacturers and suppliers as specified in the Specifications and shall report to the Owner, Architect, and Engineer when those submittals are not made in a timely manner.
- G. Limitations of Authority: The Testing Laboratory is not authorized to revoke, alter, relax, enlarge upon, or release any requirements of the Specifications or to approve or accept any portion of the work or to perform any duties of the General Contractor and his Subcontractors.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. The Testing Laboratory shall cooperate with the Architect, Engineer, and Contractor and provide qualified personnel promptly on notice.
 - 2. The Contractor shall cooperate with Testing Laboratory personnel and provide access to the work and to manufacturers' operations.
 - 3. Notification of Source Change: The Contractor shall be responsible for notifying the Owner, Architect, Engineer, and Testing Laboratory when the source of any material is changed after the original tests or inspections have been made.

- B. Scheduling:
 - 1. Advance Notice: The Contractor shall be responsible for notifying the Testing Laboratory sufficiently in advance of operations to allow for assignment of personnel and scheduling of tests. Failure to sufficiently notify may result in additional costs incurred by the Testing Laboratory that may be back-charged to the Contractor by the Owner.

1.07 SUBMITTALS

- A. Quality Control Reports:
 - 1. Information on Reports: The Testing Laboratory shall submit copies of reports of inspections and tests promptly. The reports shall contain at least the following information:
 - a. Project name.
 - b. Date report issued.
 - c. Testing Laboratory name and address.
 - d. Name and signature of inspector/technician.
 - e. Date of inspection and/or sampling.
 - f. Date of test.
 - g. Identification of product and Specification section.
 - h. Location in the project.
 - i. Identification of inspection or test.
 - j. Record of weather conditions and temperature (if applicable).
 - k. Results of test regarding compliance with Contract Documents.
 - 2. Copies: The Laboratory shall send signed copies of test and inspection reports to the following parties:
 - a. Two copies to the Owner or his/her representative.
 - b. Two copies to the General Contractor.
 - c. One copy to the Architect.
 - d. One copy to the Engineer of Record.
- B. Discrepancy Log: The Testing Laboratory shall create and maintain a log of all discrepancies throughout the duration of the project.
 - 1. Information on Log: This log shall include, but is not limited to:
 - a. Discrepancy date.
 - b. Description of discrepancy.
 - c. Drawing and/or detail reference.
 - d. Description of as-built condition.
 - e. Description of any remedial work performed.
 - f. Status of discrepancy.
 - 2. Submission Schedule: This log shall be submitted to the Architect/Engineer on a periodic basis for review and comment. Upon completion of the Project, this log shall be submitted in its entirety as an attachment to the final signed report described below under Certifications.
- C. Certification: Upon completion of the job, the Laboratory shall furnish to the Owner, Architect, and Engineer of Record, a statement signed by a licensed professional engineer that, to the best of their knowledge, required tests and inspections were made in accordance with the requirements of the Contract Documents.

1.08 QUALITY ASSURANCE

- A. Qualifications of Testing Laboratory:
 - 1. The Testing Laboratory shall meet the basic requirements of ASTM E 329 and shall submit to the Owner, Architect, and Engineer evidence of current accreditation from the American Association for Laboratory Accreditation, the AASHTO Accreditation Program or the "NIST" National Voluntary Laboratory Accreditation Program.

2. The Testing Laboratory shall be an Approved Agency by the Building Official to perform Special Inspections and other tests and inspections as outlined in the applicable building code.
 3. Tests and inspections shall be conducted in accordance with specified requirements, and if not specified, in accordance with the applicable standards of the American Society for Testing and Materials or other recognized and accepted authorities in the field.
 4. Qualifications of Welding Inspectors
 - a. Inspectors performing visual weld inspection shall meet the requirements of AWS D1.1 Section 6.1.4. Inspectors shall have current certification as an AWS Certified Welding Inspector (CWI). Assistant inspectors, if any, shall be supervised by an Inspector and shall be qualified by training and experience to perform the specific functions to which they are assigned.
 - b. Inspectors performing nondestructive examinations of welds other than visual inspection (MT, PT, UT, and RT) shall meet the requirements of AWS D1.1, Section 6.14.6.
- B. The Contractor shall not engage the same testing laboratory for construction services as the Owner has for quality assurance testing, unless agreed to by the Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 SCOPE OF WORK

- A. The work to be performed by the Testing Laboratory shall be as specified in this Section of the Specification and as determined in meetings with the Owner, Architect, and Engineer.

3.02 CONCRETE REINFORCING

- A. Field Inspection: The scope of the work to be performed by the inspector on the jobsite shall be as follows:
1. Reinforcing Steel: The Testing Laboratory or designated Special Inspector shall inspect 100% of reinforcement before each concrete pour to verify the information noted below. Inspection reports shall be prepared and distributed in accordance with the local building code and as specified in this specification.
 - a. Primary and secondary longitudinal reinforcement has correct size and number in proper layers.
 - b. Longitudinal reinforcement has correct length and lap.
 - c. Reinforcement is properly supported and braced to formwork to prevent movement during concrete placement.
 - d. Reinforcement has proper cover.
 - e. Sufficient spacing between reinforcement for concrete placement.

3.03 CAST-IN-PLACE CONCRETE

- A. Quality Assurance:
1. Concrete Mix Designs: The Testing Laboratory shall review the submitted mix designs for conformance to the specifications and for suitability for use in the project.
- B. Field Testing: The following tests shall be completed by the Testing Laboratory:
1. During Concrete Placement:
 - a. Record the amount of water added and note if it exceeds the amount allowed to be added shown in the approved mix design.
 - b. Mold concrete test cylinders as specified below in Paragraph 3.a.
 - c. Perform tests to determine slump, concrete temperature, unit weight, and air entrainment as specified below.
 - d. Record information for concrete test reports as specified below.
 - e. Pick up and transport to Laboratory cylinders cast the previous day.

2. After Concrete Placement:
 - a. Investigation of Low Strength Concrete Test Results:
 - (1) Cost of Investigations for Low Strength Concrete: The Contractor shall reimburse the Owner for the costs of investigations of low strength concrete, as defined in Part I above.
 - (2) Scope of Investigations: See Specification Section 033000 "Cast-In-Place Concrete" for the investigations that may be required by the Engineer. The Testing Laboratory will conduct these investigations if required.
 - b. Post-Installed Anchors in Concrete:
 - (1) Verify maximum anchor tightening torque for all applicable post-installed anchors.
 - (2) Provide pull tests on individual anchors as specified in the ICC Evaluation Services Report, on the drawings, or as directed by the Engineer-of-Record.
 - c. Testing of Concrete Floor Slabs for Acceptability to Receive an Adhesive-Applied, Low-Permeable Floor Covering: Perform tests as defined below.
3. Standards for Concrete Tests:
 - a. Concrete Test Cylinders: Mold and test concrete cylinders as described below:
 - (1) Cylinder Molding and Testing: Cylinders for strength tests shall be molded and Laboratory cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39. Cylinders may be either 6" in diameter by 12" or 4" in diameter by 8", however, the diameter of the cylinder shall be at least three times the nominal maximum size of the coarse aggregate in the mix tested. All of the cylinders for each class of concrete shall be of the same dimension for all sets of that class.
 - (2) Field Samples: Field samples for strength tests shall be taken in accordance with ASTM C 172 at the point of placement.
 - (3) Quantity of Cylinders: Each set of test cylinders shall consist of a minimum of four standard test cylinders.
 - (4) Frequency of Testing: A set of test cylinders shall be made according to the following minimum frequency guidelines:
 - (a) One set for each class of concrete taken not less than once a day.
 - (b) Floors: One set for each 150 cubic yards or fraction thereof but not less than one set for each 5,000 square foot of floor area.
 - (c) No more than one set of cylinders at a time shall be made from any single truck.
 - (d) If the total volume of concrete is such that the frequency of testing as specified above would provide less than five strength tests for a given class of concrete, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are used.
 - (e) The above frequencies assume that one batch plant will be used for each pour. If more than one batch plant is used, the frequencies cited above shall apply for each plant used.
 - (5) The cylinders shall be numbered, dated, and the point of concrete placement in the building recorded.

- (6) For concrete specified on the drawings to reach the required strength at 28 days, break one cylinder of the set at seven days, two 6" by 12" cylinders or three 4" by 8" cylinders at 28 days, and keep one in reserve for testing at the Engineer's direction.
- (7) Cylinder Storage Box: The Contractor shall be responsible for providing a protected concrete cylinder wooden storage box at a point on the job site mutually agreeable with the Testing Laboratory for the purpose of storing concrete cylinders until they are transported to the Laboratory. The box shall be constructed and equipped to maintain the environment specified for initial curing in ASTM C 31.
- (8) Transporting Cylinders: The Testing Laboratory shall be responsible for transporting the cylinders to the Laboratory in a protected environment such that no damage or ill effect will occur to the concrete cylinders including loss of moisture, freezing temperatures or jarring.
- (9) Information on Concrete Test Reports: The Testing Laboratory shall make and distribute concrete test reports after each job cylinder is broken. Such reports shall contain the following information:
 - (a) Truck number and ticket number.
 - (b) Concrete Batch Plant.
 - (c) Mix design number.
 - (d) Accurate location of pour in the structure.
 - (e) Strength requirement.
 - (f) Date cylinders made and broken.
 - (g) Technician making cylinders.
 - (h) Concrete temperature at placing.
 - (i) Air temperature at point of placement in the structure.
 - (j) Amount of water added to the truck at the batch plant and at the site and whether or not it exceeds the amount allowed by the mix design.
 - (k) Slump.
 - (l) Unit weight.
 - (m) Air content.
 - (n) Cylinder compressive strengths with type of failure if concrete does not meet Specification requirements. Seven day breaks are to be flagged if they are less than 60% of the required 28 day strength. 28 day breaks are to be brought to the attention of the Architect and Engineer in writing if either cylinder fails to meet specification requirements.
- b. Slump Tests: Slump Tests (ASTM C 143) shall be completed at the beginning of concrete placement for each batch plant and for each set of test cylinders made. The slump test shall be made from concrete taken from the end of the concrete truck chute. The concrete shall be considered acceptable if the slump is within the slump tolerance noted on the mix design submittal form for that class of concrete.
- c. Air Entrainment: Air entrainment tests (ASTM C 231 or C 173, C 173 only for lightweight concrete) shall be made at the same time slump tests are made as cited above. Samples for air entrainment tests shall be taken at the point of placement.
- d. Concrete Temperature: Concrete temperature at placement shall be measured (ASTM C 1064) at the same time slump tests are made as cited above.
- e. Unit Weight Test: ASTM C 138.

- f. Testing of Concrete Floor Slabs for Acceptability to Receive an Adhesive-Applied, Low-Permeable Floor Covering:
 - (1) The following tests shall be performed by the Testing Laboratory as a part of quality assurance testing to insure that the proper moisture condition and alkalinity of the substrate has been achieved prior to installing adhesive-applied, low-permeability floor coverings such as vinyl composition tile (VCT), linoleum, sheet vinyl, vinyl-backed carpet, rubber, athletic flooring, synthetic turf, wood, acrylic terrazzo, thin-set tile, epoxy overlays and adhesives, waterproofing, et.al.
 - (2) Moisture Vapor Emission Rate: Perform testing according to ASTM F 1869 to determine if the moisture emission rate from the floor is below the flooring manufacturer's maximum recommended value but not greater than five pounds per 1,000 square feet per 24 hours.
 - (3) Relative Humidity Determination Test: As an alternate to the Moisture Vapor Emission Rate Test, and if agreed to by the Contractor, Architect and Owner, perform testing according to ASTM F 2170 to determine if the relative humidity of the concrete slab is below the flooring manufacturer's maximum recommended value but not greater than 75%.
 - (4) Alkalinity Testing: Perform testing in accordance with ASTM F 710, Paragraph 5.3, to determine if the pH level of the concrete slab surface is below the flooring manufacturer's maximum recommended value but not greater than 10. Perform one test per 1,000 square feet with a minimum of three tests within the total area being tested.
- 4. Evaluation and Acceptance of Concrete:
 - a. Strength Test: A strength test shall be defined as the average strength of two six inch cylinder breaks or three four inch cylinder breaks from each set of cylinders tested at the time indicated above.
 - b. Quality Control Charts and Logs: The Testing Laboratory shall keep the following quality control logs and charts for each class of concrete containing more than 2,000 cubic yards. The records shall be kept for each batch plant and submitted on a weekly basis with cylinder test reports:
 - (1) Number of strength tests made to date.
 - (2) Strength test results containing the average of all strength tests to date, the high test result, the low test result, the standard deviation, and the coefficient of variation.
 - (3) Number of tests under specified strength.
 - (4) A histogram plotting the number of strength test cylinders versus compressive strength.
 - (5) Quality control chart plotting compressive strength test results for each test.
 - (6) Quality control chart plotting moving average for strength where each point plotted is the average strength of three previous test results.
 - (7) Quality control chart plotting moving average for range where each point plotted is the average of 10 previous ranges.
 - c. Acceptance Criteria: The strength level of an individual class of concrete shall be considered satisfactory if both of the following requirements are met:
 - (1) The average of all sets of three consecutive strength tests equal or exceed the required f'_c .
 - (2) No individual strength test falls below the required f'_c by more than the greater of 10% of f'_c or 500 PSI.

- d. If either of the above Acceptance Criteria requirements is not met, the Testing Laboratory shall immediately notify the Engineer by telephone. Steps shall immediately be taken to increase the average of subsequent strength tests.
- C. Field Inspection: The scope of the work to be performed by the inspector on the jobsite shall be as follows:
1. Before Concrete Placement:
 - a. Inspect concrete reinforcing per Article 3.02.
 - b. Verify that there is no standing water in pour area and that all debris has been removed from the area and from the formwork.
 - c. Verify that openings and sleeves in slabs are correct size and location. Verify that the openings are shown on the structural drawings and notify the Engineer immediately of any openings in the field that are not shown on the drawings.
 2. During Concrete Placement: Provide continuous monitoring to:
 - a. Upon arrival of concrete, inspect the concrete to verify that the proper concrete mix number, type of concrete, concrete strength is being placed at the proper location. Verify that the mix meets the project specifications and is not over 90 minutes old at the time of placement. Report concrete not meeting the specified requirements and immediately notify the Contractor, Batch Plant Inspector, Architect, Engineer, and Owner.
 - b. Inspect plastic concrete upon arrival at the jobsite to verify proper batching. Observe mix consistency and adding of water as required to achieve target slumps in mix designs. The responsibility for adding water to trucks at the job site shall rest only with the Contractor's designated representative. The Contractor is responsible that all concrete placed in the field is in conformance to the Contract Documents.
 - c. Verify that concrete deposited is uniform and that vertical drop does not exceed six feet and is not permitted to drop freely over reinforcement causing segregation.
 - d. Verify that there are no cold joints.
 - e. Verify that the concrete is properly vibrated.
 - f. Verify that the finishing of the concrete surface is done according to specifications.

The Testing Laboratory shall report any irregularities that occur in the concrete at the job site or test results to the Contractor, Architect, Owner, and Engineer.

3. After Concrete Placement:
 - a. Verify that the curing process is according to Specifications and that any curing compound used is applied in accordance with the manufacturer's recommendations.
 - b. Post-Installed Anchors in Concrete: Provide inspection of post-installed anchor installations at the frequency noted in the specifications and in accordance with the published, currently valid, Evaluation Service Report (ESR) for each anchor product. Post-installed anchors include anchors and reinforcing steel. Inspection of post-installed anchors shall include but not be limited to the following:
 - (1) Periodic Inspection: Verify initial installation of post-installed anchors in concrete for each individual installer with each individual anchor product in accordance with the requirements stated below for each type of anchor. Periodically inspect anchor installation after the initial verification.
 - (2) All Post-Installed Anchors: Verify that the anchor is installed in accordance with manufacturer's printed installation instructions as well as the following design requirements.

- (a) Concrete type, concrete strength and concrete thickness are in accordance with design drawings.
 - (b) Anchor manufacturer and product, including material, is in accordance with design drawings or approved substitution.
 - (c) Anchor diameter, length and installed embedment depth.
 - (d) Drill bit type and diameter.
 - (e) Anchor edge distance and spacing.
 - (f) Hole diameter and depth.
 - (g) Hole cleaning procedure and cleanliness.
 - (h) Anchor maximum tightening torque.
- (3) Adhesive Anchors: In addition to the requirements for All Post-Installed Anchors, verify adhesive identification and expiration date.
- (a) The installation of all adhesive anchors shall be continuously inspected when anchors are subject to sustained tension loads, such as anchors for shelf angles, or when anchors are installed in an upwardly inclined condition.
- D. Causes for Rejection of Concrete: The Contractor shall reject concrete delivered to the site for any of the following reasons:
- 1. Wrong class of concrete (incorrect mix design number).
 - 2. Concrete with temperatures exceeding 95°F shall not be placed in the structure.
 - 3. Air contents outside the limits specified in the mix designs.
 - 4. Slumps outside the limits specified.
 - 5. Excessive Age: Concrete shall be discharged within 90 minutes of plant departure or before it begins to set if sooner than 90 minutes unless approved by the Laboratory job inspector or other duly appointed representative.
- E. Concrete Batch Trip Tickets: Concrete batch trip tickets shall be collected and retained by the Contractor. Compressive strength, slump, air, and temperature tests shall be identified by reference to a particular trip ticket. Tickets shall contain the information specified in ASTM C 94. Each ticket shall also show the amount of water that may be added in the field for the entire batch that will not exceed the specified water cement ratio for the design mix. The Contractor and Testing Laboratory shall immediately notify the Architect/Engineer and each other of tickets not meeting the criteria specified.

3.04 STRUCTURAL STEEL

- A. Scope of Work:
- 1. Contract Obligations:
 - a. Owner Responsibility: The Owner shall pay for initial shop and field inspections and tests as required during the fabrication and erection of the structural steel.
 - b. Testing Laboratory Responsibility: The inspection by the Testing Laboratory of the Fabricator's work shall be in sequence, timely, and performed in such a manner so that corrections can be made without delaying the progress of the work. Inspections shall be performed by qualified technicians with a minimum of two years of experience in structural steel testing and inspection. Refer to Paragraph 1.08A.4 for special requirements for welding inspectors. The Testing Laboratory shall provide test reports of inspections. All test reports shall indicate types and locations of defects found during inspection, the measures required and performed to correct such defects, statements of final approval of welding and bolting of shop and field connections, and other fabrication and erection data pertinent to the safe and proper welding and bolting of shop and field connections. Weld inspection reports shall

- be signed by an inspector with current certification as an AWS Certified Welding Inspector (CWI). In addition to the parties listed in this Specification the Fabricator and Erector shall receive copies of the test reports.
- c. Rejection of Material or Workmanship: The Owner, Architect, Engineer, and Testing Laboratory reserve the right to reject any material or workmanship not in conformance with the Contract Documents at any time during the progress of the work. However, this provision does not allow waiving the obligation for timely, in sequence inspections.
- B. Quality Assurance: Review field welder qualifications by certification or verify by retesting. Obtain welder certificates.
 - C. Field Testing: The Testing Laboratory shall provide the following tests in the field:
 - 1. Test welds completed in the field.
 - D. Field Inspection: The Testing Laboratory shall provide the following inspections in the field:
 - 1. Provide continuous or periodic monitoring of field welding.
 - 2. Inspect welded or bolted connections that were completed, but not inspected, in the shop.
 - 3. Check structural steel as received in the field for possible shipping damage, workmanship, and identification marking to conform to AISC 360 for structural steel and specified ASTM standards for other steel.
 - 4. Endeavor to guard the Owner against the Contractor cutting, grinding, reaming, or making any other field modification to structural steel without the prior approval of the Engineer. Report any noted unauthorized modifications to the Owner and Engineer.
 - E. Weld Inspection and Process Monitoring: The Testing Laboratory shall make the following inspections of the welds and welding processes. Welds performed in the fabricating shop may be inspected in the field unless continuous monitoring of the welding process is herein specified or if access in the field due to other work or shop finishes makes field inspection impractical:
 - 1. Approve Welding Procedure Specifications submitted by the Contractor. Approve any changes submitted by the Contractor to any WPS that has already been approved. Obtain the Welding Procedure Qualification Record (WPQR) for each successful WPS qualification.
 - 2. Periodically verify welding electrodes to be used and other welding consumables as the job progresses.
 - 3. Periodically observe joint preparation, assembly practice, welding techniques including preheating and sequence, and the performance of welders with sufficient frequency to assure compliance with code and contract document requirements. Check preheating to assure conformance with AWS D1.1, Section 5.6. Verify procedure for control of distortion and shrinkage stresses.
 - 4. Visually inspect 100 % of welds for proper size, length, location, and weld quality in accordance with AWS D1.1 requirements. Unless specifically noted otherwise, all welding shall be considered statically loaded nontubular connections.
 - 5. In addition to the inspections above, perform the following:
 - a. Continuously monitor and observe joint preparation, assembly practice, welding techniques including preheating and sequence, and the performance of welders for 100% of complete and partial joint penetration welds, plug and slot welds, multiple-pass fillet welds, and single-pass fillet welds greater than 5/16 inch. Check preheating to assure conformance with AWS D1.1, Section 5.6. Verify procedure for control of distortion and shrinkage stresses.
 - b. Periodically monitor welding of single-pass fillet welds that are less than or equal to 5/16 inch.

- F. Weld Testing:
1. Perform nondestructive examination services using a qualified technician with the necessary equipment to perform the following:
 - a. Nondestructive examination conducted in accordance with the specific requirements for the item being examined including radiographic (RT), ultrasonic (UT), magnetic particle (MT), or dye-penetrant inspection (PT). Nondestructive inspection procedures shall conform to AWS D1.1.
 - b. Interpret, record, and report results of the nondestructive tests.
 - c. Mark for repair, any area not meeting Specification requirements. Correction of rejected welds shall be made in accordance with AWS D1.1.
 - d. Re-examine repair areas and interpret, record, and report the results of examinations of repair welds.
 - e. Verify that quality of welds meet the requirements of AWS D1.1.
 2. Fillet Welds: Provide the following:
 - a. MT test a minimum of 10% of the length of each fillet weld exceeding 5/16".
 - b. Periodic MT testing of representative fillet welds 5/16" and less but need not exceed 10% of all such welds, except as required for high rejection rates as indicated in the following paragraph.
 - c. Increase MT testing rate for welders having a high rejection rate as required to ensure acceptable welds.
- G. High-Strength Bolt Inspection and Process Monitoring: The Testing Laboratory shall perform the following inspections for connections joined with high-strength bolts. Bolting performed in the shop may be inspected in the field unless continuous monitoring of the bolting operation is specified herein:
1. Observe preinstallation verification testing of the pretensioning method to be used in accordance with the requirements of the "Specification for Structural Joints Using High-Strength Bolts".
 2. Check daily the calibration of impact wrenches used in field bolted connections.
 3. Inspect bolt installation for 100% of high strength bolted connections according to inspection procedures outlined in the "Specification for Structural Joints Using High-Strength Bolts".
 4. Monitoring of Bolting Installation:
 - a. Periodic Monitoring: All joint types and bolt installation methods shall be monitored on a periodic basis.
- H. High-Strength Bolt Testing: The Testing Laboratory shall perform the following tests for connections joined with high-strength bolts:
1. Perform Arbitration Testing according to procedures outlined in the "Specification for Structural Joints using High-Strength Bolts" when a disagreement exists between the Testing Laboratory and the Fabricator as to the minimum tension of installed bolts that have been inspected according to paragraph below.

3.05 STEEL DECKING

- A. Field Inspection:
1. Check steel deck as received in the field for possible shipping damage, workmanship, and identification marking to conform to specified ASTM standards for steel deck.
 2. Periodically monitor the method of attaching the steel floor and roof decking to the structural frame.
 3. Visually inspect 100% of the welding or other attachment method of steel deck to the structure and at sidelaps.

END OF SECTION

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Temporary telecommunications services.
- B. Temporary sanitary facilities.
- C. Temporary Controls: Barriers, enclosures, and fencing.
- D. Security requirements.
- E. Waste removal facilities and services.
- F. Project identification sign.

1.02 RELATED REQUIREMENTS

- A. Section 01 51 00 - Temporary Utilities.
- B. Section 01 52 13 - Field Offices and Sheds.
- C. Section 01 55 00 - Vehicular Access and Parking.
- D. Section 01 58 13 - Temporary Project Signage.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- B. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009.

1.04 TELECOMMUNICATIONS SERVICES

- A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.
- B. Provide, maintain, and pay for Internet access to field office at time of project mobilization. Internet service shall include access to e-mail and access to the World Wide Web.
- C. Telecommunications services shall include:
- D. Provide, maintain and pay for facsimile service and a dedicated telephone line to field office at time of project mobilization.

1.05 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.
- B. Use of existing facilities designated by the Owner is permitted.
- C. Maintain daily in clean and sanitary condition.
- D. At end of construction, return facilities to same or better condition as originally found.

1.06 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing building.
- C. Provide protection for plants designated to remain. Replace damaged plants.
- D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.07 FENCING

- A. Provide 6 foot high fence around construction site; equip with vehicular and pedestrian gates with locks.

1.08 EXTERIOR ENCLOSURES

- A. Provide temporary insulated weather tight closure of exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.09 INTERIOR ENCLOSURES

- A. Provide temporary partitions as indicated to separate work areas from Owner-occupied areas, to prevent penetration of dust and moisture into Owner-occupied areas, and to prevent damage to existing materials and equipment.
- B. Construction: Framing and gypsum board sheet materials with closed joints and sealed edges at intersections with existing surfaces:
 - 1. STC rating of 35 in accordance with ASTM E90.
 - 2. Maximum flame spread rating of 75 in accordance with ASTM E84.
- C. Paint surfaces exposed to view from Owner-occupied areas.

1.10 SECURITY - SEE SECTION 01 35 53

- A. Provide security and facilities to protect Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.
- B. Coordinate with Owner's security program.

1.11 WASTE REMOVAL

- A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.
- B. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.
- C. Provide containers with lids. Remove trash from site daily.
- D. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.
- E. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.12 PROJECT SIGNS - SEE SECTION 01 58 13

1.13 FIELD OFFICES - SEE SECTION 01 52 13

- A. Locate offices a minimum distance of 30 feet from existing and new structures.

1.14 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.
- B. Remove underground installations to a minimum depth of 2 feet. Grade site as indicated.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore existing facilities used during construction to original condition.
- E. Restore new permanent facilities used during construction to specified condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 51 00
TEMPORARY UTILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Temporary Utilities: Electricity, lighting, heat, ventilation, and water.

1.02 RELATED REQUIREMENTS

- A. Section 01 50 00 - Temporary Facilities and Controls:
 - 1. Temporary telecommunications services for administrative purposes.

1.03 TEMPORARY ELECTRICITY

- A. Cost: By Owner.
- B. Connect to Owner's existing power service.
 - 1. Do not disrupt Owner's need for continuous service.
 - 2. Exercise measures to conserve energy.
- C. Provide temporary electric feeder from existing building electrical service at location as directed.
- D. Complement existing power service capacity and characteristics as required.
- E. Provide power outlets for construction operations, with branch wiring and distribution boxes located as required. Provide flexible power cords as required.
- F. Provide main service disconnect and over-current protection at convenient location .
- G. Permanent convenience receptacles may be utilized during construction.
- H. Provide adequate distribution equipment, wiring, and outlets to provide single phase branch circuits for power and lighting.

1.04 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

- A. Provide and maintain lighting for construction operations to achieve a minimum lighting level of 2 watt/sq ft .
- B. Provide and maintain 1 watt/sq ft lighting to exterior staging and storage areas after dark for security purposes.
- C. Provide and maintain 0.25 watt/sq ft H.I.D. lighting to interior work areas after dark for security purposes.
- D. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.
- E. Maintain lighting and provide routine repairs.
- F. Permanent building lighting may be utilized during construction.

1.05 TEMPORARY HEATING

- A. Cost of Energy: By Owner.
- B. Provide heating devices and heat as needed to maintain specified conditions for construction operations.
- C. Maintain minimum ambient temperature of 50 degrees F in areas where construction is in progress, unless indicated otherwise in specifications.
- D. Owner's existing heat plant may be used.
 - 1. Exercise measures to conserve energy.
 - 2. Enclose building prior to activating temporary heat.
- E. Prior to operation of permanent equipment for temporary heating purposes, verify that installation is approved for operation, equipment is lubricated and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts.

1.06 TEMPORARY COOLING

- A. Cost of Energy: By Owner.
- B. Provide cooling devices and cooling as needed to maintain specified conditions for construction operations.
- C. Maintain maximum ambient temperature of 80 degrees F in areas where construction is in progress, unless indicated otherwise in specifications.
- D. Owner's existing cooling plant may be used.
 - 1. Exercise measures to conserve energy.
 - 2. Enclose building prior to activating temporary cooling.
- E. Prior to operation of permanent equipment for temporary cooling purposes, verify that installation is approved for operation, equipment is lubricated and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts.

1.07 TEMPORARY VENTILATION

- A. Existing ventilation equipment may not be used.

1.08 TEMPORARY WATER SERVICE

- A. Cost of Water Used: By Owner.
- B. Provide and maintain suitable quality water service for construction operations at time of project mobilization.
- C. Connect to existing water source.
 - 1. Exercise measures to conserve water.
- D. Extend branch piping with outlets located so water is available by hoses with threaded connections. Provide temporary pipe insulation to prevent freezing.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 52 13
FIELD OFFICES AND SHEDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Temporary field offices for use of Contractor.

1.02 RELATED REQUIREMENTS

- A. Section 01 10 00 - Summary: use of premises and responsibility for providing field offices.
- B. Section 01 50 00 - Temporary Facilities and Controls:
 - 1. Temporary telecommunications services for administrative purposes.
 - 2. Temporary sanitary facilities required by law.

1.03 USE OF EXISTING FACILITIES

- A. Designated existing spaces may be used for field offices: As designated by the Owner.

1.04 USE OF PERMANENT FACILITIES

- A. When permanent facilities are enclosed with operable utilities, relocate offices into building, with written agreement of Owner, and remove temporary buildings.

PART 2 PRODUCTS

2.01 MATERIALS, EQUIPMENT, FURNISHINGS

- A. Materials, Equipment, Furnishings: Serviceable, new or used, adequate for required purpose.

2.02 CONSTRUCTION

- A. Construction: Structurally sound, secure, weather tight enclosures for office. Maintain during progress of Work; remove when no longer needed.
- B. Temperature Transmission Resistance of Floors, Walls, and Ceilings: Compatible with occupancy requirements.
- C. Interior Materials in Offices: Sheet type materials for walls and ceilings, prefinished or painted; resilient floors and bases.
- D. Lighting for Offices: 50 fc at desk top height, exterior lighting at entrance doors.
- E. Fire Extinguishers: Appropriate type fire extinguisher at each office.

2.03 ENVIRONMENTAL CONTROL

- A. Heating, Cooling, and Ventilating: Automatic equipment to maintain comfort conditions.

2.04 CONTRACTOR OFFICE AND FACILITIES

- A. Size: For Contractor's needs and to provide space for project meetings.
- B. Telephone: As specified in Section 01 50 00.
- C. Furnishings in Meeting Area: Conference table and chairs to seat at least eight persons; racks and files for Contract Documents, submittals, and project record documents.
- D. Other Furnishings: Contractor's option.
- E. Equipment: Six adjustable band protective helmets for visitors, one 10 inch outdoor weather thermometer .

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install office spaces ready for occupancy 15 days after date fixed in Notice to Proceed.

3.02 MAINTENANCE AND CLEANING

- A. Weekly janitorial services for offices; periodic cleaning and maintenance for offices.

3.03 REMOVAL

- A. At completion of Work remove buildings, foundations, utility services, and debris. Restore areas.

END OF SECTION

SECTION 01 55 00
VEHICULAR ACCESS AND PARKING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Access roads.
- B. Parking.
- C. Existing pavements and parking areas.
- D. Permanent pavements and parking facilities.
- E. Construction parking controls.
- F. Flag persons.
- G. Flares and lights.
- H. Haul routes.
- I. Traffic signs and signals.
- J. Maintenance.
- K. Removal, repair.
- L. Mud from site vehicles.

1.02 RELATED REQUIREMENTS

- A. Section 01 10 00 - Summary: access to site, work sequence, and occupancy.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials for Permanent Construction: As specified in product specification sections, including earthwork, paving base, and topping.

2.02 SIGNS, SIGNALS, AND DEVICES

- A. Post Mounted and Wall Mounted Traffic Control and Informational Signs: Specified in Section 01 58 13 - Temporary Project Signage.
- B. Traffic Control Signals: As approved by local jurisdictions.
- C. Traffic Cones and Drums, Flares and Lights: As approved by local jurisdictions.
- D. Flag Person Equipment: As required by local jurisdictions.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clear areas, provide surface and storm drainage of road, parking, area premises, and adjacent areas.

3.02 ACCESS ROADS

- A. Use of designated existing on-site streets and driveways for construction traffic is permitted.
- B. Tracked vehicles not allowed on paved areas.
- C. Extend and relocate as Work progress requires, provide detours as necessary for unimpeded traffic flow.
- D. Provide unimpeded access for emergency vehicles. Maintain 20 foot width driveways with turning space between and around combustible materials.
- E. Provide and maintain access to fire hydrants free of obstructions.

3.03 PARKING

- A. Use of designated areas of existing parking facilities by construction personnel is permitted.

- B. Do not allow heavy vehicles or construction equipment in parking areas.
- C. When site space is not adequate, provide additional off-site parking.

3.04 PERMANENT PAVEMENTS AND PARKING FACILITIES

- A. Prior to Substantial Completion the base for permanent roads and parking areas may be used for construction traffic.
- B. Avoid traffic loading beyond paving design capacity. Tracked vehicles not allowed.

3.05 CONSTRUCTION PARKING CONTROL

- A. Control vehicular parking to prevent interference with public traffic and parking, access by emergency vehicles, and Owner's operations.
- B. Monitor parking of construction personnel's vehicles in existing facilities. Maintain vehicular access to and through parking areas.
- C. Prevent parking on or adjacent to access roads or in non-designated areas.

3.06 FLAG PERSONS

- A. Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.

3.07 FLARES AND LIGHTS

- A. Use flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.

3.08 HAUL ROUTES

- A. Confine construction traffic to designated haul routes.
- B. Provide traffic control at critical areas of haul routes to regulate traffic, to minimize interference with public traffic.

3.09 TRAFFIC SIGNS AND SIGNALS

- A. At approaches to site and on site, install at crossroads, detours, parking areas, and elsewhere as needed to direct construction and affected public traffic.
- B. Relocate as Work progresses, to maintain effective traffic control.

3.10 MAINTENANCE

- A. Maintain traffic and parking areas in a sound condition free of excavated material, construction equipment, Products, mud, snow, and ice.
- B. Maintain existing paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.

3.11 REMOVAL, REPAIR

- A. Repair existing facilities damaged by use, to original condition.
- B. Remove equipment and devices when no longer required.
- C. Repair damage caused by installation.
- D. Remove post settings to a depth of 2 feet.

3.12 MUD FROM SITE VEHICLES

- A. Provide means of removing mud from vehicle wheels before entering streets.

END OF SECTION

SECTION 01 57 21
INDOOR AIR QUALITY CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Construction procedures to promote adequate indoor air quality after construction.
- B. Building flush-out after construction and before occupancy.
- C. Testing indoor air quality after completion of construction.

1.02 PROJECT GOALS

- A. Dust and Airborne Particulates: Prevent deposition of dust and other particulates in HVAC ducts and equipment.
 - 1. Cleaning of ductwork is not contemplated under this Contract.
 - 2. Contractor shall bear the cost of cleaning required due to failure to protect ducts and equipment from construction dust.
- B. Airborne Contaminants: Procedures and products have been specified to minimize indoor air pollutants.
 - 1. Furnish products meeting the specifications.
 - 2. Avoid construction practices that could result in contamination of installed products leading to indoor air pollution.
- C. Ventilation: HVAC system has been designed to achieve the minimum requirements for ventilation specified in ASHRAE 62.1.

1.03 RELATED REQUIREMENTS

- A. Section 01 40 00 - Quality Requirements: Testing and inspection services.

1.04 REFERENCE STANDARDS

- A. ASHRAE Std 62.1 - Ventilation For Acceptable Indoor Air Quality; 2013.
- B. SMACNA (OCC) - IAQ Guidelines for Occupied Buildings Under Construction; 2007.

1.05 DEFINITIONS

- A. Adsorptive Materials: Gypsum board, acoustical ceiling tile and panels, carpet and carpet tile, fabrics, fibrous insulation, and other similar products.
- B. Contaminants: Gases, vapors, regulated pollutants, airborne mold and mildew, and the like, as specified.
- C. Particulates: Dust, dirt, and other airborne solid matter.
- D. Wet Work: Concrete, plaster, coatings, and other products that emit water vapor or volatile organic compounds during installation, drying, or curing.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Indoor Air Quality Management Plan: Describe in detail measures to be taken to promote adequate indoor air quality upon completion; use SMACNA (OCC) as a guide.
 - 1. Submit not less than 60 days before enclosure of building.
 - 2. Identify potential sources of odor and dust.
 - 3. Identify construction activities likely to produce odor or dust.
 - 4. Identify areas of project potentially affected, especially occupied areas.
 - 5. Evaluate potential problems by severity and describe methods of control.
 - 6. Describe construction ventilation to be provided, including type and duration of ventilation, use of permanent HVAC systems, types of filters and schedule for replacement of filters.
 - 7. Describe cleaning and dust control procedures.

- C. Interior Finishes Installation Schedule: Identify each interior finish that either generates odors, moisture, or vapors or is susceptible to adsorption of odors and vapors, and indicate air handling zone, sequence of application, and curing times.
- D. Duct and Terminal Unit Inspection Report.
- E. Air Contaminant Test Plan: Identify:
 - 1. Testing agency qualifications.
 - 2. Locations and scheduling of air sampling.
 - 3. Test procedures, in detail.
 - 4. Test instruments and apparatus.
 - 5. Sampling methods.
- F. Air Contaminant Test Reports: Show:
 - 1. Location where each sample was taken, and time.
 - 2. Test values for each air sample; average the values of each set of 3.
 - 3. HVAC operating conditions.
 - 4. Certification of test equipment calibration.
 - 5. Other conditions or discrepancies that might have influenced results.

1.07 QUALITY ASSURANCE

- A. Testing and Inspection Agency Qualifications: Independent testing agency having minimum of 5 years experience in performing the types of testing specified.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Low VOC Materials: See other sections for specific requirements for materials with low VOC content.

PART 3 EXECUTION

3.01 CONSTRUCTION PROCEDURES

- A. Prevent the absorption of moisture and humidity by adsorptive materials by:
 - 1. Sequencing the delivery of such materials so that they are not present in the building until wet work is completed and dry.
 - 2. Delivery and storage of such materials in fully sealed moisture-impermeable packaging.
 - 3. Provide sufficient ventilation for drying within reasonable time frame.
- B. Begin construction ventilation when building is substantially enclosed.
- C. HVAC equipment and supply air ductwork may be used for ventilation during construction:
 - 1. Operate HVAC system on 100 percent outside air, with 1.5 air changes per hour, minimum.
 - 2. Ensure that air filters are correctly installed prior to starting use; replace filters when they lose efficiency.
- D. Do not store construction materials or waste in mechanical or electrical rooms.
- E. Prior to use of return air ductwork without intake filters clean up and remove dust and debris generated by construction activities.
 - 1. Inspect duct intakes, return air grilles, and terminal units for dust.
 - 2. Clean plenum spaces, including top sides of lay-in ceilings, outsides of ducts, tops of pipes and conduit.
 - 3. Clean tops of doors and frames.
 - 4. Clean mechanical and electrical rooms, including tops of pipes, ducts, and conduit, equipment, and supports.
 - 5. Clean return plenums of air handling units.
 - 6. Remove intake filters last, after cleaning is complete.
- F. Do not perform dusty or dirty work after starting use of return air ducts without intake filters.

- G. Use other relevant recommendations of SMACNA (OCC) for avoiding unnecessary contamination due to construction procedures.

3.02 BUILDING FLUSH-OUT

- A. Contractor's Option: Either full continuous flush-out OR satisfactory air contaminant testing is required, not both.
- B. Perform building flush-out before occupancy.
- C. Do not start flush-out until:
 - 1. All construction is complete.
 - 2. HVAC systems have been tested, adjusted, and balanced for proper operation.
 - 3. Inspection of inside of return air ducts and terminal units confirms that cleaning is not necessary.
 - 4. New HVAC filtration media have been installed.
- D. Building Flush-Out: Operate all ventilation systems at normal flow rates with 100 percent outside air until a total air volume of 14,000 cubic feet per square foot of floor area has been supplied.
 - 1. Obtain Owner's concurrence that construction is complete enough before beginning flush-out.
 - 2. Maintain interior temperature of at least 60 degrees F and interior relative humidity no higher than 60 percent.
 - 3. If additional construction involving materials that produce particulates or any of the specified contaminants is conducted during flush-out, start flush-out over.
 - 4. If interior spaces must be occupied prior to completion of the flush-out, supply a minimum of 25 percent of the total air volume prior to occupancy, and:
 - a. Begin ventilation at least three hours prior to daily occupancy.
 - b. Continue ventilation during all occupied periods.
 - c. Provide minimum outside air volume of 0.30 cfm per square foot or design minimum outside air rate, whichever is greater.
- E. Install new HVAC filtration media after completion of flush-out and before occupancy or further testing.

3.03 AIR CONTAMINANT TESTING

- A. Contractor's Option: Either full continuous flush-out OR satisfactory air contaminant testing is required, not both.
- B. Perform air contaminant testing before occupancy.
- C. Do not start air contaminant testing until:
 - 1. All construction is complete, including interior finishes.
 - 2. HVAC systems have been tested, adjusted, and balanced for proper operation.
 - 3. New HVAC filtration media have been installed.
- D. Indoor Air Samples: Collect from spaces representative of occupied areas:
 - 1. Collect samples while operable windows and exterior doors are closed, HVAC system is running normally as if occupied, with design minimum outdoor air, but with the building unoccupied.
 - 2. Collect samples from spaces in each contiguous floor area in each air handler zone, but not less than one sample per 25,000 square feet; take samples from areas having the least ventilation and those having the greatest presumed source strength.
 - 3. Collect samples from height from 36 inches to 72 inches above floor.
 - 4. Collect samples from same locations on 3 consecutive days during normal business hours; average the results of each set of 3 samples.
 - 5. Exception: Areas with normal very high outside air ventilation rates, such as laboratories, do not need to be tested.

6. When retesting the same building areas, take samples from at least the same locations as in first test.
- E. Outdoor Air Samples: Collect samples at outside air intake of each air handler at the same time as indoor samples are taken.
- F. Analyze air samples and submit report.
- G. Air Contaminant Concentration Limits:
 1. Formaldehyde: Not more than 27 parts per billion.
 2. Formaldehyde: Measure in micrograms per cubic meter, in relation to outside air; not more than 20 micrograms per cubic meter higher than outside air.
 3. PM10 Particulates: Not more than 50 micrograms per cubic meter.
 4. 4-Phenylcyclohexene (4-PC): Measure in micrograms per cubic meter, in relation to outside air; not more than 3 micrograms per cubic meter higher than outside air.
 5. Total Volatile Organic Compounds (TVOCs): Not more than 500 micrograms per cubic meter.
 6. Total Volatile Organic Compounds (TVOC): Measure in micrograms per cubic meter, in relation to outside air; not more than 200 micrograms per cubic meter higher than outside air.
 7. Chemicals Listed in CAL (CDPH SM) Table 4-1, except Formaldehyde: Allowable concentrations listed in Table 4-1.
 8. Carbon Monoxide: Not more than 9 parts per million and not more than 2 parts per million higher than outdoor air.
 9. Carbon Dioxide: Measure in ppm, in relation to outdoor air; not more than 700 ppm higher than outdoor air.
 10. Airborne Mold and Mildew: Measure in relation to outside air; not higher than outside air.
 11. Regulated Pollutants: Measure in relation to outside air; not more than contained in outside air.
- H. If air samples show concentrations higher than those specified, ventilate with 100 percent outside air and retest at no cost to Owner, or conduct full building flush-out specified above.

END OF SECTION

SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General product requirements.
- B. Transportation, handling, storage and protection.
- C. Product option requirements.
- D. Substitution limitations and procedures.
- E. Procedures for Owner-supplied products.
- F. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 RELATED REQUIREMENTS

- A. Section 01 40 00 - Quality Requirements: Product quality monitoring.
- B. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions: Requirements for VOC-restricted product categories.

1.03 SUBMITTALS

- A. Proposed Products List: Submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
 - 1. Submit within 15 days after date of Agreement.
 - 2. For products specified only by reference standards, list applicable reference standards.
- B. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- C. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- D. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
 - 1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.
- E. Indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

PART 2 PRODUCTS

2.01 NEW PRODUCTS

- A. Provide new products unless specifically required or permitted by the Contract Documents.
- B. DO NOT USE products having any of the following characteristics:
 - 1. Made using or containing CFC's or HCFC's.
 - 2. Made of wood from newly cut old growth timber.
 - 3. Containing lead, cadmium, asbestos.
- C. Where all other criteria are met, Contractor shall give preference to products that:
 - 1. Are extracted, harvested, and/or manufactured closer to the location of the project.
 - 2. Have longer documented life span under normal use.
 - 3. Result in less construction waste.
 - 4. Are made of vegetable materials that are rapidly renewable.
- D. Products with Rapidly Renewable Material Content:
 - 1. Definition: Materials made from plants that are typically harvested within 10 years or less after planting.

2. Specific Product Categories: Provide renewable material content as specified elsewhere.
- E. Products with Recycled Content:
 1. Specific Product Categories: Provide recycled content as specified elsewhere.

2.02 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.03 MAINTENANCE MATERIALS

- A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.
- B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION PROCEDURES

- A. Instructions to Bidders specify time restrictions for submitting requests for substitutions during the bidding period. Comply with requirements specified in this section.
- B. Architect will consider requests for substitutions only within 30 days after date of Agreement.
- C. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.
- D. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
- E. A request for substitution constitutes a representation that the submitter:
 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
 2. Agrees to provide the same warranty for the substitution as for the specified product.
 3. Agrees to coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to Owner.
 4. Waives claims for additional costs or time extension that may subsequently become apparent.
 5. Agrees to reimburse Owner and Architect for review or redesign services associated with re-approval by authorities.
- F. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
- G. Substitution Submittal Procedure (after contract award):
 1. Submit three copies of request for substitution for consideration. Limit each request to one proposed substitution.
 2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.
 3. The Architect will notify Contractor in writing of decision to accept or reject request.

3.02 OWNER-SUPPLIED PRODUCTS

- A. Owner's Responsibilities:
 1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples, to Contractor.
 2. Arrange and pay for product delivery to site.
 3. On delivery, inspect products jointly with Contractor.

4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
 5. Arrange for manufacturers' warranties, inspections, and service.
- B. Contractor's Responsibilities:
1. Review Owner reviewed shop drawings, product data, and samples.
 2. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
 3. Handle, store, install and finish products.
 4. Repair or replace items damaged after receipt.

3.03 TRANSPORTATION AND HANDLING

- A. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- B. Transport and handle products in accordance with manufacturer's instructions.
- C. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
- D. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- E. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.
- F. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.04 STORAGE AND PROTECTION

- A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.
- B. Store and protect products in accordance with manufacturers' instructions.
- C. Store with seals and labels intact and legible.
- D. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- E. For exterior storage of fabricated products, place on sloped supports above ground.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- G. Prevent contact with material that may cause corrosion, discoloration, or staining.
- 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.

END OF SECTION

SECTION 01 61 16

VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. VOC restrictions for product categories listed below under "DEFINITIONS".
- B. All products of each category that are installed in the project must comply; Owner's project goals do not allow for partial compliance.
- C. Requirements for VOC-Content-Restricted products.

1.02 RELATED REQUIREMENTS

- A. Section 01 40 00 - Quality Requirements: Procedures for testing and certifications.
- B. Section 01 60 00 - Product Requirements: Fundamental product requirements, substitutions and product options, delivery, storage, and handling.

1.03 DEFINITIONS

- A. VOC-Content-Restricted Products: All products in the following product categories, whether specified or not:
 - 1. Adhesives, sealants, and sealer coatings.
 - 2. Carpet.
 - 3. Carpet cushion.
 - 4. Carpet tile.
 - 5. Resilient floor coverings.
 - 6. Paints and coatings.
 - 7. Acoustical ceilings and panels.
 - 8. Cabinet work.
 - 9. Other products when specifically stated in the specifications.
- B. Interior of Building: Anywhere inside the exterior weather barrier.
- C. Adhesives: All gunnable, trowelable, liquid-applied, and aerosol adhesives, whether specified or not; including flooring adhesives, resilient base adhesives, and pipe jointing adhesives.
- D. Sealants: All gunnable, trowelable, and liquid-applied joint sealants and sealant primers, whether specified or not; including firestopping sealants and duct joint sealers.

1.04 REFERENCE STANDARDS

- A. GreenSeal GS-36 - Commercial Adhesives; Green Seal, Inc.; 2011.
- B. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: For each VOC-restricted product used in the project, submit evidence of compliance, except when another type of evidence of compliance is required.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Adhesives and Joint Sealants: Provide only products having volatile organic compound (VOC) content not greater than required by South Coast Air Quality Management District Rule No.1168.
 - 1. Evidence of Compliance: Acceptable types of evidence are:
 - a. Report of laboratory testing performed in accordance with requirements.
- B. Aerosol Adhesives: Provide only products having volatile organic compound (VOC) content not greater than required by GreenSeal GS-36.

1. Evidence of Compliance: Acceptable types of evidence are:
 - a. Current GreenSeal Certification.
- C. Paints and Coatings: Provide products having VOC content as specified in Section 09 9000.
- D. Carpet Tile and Adhesive: Provide products having VOC content as specified in Section 09 6813.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Owner reserves the right to reject non-compliant products, whether installed or not, and require their removal and replacement with compliant products at no extra cost to Owner.
- B. Additional costs to restore indoor air quality due to installation of non-compliant products will be borne by Contractor.

END OF SECTION

SECTION 01 70 00
EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Examination, preparation, and general installation procedures.
- B. Requirements for alterations work, including selective demolition, except removal, disposal, and/or remediation of hazardous materials and toxic substances.
- C. Pre-installation meetings.
- D. Cutting and patching.
- E. Surveying for laying out the work.
- F. Cleaning and protection.
- G. Starting of systems and equipment.
- H. Demonstration and instruction of Owner personnel.
- I. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.
- J. General requirements for maintenance service.

1.02 RELATED REQUIREMENTS

- A. Section 01 10 00 - Summary: Limitations on working in existing building; continued occupancy; work sequence; identification of salvaged and relocated materials.
- B. Section 01 30 00 - Administrative Requirements: Submittals procedures, Electronic document submittal service.
- C. Section 01 40 00 - Quality Requirements: Testing and inspection procedures.
- D. Section 01 50 00 - Temporary Facilities and Controls: Temporary exterior enclosures.
- E. Section 01 50 00 - Temporary Facilities and Controls: Temporary interior partitions.
- F. Section 01 51 00 - Temporary Utilities: Temporary heating, cooling, and ventilating facilities.
- G. Section 01 74 19 - Construction Waste Management and Disposal: Additional procedures for trash/waste removal, recycling, salvage, and reuse.
- H. Section 01 78 00 - Closeout Submittals: Project record documents, operation and maintenance data, warranties and bonds.
- I. Section 07 84 00 - Firestopping.
- J. Individual Product Specification Sections:
 - 1. Advance notification to other sections of openings required in work of those sections.

1.03 REFERENCE STANDARDS

- A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2013.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Demolition Plan: Submit demolition plan as specified by OSHA and local authorities.
 - 1. Indicate extent of demolition, removal sequence, bracing and shoring, and location and construction of barricades and fences. Include design drawings and calculations for bracing and shoring.
 - 2. Identify demolition firm and submit qualifications.
 - 3. Include a summary of safety procedures.
- C. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
 - 1. Structural integrity of any element of Project.

2. Integrity of weather exposed or moisture resistant element.
3. Efficiency, maintenance, or safety of any operational element.
4. Visual qualities of sight exposed elements.
5. Work of Owner or separate Contractor.
6. Include in request:
 - a. Identification of Project.
 - b. Location and description of affected work.
 - c. Necessity for cutting or alteration.
 - d. Description of proposed work and products to be used.
 - e. Alternatives to cutting and patching.
 - f. Effect on work of Owner or separate Contractor.
 - g. Written permission of affected separate Contractor.
 - h. Date and time work will be executed.

- D. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.05 PROJECT CONDITIONS

- A. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- B. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.
- C. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.
- D. Pest and Rodent Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.
- E. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. Comply with federal, state, and local regulations.

1.06 COORDINATION

- A. See Section 01 10 00 for occupancy-related requirements.
- B. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- C. Notify affected utility companies and comply with their requirements.
- D. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- E. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- F. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- G. Coordinate completion and clean-up of work of separate sections.
- H. 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.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
- C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
- B. Verify that 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. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
- E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
- F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

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 any new material or substance in contact or bond.

3.03 PREINSTALLATION MEETINGS

- A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.
- B. Require attendance of parties directly affecting, or affected by, work of the specific section.
- C. Notify Architect four days in advance of meeting date.
- D. Prepare agenda and preside at meeting:
 - 1. Review conditions of examination, preparation and installation procedures.
 - 2. Review coordination with related work.
- E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.
 - 1. In lieu of distributed copies, the minutes may be posted to the Internet-based collaboration system employed for the Project.

3.04 GENERAL INSTALLATION REQUIREMENTS

- A. In addition to compliance with regulatory requirements, conduct construction operations in compliance with NFPA 241, including applicable recommendations in Appendix A.
- B. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.

- C. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- D. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- E. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- F. Make neat transitions between different surfaces, maintaining texture and appearance.

3.05 ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as shown.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of alterations work constitutes acceptance of existing conditions.
- B. Keep areas in which alterations are being conducted separated from other areas that are still occupied.
 - 1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 01 50 00 in locations indicated on drawings.
- C. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove items indicated on drawings.
 - 2. Relocate items indicated on drawings.
 - 3. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
 - 4. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.
- D. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove, relocate, and extend existing systems to accommodate new construction.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
 - 2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.
 - 3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - a. Disable existing systems only to make switchovers and connections; minimize duration of outages.
 - b. See Section 01 10 00 for other limitations on outages and required notifications.
 - c. Provide temporary connections as required to maintain existing systems in service.
 - 4. Verify that abandoned services serve only abandoned facilities.
 - 5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.
- E. Protect existing work to remain.
 - 1. Prevent movement of structure; provide shoring and bracing if necessary.
 - 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 - 3. Repair adjacent construction and finishes damaged during removal work.
 - 4. Patch as specified for patching new work.
- F. Adapt existing work to fit new work: Make as neat and smooth transition as possible.

- G. When existing finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Architect.
- H. Where removal of partitions or walls results in adjacent spaces becoming one, rework floors, walls, and ceilings to a smooth plane without breaks, steps, or bulkheads.
- I. Where a change of plane of 1/4 inch or more occurs in existing work, submit recommendation for providing a smooth transition for Architect review and request instructions.
- J. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.
- K. Refinish existing surfaces as indicated:
- L. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
- M. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.
 - 1. Patch as specified for patching new work.
- N. Clean existing systems and equipment.
- O. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.
- P. Do not begin new construction in alterations areas before demolition is complete.
- Q. Comply with all other applicable requirements of this section.

3.06 CUTTING AND PATCHING

- A. Whenever possible, execute the work by methods that avoid cutting or patching.
- B. See Alterations article above for additional requirements.
- C. Perform whatever cutting and patching is necessary to:
 - 1. Complete the work.
 - 2. Fit products together to integrate with other work.
 - 3. Provide openings for penetration of mechanical, electrical, and other services.
 - 4. Match work that has been cut to adjacent work.
 - 5. Repair areas adjacent to cuts to required condition.
 - 6. Repair new work damaged by subsequent work.
 - 7. Remove samples of installed work for testing when requested.
 - 8. Remove and replace defective and non-conforming work.
- D. Execute cutting and patching including excavation and fill to complete the work, to uncover work in order to install improperly sequenced work, to remove and replace defective or non-conforming work, to remove samples of installed work for testing when requested, to provide openings in the work for penetration of mechanical and electrical work, to execute patching to complement adjacent work, and to fit products together to integrate with other work.
- E. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- F. Employ skilled and experienced installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- G. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- H. Restore work with new products in accordance with requirements of Contract Documents.
- I. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

- J. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.
- K. Patching:
 - 1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
 - 2. Match color, texture, and appearance.
 - 3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.07 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.08 PROTECTION OF INSTALLED WORK

- A. Protect installed work from damage by construction operations.
- B. Provide special protection where specified in individual specification sections.
- C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- G. Remove protective coverings when no longer needed; reuse or recycle plastic coverings if possible.

3.09 SYSTEM STARTUP

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Architect and owner seven days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify that wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.
- G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

- H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.10 DEMONSTRATION AND INSTRUCTION

- A. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to date of Substantial Completion.
- B. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at equipment location.
- C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Provide a qualified person who is knowledgeable about the Project to perform demonstration and instruction of owner personnel.
- E. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
- F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

3.11 ADJUSTING

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

3.12 FINAL CLEANING

- A. Execute final cleaning prior to final project assessment.
 - 1. Clean areas to be occupied by Owner prior to final completion before Owner occupancy.
- B. Use cleaning materials that are nonhazardous.
- C. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- D. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
- E. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- F. Clean filters of operating equipment.
- G. Clean debris from area drains and drainage systems.
- H. Clean site; sweep paved areas, rake clean landscaped surfaces.
- I. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.13 CLOSEOUT PROCEDURES

- A. Make submittals that are required by governing or other authorities.
 - 1. Provide copies to Architect.
- B. Notify Architect when work is considered ready for Architect's Substantial Completion inspection.
- C. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's Substantial Completion inspection.
- D. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.
- E. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.

- F. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

3.14 MAINTENANCE

- A. Provide service and maintenance of components indicated in specification sections.
- B. Maintenance Period: As indicated in specification sections or, if not indicated, not less than 90 days from the Date of Substantial Completion or the length of the specified warranty, whichever is longer.
- C. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- D. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.
- E. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

END OF SECTION

SECTION 01 74 19
CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 WASTE MANAGEMENT REQUIREMENTS

- A. Owner requires that this project generate the least amount of trash and waste possible.
- B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.
- C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.
- D. Owner may decide to pay for additional recycling, salvage, and/or reuse based on Landfill Alternatives Proposal specified below.
- E. Required Recycling, Salvage, and Reuse: The following may not be disposed of in landfills or by incineration:
 - 1. Aluminum and plastic beverage containers.
 - 2. Corrugated cardboard.
 - 3. Wood pallets.
 - 4. Clean dimensional wood: May be used as blocking or furring.
 - 5. Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.
 - 6. Glass.
 - 7. Gypsum drywall and plaster.
 - 8. Carpet, carpet cushion, carpet tile, and carpet remnants, both new and removed: DuPont (<http://flooring.dupont.com>) and Interface (www.interfaceinc.com) conduct reclamation programs.
 - 9. Plastic sheeting.
- F. Contractor shall submit periodic Waste Disposal Reports; all landfill disposal, recycling, salvage, and reuse must be reported regardless of to whom the cost or savings accrues; use the same units of measure on all reports.
- G. Contractor shall develop and follow a Waste Management Plan designed to implement these requirements.
- H. The following sources may be useful in developing the Waste Management Plan:
 - 1. State Texas Commission on Environmental Quality, at <http://www.tceq.texas.gov/nav/main/recycling.html>.
- I. Methods of trash/waste disposal that are not acceptable are:
 - 1. Burning on the project site.
 - 2. Burying on the project site.
 - 3. Dumping or burying on other property, public or private.
 - 4. Other illegal dumping or burying.
 - 5. Incineration, either on- or off-site.
- J. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 DEFINITIONS

- A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.
- B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.

- C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.
- D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.
- E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.
- F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.
- G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.
- H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
- I. Return: To give back reusable items or unused products to vendors for credit.
- J. Reuse: To reuse a construction waste material in some manner on the project site.
- K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.
- L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.
- M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.
- N. Toxic: Poisonous to humans either immediately or after a long period of exposure.
- O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.
- P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Landfill Alternatives Proposal: Within 10 calendar days after receipt of Notice of Award of Bid, or prior to any trash or waste removal, whichever occurs sooner, submit a projection of trash/waste that will require disposal and alternatives to landfilling, with net costs.
 - 1. Submit to Architect for Owner's review and approval.
 - 2. If Owner wishes to implement any cost alternatives, the Contract Sum will be adjusted as specified elsewhere.
 - 3. Include an analysis of trash/waste to be generated and landfill options as specified for Waste Management Plan described below.
 - 4. Describe as many alternatives to landfilling as possible:
 - a. List each material proposed to be salvaged, reused, or recycled.
 - b. List the proposed local market for each material.
 - c. State the estimated net cost resulting from each alternative, after subtracting revenue from sale of recycled or salvaged materials and landfill tipping fees saved due to diversion of materials from the landfill.
 - 5. Provide alternatives to landfilling for at least the following materials:
 - a. Land clearing debris, including brush, branches, logs, and stumps.
 - b. Concrete.
 - c. Bricks.
 - d. Concrete masonry units.
 - e. Asphalt paving.

- C. Once Owner has determined which of the landfill alternatives addressed in the Proposal above are acceptable, prepare and submit Waste Management Plan; submit within 10 calendar days after notification by Architect.
- D. Waste Management Plan: Include the following information:
 - 1. Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.
 - 2. Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s), and the projected cost of disposing of all project trash/waste in the landfill(s).
 - 3. Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.
 - a. List each material proposed to be salvaged, reused, or recycled.
 - b. State the estimated net cost, versus landfill disposal.
 - 4. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
 - 5. Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
 - 6. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.
- E. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.
 - 1. Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
 - 2. Submit Report on a form acceptable to Owner.
 - 3. Landfill Disposal: Include the following information:
 - a. Identification of material.
 - b. Amount, in tons or cubic yards, of trash/waste material from the project disposed of in landfills.
 - c. State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.
 - d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
 - 4. Recycled and Salvaged Materials: Include the following information for each:
 - a. Identification of material, including those retrieved by installer for use on other projects.
 - b. Amount, in tons or cubic yards, date removed from the project site, and receiving party.
 - c. Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.
 - d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
 - e. Certification by receiving party that materials will not be disposed of in landfills or by incineration.
 - 5. Material Reused on Project: Include the following information for each:
 - a. Identification of material and how it was used in the project.
 - b. Amount, in tons or cubic yards.
 - c. Include weight tickets as evidence of quantity.
 - 6. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.

PART 3 EXECUTION

2.01 WASTE MANAGEMENT PROCEDURES

- A. See Section 01 30 00 for additional requirements for project meetings, reports, submittal procedures, and project documentation.
- B. See Section 01 50 00 for additional requirements related to trash/waste collection and removal facilities and services.
- C. See Section 01 60 00 for waste prevention requirements related to delivery, storage, and handling.
- D. See Section 01 70 00 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

2.02 WASTE MANAGEMENT PLAN IMPLEMENTATION

- A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.
- B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.
- C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.
- D. Meetings: Discuss trash/waste management goals and issues at project meetings.
 - 1. Pre-bid meeting.
 - 2. Pre-construction meeting.
 - 3. Regular job-site meetings.
- E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
 - 1. As a minimum, provide:
 - a. Separate area for storage of materials to be reused on-site, such as wood cut-offs for blocking.
 - b. Separate dumpsters for each category of recyclable.
 - c. Recycling bins at worker lunch area.
 - 2. Provide containers as required.
 - 3. Provide temporary enclosures around piles of separated materials to be recycled or salvaged.
 - 4. Provide materials for barriers and enclosures that are nonhazardous, recyclable, or reusable to the maximum extent possible; reuse project construction waste materials if possible.
 - 5. Locate enclosures out of the way of construction traffic.
 - 6. Provide adequate space for pick-up and delivery and convenience to subcontractors.
 - 7. If an enclosed area is not provided, clearly lay out and label a specific area on-site.
 - 8. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.
- F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.
- G. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.
- H. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.

- I. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION

SECTION 01 78 00
CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Project Record Documents.
- B. Operation and Maintenance Data.
- C. Warranties and bonds.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- B. Section 01 70 00 - Execution and Closeout Requirements: Contract closeout procedures.
- C. Individual Product Sections: Specific requirements for operation and maintenance data.
- D. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

- A. Project Record Documents: Submit documents to Architect _____.
- B. Operation and Maintenance Data:
 - 1. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Architect will review draft and return one copy with comments.
 - 2. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
 - 3. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Architect comments. Revise content of all document sets as required prior to final submission.
 - 4. Submit two sets of revised final documents in final form within 10 days after final inspection.
- C. Warranties and Bonds:
 - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
 - 2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
 - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract.
 - 5. Reviewed shop drawings, product data, and samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress.

- E. Specifications: 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 alternates utilized.
 - 3. Changes made by Addenda and modifications.
- F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - 2. Field changes of dimension and detail.
 - 3. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

- A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

- A. For Each Product, Applied Material, and Finish:
 - 1. Product data, with catalog number, size, composition, and color and texture designations.
- B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning 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 information as specified in individual product specification sections.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

- A. For Each Item of Equipment and Each System:
 - 1. Description of unit or system, and component parts.
 - 2. Identify function, normal operating characteristics, and limiting conditions.
 - 3. Include performance curves, with engineering data and tests.
 - 4. Complete nomenclature and model number of replaceable parts.
- B. 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 instructions.
- C. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- D. Provide servicing and lubrication schedule, and list of lubricants required.
- E. Include manufacturer's printed operation and maintenance instructions.
- F. Include sequence of operation by controls manufacturer.
- G. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

- H. Provide control diagrams by controls manufacturer as installed.
- I. Provide Contractor's coordination drawings, with color coded piping diagrams as installed.
- J. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- K. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- L. Include test and balancing reports.
- M. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

- A. Assemble operation and maintenance data into durable manuals for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.
- B. Where systems involve more than one specification section, provide separate tabbed divider for each system.
- C. Binders: Commercial quality, 8-1/2 by 11 inch three D side ring binders with durable plastic covers; 2 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- D. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.
- E. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect, Consultants, Contractor and subcontractors, with names of responsible parties.
- F. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.
- G. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.
- H. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.
- I. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- J. Arrangement of Contents: Organize each volume in parts as follows:
 - 1. Project Directory.
 - 2. Table of Contents, of all volumes, and of this volume.
 - 3. Operation and Maintenance Data: Arranged by system, then by product category.
 - a. Source data.
 - b. Product data, shop drawings, and other submittals.
 - c. Operation and maintenance data.
 - d. Field quality control data.
 - e. Photocopies of warranties and bonds.

3.06 WARRANTIES AND BONDS

- A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.
- B. Verify that documents are in proper form, contain full information, and are notarized.
- C. Co-execute submittals when required.
- D. Retain warranties and bonds until time specified for submittal.

END OF SECTION

SECTION 02 41 00
DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Selective demolition of built site elements.
- B. Selective demolition of building elements for alteration purposes.
- C. Abandonment and removal of existing utilities and utility structures.

1.02 RELATED REQUIREMENTS

- A. Section 01 10 00 - Summary: Limitations on Contractor's use of site and premises.
- B. Section 01 50 00 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- C. Section 01 70 00 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.
- D. Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.

1.03 REFERENCE STANDARDS

- A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards; current edition.
- B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2013.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

PART 3 EXECUTION

2.01 SCOPE

- A. The general extent of demolition work and items to be removed is indicated in the Drawings.

2.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with other requirements specified in Section 01 70 00.
- B. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Comply with applicable requirements of NFPA 241.
 - 3. Use of explosives is not permitted.
 - 4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 5. Provide, erect, and maintain temporary barriers and security devices.
 - 6. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 7. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 8. Do not close or obstruct roadways or sidewalks without permit.
 - 9. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.

10. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.
- C. Do not begin removal until receipt of notification to proceed from Owner.
- D. Do not begin removal until built elements to be salvaged or relocated have been removed.
- E. Protect existing structures and other elements that are not to be removed.
 1. Provide bracing and shoring.
 2. Prevent movement or settlement of adjacent structures.
 3. Stop work immediately if adjacent structures appear to be in danger.
- F. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- G. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.
- H. Perform demolition in a manner that maximizes salvage and recycling of materials.
 1. Comply with requirements of Section 01 74 19 - Waste Management.
 2. Dismantle existing construction and separate materials.
 3. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.

2.03 EXISTING UTILITIES

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

2.04 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 1. Verify that construction and utility arrangements are as shown.
 2. Report discrepancies to Architect before disturbing existing installation.
 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Separate areas in which demolition is being conducted from other areas that are still occupied.
 1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 01 50 00 in locations indicated on drawings.
- C. Remove existing work as indicated and as required to accomplish new work.
 1. Remove items indicated on drawings.

- D. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 - 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - 3. See Section 01 10 00 for other limitations on outages and required notifications.
 - 4. Verify that abandoned services serve only abandoned facilities before removal.
 - 5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.
- E. Protect existing work to remain.
 - 1. Prevent movement of structure; provide shoring and bracing if necessary.
 - 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 - 3. Repair adjacent construction and finishes damaged during removal work.
 - 4. Patch as specified for patching new work.

2.05 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site.
- B. Remove from site all materials not to be reused on site; comply with requirements of Section 01 74 19 - Waste Management.
- C. Leave site in clean condition, ready for subsequent work.

END OF SECTION

SECTION 03 30 00
CONCRETE FOR STEEL FRAMED BUILDINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of concrete work is shown on drawings, including schedules, notes and details which show size and location of members and type of concrete to be poured. Furnish all labor, materials, services, equipment and hardware required in conjunction with or related to the forming, delivery and pouring of all poured-in-place concrete work.

1.03 QUALIFICATIONS

- A. The concrete contractor shall have a minimum of two years of experience with installation of concrete similar in material, design and extent to that indicated for this Project and whose work has resulted in construction with a record of successful -service performance.
- B. Any testing laboratory retained to run certain tests required by this specification shall meet the basic requirements of ASTM E 329.

1.04 QUALITY CONTROL

- A. The Contractor is responsible for quality control, including workmanship and materials furnished by his subcontractors and suppliers.
- B. Codes and Standards: Comply with provisions of following codes, specifications and standards, except where more stringent requirements are shown or specified:
 - 1. ACI 301, "Specifications for Structural Concrete for Buildings."
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 - 3. ACI 318, "Building Code Requirements for Structural Concrete."
 - 4. CRSI, "Manual of Standard Practice."
- C. Document Conflict and Precedence: In case of conflict among documents, including architectural and structural drawings and specifications, notify the Architect/Engineer prior to submitting proposal. In case of conflict between and/or among the structural drawings and specifications, the strictest interpretation shall govern, unless specified otherwise in writing by the Architect/Engineer.
- D. Inspection and Testing of the Work: Materials and installed work may require testing and retesting, as directed by the governing building code or the Architect/Engineer, at any time during progress of work.
 - 1. The Contractor shall provide adequate notification to the Owner's Testing Agency of construction operations including the project schedule to allow the Testing Agency to schedule inspections. Failure to sufficiently notify may result in additional costs incurred by the Testing Laboratory that may be back-charged to the Contractor by the Owner.
 - 2. The Contractor shall cooperate with laboratory personnel, provide access to the work, and to manufacturer's operations.
 - 3. The Contractor shall make adequate arrangement with the Owner's Testing Agency for inspection of material stockpiles and facilities.
 - 4. The Contractor shall provide to the laboratory certificates and representative samples of materials proposed for use in the work in quantities sufficient for accurate testing as specified.
 - 5. The Contractor shall furnish casual labor, equipment, and facilities as required for sampling and testing by the laboratory and otherwise facilitate the required inspections and tests.

6. Inspection or testing by the Owner does not relieve the Contractor of his responsibility to perform the Work in accordance with the Contract Documents. Tests not specifically indicated to be done at the Owner's expense, including retesting of rejected materials and installed work, shall be done at the Contractor's expense. See Testing Laboratory section of the Specifications.
- E. Acceptance Criteria for Concrete Strength: The strength level of an individual class of concrete shall be considered satisfactory if both the following requirements are met:
 1. The average of all sets of three consecutive strength tests equal or exceed the required f'c.
 2. No individual strength test falls below the required f'c by more than 0.1 f'c or 500 psi, whichever is greater.
 3. A strength test shall be defined as the average strength of two 6" x 12" cylinder breaks or three 4" x 8" cylinder breaks tested at the strength age indicated on the drawings for that class of concrete.
- F. Responsibility for Selection and Use of Concrete Admixtures and Chemical Treatments: The Contractor shall be responsible for selecting admixtures and surface treatments that are compatible with the intended use of the concrete including all final surface treatments called for within this or other specifications or on the structural or architectural drawings. The Contractor is responsible for following the manufacturer's instructions for the use of their product including abiding by any limitations placed by the manufacturer on the use of any of its products.
- G. Manufacturer Representative Presence:
 1. Post-installed anchors: The manufacturer's representative for each post-installed anchor product (adhesive, expansion, undercut, screw, or insert anchor) shall be present during the first day's installation of the product to observe whether the anchors are installed according to manufacturer's instructions.

1.05 SUBMITTALS

- A. Shop Drawings: Submit shop drawings for all reinforcing steel and related accessories for the Engineer's approval. Shop drawings shall show arrangement and layout, bending and assembly diagrams, bar schedules, stirrup spacing, splicing and laps of bars and shall be prepared in accordance with CRSI Standards. Submit details for steel templates that are to be used when placing dowels for columns, plinths, or pilasters out of foundation elements or for placing anchor rods for structural steel members.
- B. Product Data: Submit manufacturer's product data with application and installation instructions for proprietary materials and items, including admixtures, patching compounds, epoxies, grouts, waterstops, joint systems, fiber reinforcement, curing compounds, dry-shake finish materials, hardeners, sealers, mechanical splices, hooked anchorage systems, dowel bar substitute systems, dowel bar sleeves, and others as requested by Architect/Engineer.
- C. Samples: Submit samples of materials specified if requested by Architect/Engineer, including names, sources and descriptions.
- D. Mix Designs: Submit mix designs as specified herein.
- E. Material and Mill Certificates: Provide material and mill certificates as specified herein and in the Testing Laboratory section of the Specifications. The Manufacturer and Contractor shall sign the material and mill certificates certifying that each material item complies with specified requirements. Provide certification from admixture manufacturers that chloride ion content complies with specified requirements.
- F. International Code Council (ICC) Evaluation Service Reports: Submit evaluation service reports of approval from ICC Evaluation Service, Inc. for mechanical splice, hooked anchorage systems, and dowel bar substitute systems.

1.06 PROVISION FOR OTHER WORK

- A. Provide for installation of inserts, hangers, metal ties, anchors, bolts, angle guards, dowels, thimbles, slots, nailing strips, blocking, grounds and other fastening devices required for attachment of work. Properly locate in cooperation with other trades and secure in position before concrete is poured. Do not install sleeves in any concrete slabs except where shown on the drawings or upon written approval of the Architect/Engineer.
- B. Protect adjacent finish materials against damage and spatter during concrete placement.

PART 2 - PRODUCTS

2.01 CONCRETE MATERIALS

- A. Refer to the drawings for classes and strengths of concrete required.
- B. Hydraulic Cement:
 - 1. Use ASTM C 150, Type I or Type III, or ASTM C 1157, Type GU or HE unless otherwise specified.
 - 2. Use one brand of cement, for each class of concrete, throughout the project, unless approved otherwise by the Architect/Engineer and the Owner's Testing Laboratory. Submit mill certificates certifying conformance to this specification for each brand and type of cement.
 - 3. Testing of cement in lieu of mill certificate submittal will be required if:
 - a. The cement has been in storage at the mixing site for over 30 days
 - b. It is suspected by the Owner, Architect, Engineer or Owner's Testing Laboratory that the cement has been damaged in storage or in transit or is in any way defective.
- C. Low-alkali cement: Cement that has the additional requirement that equivalent alkalis ($\text{Na}_2\text{O} + 0.658\text{K}_2\text{O}$) do not exceed 0.60% according to ASTM C 150-00, Table 2.
- D. Fly Ash: ASTM C 618, Class C or F.
- E. Lightweight Aggregates: ASTM C 330. Submit material certificates from aggregate supplier or test results from an independent testing agency certifying conformance to this specification for each source of aggregate.
- F. Water: Comply with the requirements of ASTM C 1602.
- G. Cementitious materials, aggregate, and water must be extracted or recovered as well as manufactured within 500 miles of the project site.
- H. Air-Entraining Admixture: ASTM C 260. Provide air entrainment as specified in Table 4.2.2.4. of ACI 301-05 in all concrete exposed to freezing and thawing. Interior steel troweled surfaces subjected to vehicular traffic shall not have more than 3% entrained air. Surfaces scheduled to receive hardeners shall not have more than 3% entrained air.
 - 1. Subject to compliance with requirements, provide one of the following products and manufacturers:
 - a. W.R. Grace & Co.; Darex or Daravair series.
 - b. BASF Admixtures, Inc.; MB-VR, MB-AE90, or Micro-Air.
 - c. Sika Corporation; Sika AER.
 - d. The Euclid Chemical Company; Air Mix or AEA-92.
 - e. The Euclid Chemical Company; Eucon Air 30 or Eucon Air 40.Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.
- I. Water-Reducing Admixture: ASTM C 494, Type A. See maximum permissible chloride ion content in concrete specified below.
 - 1. Subject to compliance with requirements, provide one of the following products and manufacturers:
 - a. BASF Construction Chemicals; Pozzolith series.
 - b. Sika Chemical Corp.; Plastocrete 161.

- c. The Euclid Chemical Company; Eucon WR-75 or WR-91.
- d. W.R. Grace & Co.; WRDA series.
- e. The Euclid Chemical Company; Eucon NW or Eucon LW.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

- J. Mid-Range Water-Reducing Admixture: ASTM C 494, Type A and Type F. See maximum permissible chloride ion content in concrete specified below.
 - 1. Subject to compliance with requirements, provide one of the following products and manufacturers:
 - a. BASF Construction Chemicals; Polyheed series.
 - b. The Euclid Chemical Company; Eucon MR.
 - c. Sika Chemical Corp.; Sikament HP.
 - d. W.R. Grace & Co.; Daracem or Mira series.
 - e. The Euclid Chemical Company; Eucon X-15 or Eucon X-20.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

- K. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C 494, Type F or Type G. See maximum permissible chloride ion content in concrete specified below.
 - 1. Subject to compliance with requirements, provide one of the following products and manufacturers:
 - a. W.R. Grace & Co.; ADVA or Daracem Series.
 - b. BASF Construction Chemicals; Rheobuild 1000 or Glenium series.
 - c. Sika Chemical Corp.; Sikament.
 - d. The Euclid Chemical Company; Eucon 37/1037 or Plastol series.
 - e. The Euclid Chemical Company; Eucon SP or Eucon RD2.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

- L. Water-Reducing, Accelerator Admixture (Non-Corrosive, Non-Chloride): ASTM C 494, Type C or E. See maximum permissible chloride ion content in concrete specified below.
 - 1. Subject to compliance with requirements, provide one of the following products and manufacturers:
 - a. W.R. Grace & Co.; Polarset, Gilco, Lubricon NCA, Daraset 400, or DCI.
 - b. BASF Admixtures, Inc.; Pozzutec 20+.
 - c. The Euclid Chemical Company; Accelguard 80/90, NCA, or AcN.
 - d. Sika Chemical Co.; Plastocrete 161FL.
 - e. The Euclid Chemical Company; Eucon AcN.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

- M. Water-Reducing, Retarding Admixture: ASTM C 494, Type D. See maximum permissible chloride ion content in concrete specified below.
 - 1. Subject to compliance with requirements, provide one of the following products and manufacturers:
 - a. W.R. Grace & Co.; Daratard series.
 - b. BASF Construction Chemicals; Pozzololith series or DELVO series.
 - c. Sika Chemical Co.; Plastiment.
 - d. The Euclid Chemical Company; Eucon Retarder series.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

- N. Calcium Chloride and Chloride Ion Content: Calcium chloride or admixtures containing more than 0.5% chloride ions by weight of the admixture are not permitted.
1. Certification: Written conformance to all the above mentioned requirements and the chloride ion content of the admixture as tested by an accredited laboratory will be required from the admixture manufacturer at the time of mix design review by the Engineer. For concrete exposed to sulfate exposure class S2 or S3 as noted on the drawings, admixtures must be completely free of chloride ions.

2.02 REINFORCEMENT MATERIALS

- A. Reinforcement:
1. Reinforcing materials shall be delivered from the mill in bundles that are identified as to heat number and manufacturer and accompanied with mill and analysis test reports and an affidavit from the supplier stating that the material conforms with the requirements of the governing ASTM specification listed herein.
 2. Deformed bar material that is not identifiable according to the criteria listed above shall be tested for tensile strength and bend tests according to ASTM A 615 on a sample of 2 bars for each ten tons or fraction thereof of unidentified material for each bar size. The bars shall be a minimum of 24 inches long.
 3. Reinforcing Steel: Reinforcing steel shall conform to ASTM A 615 Grade 60 as noted on the drawings.
 4. Tie Wire: Tie wire shall be annealed steel tie wire, minimum 16 gauge. Provide only plastic coated or stainless steel tie wire in exposed concrete structures and all architectural concrete.
- B. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar type or all plastic supports complying with CRSI recommendations.

2.03 SPLICES

- A. Splice Type and Lap Lengths: Required splice type and lap lengths are defined on the drawings. Lap splice lengths for unscheduled bars not shown otherwise on the drawings shall be 30 bar diameters minimum.

2.04 RELATED MATERIALS

- A. Bonding Compound: Polyvinyl acetate or acrylic base, for use in cosmetic and/or nonstructural repairs.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Acrylic or Styrene Butadiene:
 - (1) Dayton-Superior; Day-Chem Ad Bond (J-40).
 - (2) The Euclid Chemical Company; SBR Latex.
 - (3) W.R. Grace; Daraweld C.
 - (4) BASF Building Systems; Acrylic Additive.
 - (5) Sika Chemical Co.; SikaLatex.
 - (6) W.R. Meadows; Intralok.
 - (7) US Mix Co.; US Spec Acrylcoat.
 - (8) The Euclid Chemical Company; Akkro 7-T.
 - (9) SpecChem; Acrylic Bonder.
 - b. Polyvinyl Acetate (Interior Use Only)
 - (1) The Euclid Chemical Company; Tammseld.
 - (2) L&M Construction Chemicals; Everweld.
 - (3) Dayton-Superior; Superior Concrete Bonder (J-41).
 - (4) US Mix Co.; US Spec Bondcoat.
 - (5) SpecChem; SpecWeld.

- B. Epoxy Products: Two component material suitable for use on dry or damp surface, complying with ASTM C 881.
1. Products for Epoxy Mortar Patches:
 - a. Sika Chemical Co.; Sikadur Lo-Mod LV.
 - b. The Euclid Chemical Company; Duracrete.
 - c. Dayton-Superior; Sure Level Epoxy (J-57).
 - d. BASF Building Systems; Epofil.
 - e. Unitex; Pro-Poxy 2500.
 - f. W.R. Meadows; Rezi-Weld 1000.
 - g. US Mix Co.; US Spec EPM 3000.
 - h. The Euclid Chemical Company; Duralcrete LV.
 - i. SpecChem; SpecPoxy Binder.
- B. Self-Leveling Mortars, Underlayment Compound: Freeflowing, self-leveling, pumpable cementitious base compound. Follow manufacturer's instruction regarding the use of a bonding agent.
1. Products: Unless specified otherwise, provide one of the following:
 - a. BASF Building Systems; Sonoflow.
 - b. Sika Chemical Co.; Sikatop 111.
 - c. The Euclid Chemical Company; Flo-Top or Super Flo-Top.
 - d. Dayton-Superior; Levelayer I.
 - e. US Mix Co.; US Spec Self-Leveling Underlayment.
 - f. The Euclid Chemical Company; Level Magic.
 - g. SpecChem; SpecFlow.
- C. Expansion Anchors in Concrete:
1. ICC Approval: Only anchors evaluated by the ICC Evaluation Service, Inc. (ICC-ES) with a published Evaluation Report showing having passed Acceptance Criteria 193 and approval for use in cracked concrete and resisting wind and seismic loads shall be approved for use.
 2. Type: All expansion anchors in concrete shall be only wedge type expansion, sleeve type expansion or undercut type bolts.
 3. Interior Use: All expansion anchors, nuts and washers for use in interior conditioned environments free of potential moisture shall be manufactured from carbon steel zinc plated in accordance with Federal Specification QQ-Z-325C, Type II, Class 3.
 4. Exterior or Exposed Use: All expansion anchors, nuts and washers for use in exposed or potentially wet environments, or for attachment of exterior cladding materials shall be galvanized or stainless steel. Galvanized bolts, nuts and washers shall conform to ASTM A 153. Stainless steel bolts shall be manufactured from 300 series stainless steel and nuts and washers from 300 series or Type 18-8 stainless steel.
 5. Nuts and Washers: Nuts and washers shall be furnished from the manufacturer and used with the bolts.
 6. Acceptable Products and Manufacturers – Normal and Lightweight Concrete:
 - a. Hilti Fastening Systems; Kwik Bolt TZ (periodic inspection)
 - b. Hilti Fastening Systems; HDA Undercut Anchor (periodic inspection)
 - c. Hilti Fastening Systems; HSL-3 Heavy Duty Sleeve Anchor (periodic inspection)
 - d. Simpson Strong-Tie Co., Inc.; Strong-Bolt Wedge Anchor (periodic inspection)
 - e. Simpson Strong-Tie Co., Inc.; Strong-Bolt 2 Wedge Anchor (periodic inspection)
 - f. ITW Red Head; Red Head Trubolt + Wedge Anchor (periodic inspection)
 - g. USP Structural Connectors; DUC Undercut Anchor (periodic inspection)
 - h. Powers Fasteners, Inc.; Power Stud + SD1 Expansion Anchor (periodic inspection)
 - i. Powers Fasteners, Inc.; Power Stud + SD2 Anchor (periodic inspection)
 - j. MKT Metall-Kunststoff-Technik/UCan Fastening Products; SRS TZ Anchor, (periodic inspection)

7. Acceptable Products and Manufacturers – Normal and Light Weight Concrete on Corrugated Deck:
 - a. Hilti Fastening Systems; Kwik Bolt TZ (periodic inspection)
 - b. Simpson Strong-Tie Co., Inc.; Strong-Bolt Wedge-Anchor (periodic inspection)
 - c. Powers Fasteners, Inc.; Power Stud + SD2 Anchor (periodic inspection)
8. Install only anchors identified on the drawings by manufacturer and product. Substitutions using products approved by this Specification may be permitted provided complete design calculations, as required by and in accordance with the proposed product's current and valid ICC Evaluation Service Report (ESR) and ACI 318 Appendix D, are signed and sealed by a professional engineer licensed in the state where the project is located and furnished to the Engineer for review and approval prior to commencement of work. The contractor shall request design criteria for all conditions where a product substitution is considered. Failure to obtain approval for an anchor substitution may result in the request by the Engineer to remove installed anchors and replace with the product specified on the drawings at the Contractor's expense.

2.05 PROPORTIONING AND DESIGN OF CONCRETE MIXES

- A. The Contractor shall submit concrete mix designs and the Concrete Mix Design Submittal Form located at the end of this specification section for each class of concrete indicated on the structural drawings and in the Specifications for approval by the Engineer and Owner's Testing Laboratory at least 15 working days prior to the start of construction,. If required, the Contractor shall engage the services of an independent Testing Laboratory to assist in preparing the mix design. The Contractor shall not begin work with a particular mix until that mix design has been approved.
- B. The Contractor, acting in conjunction with his Concrete Supplier and his Testing Laboratory, shall submit in writing, with his mix designs, the method used to select mix proportions. Either of the following methods, as outlined in ACI 301, may be used.
 1. Field Experience Method
 2. Laboratory Trial Mixture Method
- C. Required types of concrete and compressive strengths shall be as indicated on the Structural Drawings.
- D. All mix designs shall state the following information:
 1. Mix design number or code designation by which the Contractor shall order the concrete from the Supplier.
 2. Structural slab or member for which the concrete is designed (i.e. columns, shear walls, footings, slab on grade, etc.).
 3. Wet and dry unit weight.
 4. 28 day compressive strength.
 5. Aggregate type, source, size, gradation, fineness modulus.
 6. Cement type and brand.
 7. Fly ash or other pozzolan type and brand (if any).
 8. Admixtures including air entrainment, water reducers, high-range water reducers, accelerators, and retarders.
 9. Design Slump or Slump/Flow.
 10. Proportions of each material used.
 11. Water/cementitious ratio and maximum allowable water content.
 12. Method by which the concrete is intended to be placed (bucket, chute, or pump).
 13. Required average strength qualification calculations per ACI 301 4.2.3.3a and 4.2.3.3b. Submit separate qualification calculations for each production facility that will supply concrete to the project.
 14. Documentation of Average strength (trial mix data or field test data) per ACI 301: When field test data is used to qualify average strength, submit separate documentation for each production facility that will supply concrete to the project.

15. Field test data submitted for qualification of average strength under ACI 301 shall include copies of the Concrete Testing Agency's reports from which the data was compiled.
 16. All other information requested in the Concrete Mix Design Submittal Form located at the end of this specification section.
- E. Supplementary Cementitious Materials: Fly ash and/or ground granulated blast-furnace slag replacement of Portland cement shall meet the performance criteria and replacement percentage requirements listed below unless noted otherwise. Every effort should be made to reduce the amount of cement to the minimum practical amount, and still achieve the performance requirements contained in the Contract Documents.
1. Cement replacement shall not exceed a percentage level that has been shown by experience on other projects to exhibit satisfactory performance using materials from identical sources as proposed for this project. As an alternate, trial concrete batches can be performed to identify mix designs that maximize cement replacement while meeting strength requirements per ACI 318 Section 5.3 and workability criteria.
 2. Minimum and maximum replacement percentages:
 - a. All Concrete: 0% - 35% (If fly ash is used, it must be at a minimum replacement percentage of 15%)
 3. Replacement percentages exceeding the maximum may be permitted at the discretion of the Architect, Engineer of Record, and Contractor.
- F. Aggregate: Comply with the following special requirements:
1. For slabs and other designated concrete, combined aggregate gradation shall be 8% - 18% for large top size aggregates (1 1/2 in.) or 8% - 22% for smaller top size aggregates (1 in. or 3/4 in.) retained on each sieve below the top size and above the No. 100. Deviations from this gradation may be allowed upon the approval of the Engineer subject to the following limitations:
 - a. The percent retained on two adjacent sieves shall be not less than 5%.
 - b. The percent retained on three adjacent sieves shall be not less than 8%.
 - c. If the percent retained on two adjacent sieves is less than 8%, the total percent retained on either of those sieves and the adjacent outside sieve shall be not less than 13 %.
- G. Admixtures:
1. Admixtures to be used in concrete shall be subject to the approval of the Engineer and Owner's Testing Laboratory and shall be used for the purpose intended by the manufacturer to produce concrete to meet the specified requirements.
 2. Quantities of admixtures to be used shall be in strict accordance with the manufacturer's instructions.
 3. Air Content Requirements: For concrete subject to Exposure Class F1, F2 or F3 as noted on the drawings, use air-entrainment admixtures to provide concrete such that the air content at the point of delivery shall conform to the requirements of Table 4.4.1. of ACI 318-08 within plus or minus 1.5%. Required air content levels may be reduced by 1.0 percent for concrete strengths above 5000 psi. Interior steel troweled surfaces subjected to vehicular traffic shall not have more than 3% entrained air. Surfaces scheduled to receive hardeners shall not have more than 3% entrained air.
- H. Lightweight Structural Concrete:
1. Comply with the requirements of ACI 211 and ACI 301.
 2. Provide concrete with a dry unit weight of not more than 116 pounds per cubic foot and not less than 110 pounds per cubic foot. Design mix to produce strengths as indicated on the drawings with a split cylinder strength factor $(f_{ct}/(f'c)^{0.5})$ of not less than 5.7.

- I. Adjustments of Concrete Mixes: Mix design adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant. Such mix design adjustments shall be provided at no additional cost to the Owner. Any adjustments in approved mix designs including changes in admixtures shall be submitted in writing with the specified Concrete Mix Design Submittal Form to the Engineer and Owner's Testing Laboratory for approval prior to field use.
- J. Chloride Ion Content:
 - 1. Unless noted otherwise, The maximum water soluble chloride ion concentration in hardened concrete measured at ages from 28 to 42 days contributed from all ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed the limits specified in ACI 318-08 Table 4.3.1 depending on to which Corrosion Exposure Class (CO, C1 or C2) the concrete is subject as noted on the drawings. Water-soluble chloride ion tests shall conform to ASTM C 1218. One test shall be run for each class of concrete before the mix design submittal and each time a change is made to the mix design (such as change in aggregate type or source).
 - 2. The Concrete Supplier shall certify on the Mix Design Submittal Form that the chloride ion content in all concrete mix designs used on the project does not exceed the limits stated above.

2.06 CONCRETE MIXING

- A. Ready-Mix Concrete: Comply with requirements of ANSI/ASTM C 94, "Ready Mixed Concrete" and Testing Laboratory section of the specifications.

PART 3 - EXECUTION

3.01 FABRICATION AND DELIVERY OF REINFORCEMENT

- A. Bending and Forming: Fabricate bars of indicated sizes and accurately form to shapes and lengths indicated and required, by methods not injurious to materials. Do not heat reinforcement for bending. Bars shall be free from injurious defects, have a workman-like finish with no excessive rust and/or pitting and have no unusual kinks or bends.
- B. Marking and Shipping: Bundle reinforcement and tag in accordance with section 7.4.5 of the CRSI "Manual of Standard Practice". Transport and store at site so as not to damage material. Keep sufficient supply of tested, approved and proper reinforcement at the site to avoid delays. Maintain reinforcing bars free of mud, dirt, grease, or other coating.

3.02 PLACING REINFORCEMENT

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports and as herein specified.
- B. Before placing and again before concrete is placed, clean reinforcement of loose rust and mill scale, earth, ice and other materials which reduce or destroy bond with concrete.
- C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by chairs, runners, bolsters, spacers and hangers, as required. Exercise particular care to maintain proper distance and clearance between parallel bars and between bars and forms. Provide metal spreaders and spacers to hold steel in position. Support steel at proper height upon approved chairs.
- D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Coordinate with other trades and expedite materials and labor to avoid omissions and delay.

- F. Provide and place additional reinforcing steel at all sleeves and openings in beams, slabs and walls as specified on the drawings. Where sleeves or openings not shown on the drawings interrupt the reinforcement, consult with Engineer for instructions for placing and splicing of bars. Provide required additional reinforcing steel at no additional cost to the Owner.

3.03 SPLICING REINFORCING STEEL

- A. Provide splice as indicated on the drawings. Splice reinforcing bars only at locations shown on the structural drawings and approved shop drawings. Unauthorized or unscheduled splices not approved by the Engineer in writing will not be accepted.
- B. All lap splices in reinforcing steel shall be contact lap splices unless detailed otherwise on the drawings.
- C. Maintain proper cover between reinforcing bars at splices.
- D. Lap unscheduled reinforcing bars not otherwise specified a minimum of 30 bar diameters at splices. Lap welded wire fabric a minimum of one full wire mesh plus two inches.

3.04 SLUMP LIMIT

- A. The slump, as measured in the field where concrete cylinders are taken, shall be within plus or minus 1 inch of the design slump noted on the Mix Design Submittal Form. Self-consolidating concrete shall have a slump/flow of plus or minus 2 inches of the design slump noted on the Mix Design Submittal Form. Water may be added to the concrete in the field only to the extent that the prescribed water/cementitious ratio noted in the Mix Design Submittal Form is not exceeded.

3.05 JOINTS IN CONCRETE

- A. Construction Joints: Locate and install construction joints as indicated on the drawings or if not shown on drawings, located so as not to impair strength and appearance of the structure, as acceptable to Architect/Engineer.

3.06 CONCRETE PLACEMENT

- A. Preplacement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.
- B. Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel.
- C. Comply with ACI 301 and as herein specified.
 - 1. The maximum acceptable concrete temperature at the truck discharge point shall be 95°F.
 - 2. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation. Spread concrete using short-handled, square-ended shovels, or come-alongs.
 - 3. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use internal vibrators of the largest size and power that can properly be used in the work as described in the table entitled "Range of characteristics, performance, and applications of internal vibrators" found in ACI 301.
 - 4. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time

- necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
5. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
 6. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners of forms, eliminating air and stone pockets that may cause honeycombing, pitting, or planes of weakness.
 7. Bring slab surfaces to correct level with straightedge and strikeoff. Use highway straightedges, bull floats or darbies to smooth surface free of humps or hollows before excess moisture or bleedwater appears on the surface. Do not disturb slab surfaces prior to beginning finishing operations.
 8. Maintain reinforcing in proper position during concrete placement operations.
 9. Placing Concrete by Pump: If concrete is placed by using a pump, the grout used for pump priming must not become a part of the completed structure unless an engineered grout design mix and grout location are approved in advance by the Engineer.

3.07 FINISH OF FORMED SURFACES

- A. General: Formed surfaces shall have the finishes as described below and as shown on the drawings after formwork is removed and repairs made.
- B. Matching Sample Finish: Finish on surfaces at locations noted on drawings shall match sample panel furnished to Contractor. Reproduce finish on a 100 square foot mock-up panel in a location designated by Architect/Engineer. Protect mock-up from damage for the duration of project. Approval of mock-up by Architect is required before proceeding with application of finish in project.

3.08 CONCRETE FINISH MEASUREMENT AND TOLERANCES

- A. Testing Procedure: ASTM E 1155:
- B. Tolerance on Floor Elevations: Construction tolerance on absolute floor elevation from the specified elevation as shown on the drawings shall be as specified below, taken from ACI 117:
 1. Top surfaces of all other slabs: $\pm 3/4"$.
- C. Concrete Floor Finish Tolerance - Unshored Metal Deck on Shored or Unshored Steel Beam or Open-Web Joist Floor Construction:
 1. Concrete Placement: Concrete over metal deck shall be placed and screeded level and flat to the tolerance specified below, maintaining at least the minimum slab thickness at all locations as specified on the drawings. The Contractor shall increase the slab thickness as required to compensate for metal deck deflection, and in unshored beam construction, beam deflection in excess of actual beam camber in order to achieve a level and flat floor within specified tolerances.
 2. Extra Concrete: The contractor shall include in his bid any additional concrete required to achieve the specified slab surface finish tolerance and to compensate for metal deck deflection, and for beam deflection in excess of actual beam camber.
- D. Remedial Measures for Slab Finish Construction Not Meeting Specified Tolerances:
 1. Modification of Existing Surface:
 - a. If, in the opinion of the Architect/Engineer or Owner's Representative, all or any portion of the substandard work can be repaired without sacrifice to the appearance or serviceability of the area, then the Contractor shall immediately undertake the approved repair method.
 - b. The Contractor shall submit for review and approval a detailed work plan of the proposed repair showing areas to be repaired, method of repair and time to affect the repair.

- c. Repair method(s), at the sole discretion of the Architect/Engineer or Owner's Representative, may include grinding (floor stoning), planning, retopping with self leveling underlayment compound or repair topping, or any combination of the above.
 - d. The Architect/Engineer or Owner's Representative maintains the right to require a test repair section using the approved method of repair for review and approval to demonstrate a satisfactory end product. If, in the opinion of the Architect/Engineer or Owner's Representative, the repair is not satisfactory an alternate method of repair shall be submitted or the defective area shall be replaced.
 - e. The judgment of the Architect/Engineer or Owner's Representative on the appropriateness of a repair method and its ability to achieve the desired end product shall be final.
 - f. All repair work shall be performed at no additional cost to the Owner and with no extension to the construction schedule.
2. Removal and Replacement:
- a. If, in the opinion of the Architect/Engineer or Owner's Representative, all or any portion of the substandard work cannot be satisfactorily repaired without sacrifice to the appearance or serviceability of the area, then the Contractor shall immediately commence to remove and replace the defective work.
 - b. Replacement section boundaries shall be made to coincide with the test section boundaries as previously defined.
 - c. Sections requiring replacement shall be removed by sawcutting along the section boundary lines to provide a neat clean joint between new replacement floor and existing floor.
 - d. The new section shall be reinforced the same as the removed section and doweled into the existing floor as required by the Engineer. No existing removed reinforcing steel may be used. All reinforcing steel shall be new steel.
 - e. Replacement sections may be retested for compliance at the discretion of the Architect/Engineer or Owner's Representative.
 - f. The judgment of the Architect/Engineer or Owner's Representative on the need for replacement shall be final.
 - g. All replacement work shall be performed at no additional cost to the Owner and with no extension to the construction schedule.

3.09 CONCRETE CURING AND PROTECTION

- A. General:
1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Maintain concrete with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of concrete. Limit moisture loss to a maximum of 0.05 lb./sq. ft – hr for concrete containing silica fume and 0.2 lb./sq. ft. - hr for all other concrete before and during finishing operations.. If using an evaporation retarder, apply in accordance with manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
 2. Curing shall commence as soon as free water has disappeared from the concrete surface after placing and finishing. The curing period shall be 7 days for all concrete except high early strength concrete which shall be cured for 3 days minimum.
 3. Curing shall be in accordance with ACI 301 procedures. Avoid rapid drying at the end of the curing period.
- B. Curing Formed Surfaces: Where wooden forms are used, cure formed concrete surfaces by moist curing with forms in place for full curing period or until forms are removed. When forms are removed, continue curing by one or a combination of the methods specified below, as applicable.

- C. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping and other flat surfaces by one or a combination of the methods specified below, as applicable. The Contractor shall choose a curing method that is compatible with the requirements for subsequent material usage on the concrete surface.
1. Floors that are to receive subsequent cementitious toppings, sealers, hardeners, ceramic tile, acrylic terrazzo, vinyl composition tile, sheet vinyl, linoleum, vinyl-backed carpet, rubber, athletic flooring, synthetic turf, wood, epoxy overlay or adhesive, or other coating or finishing products: Cure using methods 2 or 3 as specified below. Use a water-based dissipating resin type curing compound conforming to ASTM C 309, type 1, class A or B for method 3.
- D. Curing Methods
1. Method 2 - Moisture-Retaining Cover Curing: Provide moisture-retaining cover curing as follows:
 - a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape. Water may be added to concrete surface to prevent drying before the cover is installed, but the surface shall not be flooded with water if a non-absorptive cover is used.
 2. Method 3 – Curing or Curing and Sealing Compound: Provide curing, curing/hardener, liquid membrane-forming curing, or curing and sealing compound as follows:
 - a. Apply specified compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Do not allow to puddle. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period. Apply second coat for sealing 2 to 3 hours after the first coat was applied.
 - b. Do not use membrane-forming curing and sealing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring (such as ceramic or quarry tile, glued-down carpet, vinyl composition tile, linoleum, sheet vinyl, rubber, athletic flooring, synthetic turf, epoxy overlay or adhesive, or wood), paint or other coatings and finish materials., Dissipating resin type cures are acceptable in these locations.

3.10 REINFORCEMENT IN COMPOSITE STEEL DECK SLAB

- A. Composite steel deck slabs shall be reinforced as indicated on the drawings.
- B. Extra Reinforcement over Girders: Provide additional reinforcing steel over interior girders as shown on the drawings.
- C. Placement of Slab Reinforcement: Provide bolsters, high chairs, and/or additional reinforcing as shown in details on the drawings to support the reinforcing with the clear cover shown on the details.

3.11 REINFORCEMENT AROUND OPENINGS IN COMPOSITE STEEL DECK SLABS

- A. For all openings in steel deck not framed with structural steel and greater than 10" in width in either direction, provide additional reinforcing steel as shown in details on the drawings.

3.12 INVESTIGATION OF LOW CONCRETE STRENGTH TEST RESULTS

- A. Contractor Responsibility for Low Strength Concrete
1. If the average of any three consecutive strength tests falls below the required f'_c for a class of concrete but no individual strength test is more than 500 psi below f'_c , the Contractor shall immediately notify the Engineer by telephone or e-mail and take immediate steps to increase the average of subsequent strength tests.
 2. If any individual strength test falls more than 500 psi below the required f'_c , the Contractor shall immediately notify the Engineer by telephone or e-mail and take immediate steps to assure that the load-carrying capacity of the structure is not jeopardized.
- B. Additional Field Tests to Confirm Low Concrete Strengths
1. The cost of all investigations of low-strength concrete, as defined by any individual strength test being more than 500 psi below the required f'_c , shall be borne by the Contractor.
 2. Code-Prescribed Acceptance: The only accepted field-test methods of determining actual in-situ concrete strength is by the way of core tests as prescribed below.
 3. Non-Destructive Tests: If any individual strength test falls more than 500 psi below the required f'_c , the Engineer may request that non-destructive field tests be performed on the concrete in question using Swiss Hammer, Windsor Probe, or other appropriate methods as approved by the Engineer. Report the comparative test results of the suspect concrete under consideration with identical tests done on concrete of known strength and of the same class. The Engineer considers these test results as only approximate indicators of strength and may not necessarily, by themselves, resolve the low concrete strength issue. These test results will be considered as additional information by which to make an informed judgment. The Engineer reserves the right to accept the concrete based on the results of these approximate tests or order that core tests be taken as prescribed below. At the Contractor's option, the approximate non-destructive field-tests may be waived and core tests immediately initiated.
 4. Core Tests: If, in the opinion of the Engineer, the likelihood of low-strength concrete is confirmed and it has been determined that the load-carrying capacity of the structure is significantly reduced as a result, the Engineer may request that core tests be taken from the area in question as directed by the Engineer. There shall be a minimum of three cores taken for each strength test more than 500 psi below the required f'_c and tested in accordance with ASTM C 42. If concrete in the structure will be dry under service conditions, cores shall be air dried (temperature 60° to 80°F, relative humidity less than 60 percent) for 7 days before test and shall be tested dry. If concrete in the structure will be more than superficially wet under service conditions, cores shall be immersed in water for at least 48 hours and tested wet. The Contractor shall fill all holes made by drilling cores with an approved drypack concrete.
 5. Acceptance Criteria for Core Test: Concrete in an area represented by core tests shall be considered adequate if the average of three cores is equal to at least 85% of the required f'_c and no single core is less than 75% of the required f'_c . If approved by the Engineer, locations of erratic core strengths may be retested to check testing accuracy.
 6. Load Test: If the concrete strength is not considered adequate based on core tests and the structural adequacy remains in doubt, the Engineer may order a load test as specified in ACI 318 be conducted for the questionable portion of the structure.
 7. Strengthening of the Structure or Demolition: If the structural adequacy of the affected portion of the structure remains in doubt following the load test, the Engineer may order the structure to be strengthened by an appropriate means or demolished and rebuilt at the Contractor's expense.

END OF SECTION

Date: _____

Concrete Mix Design
Submittal Form (Note 1)

I. Project Information

- A. Name of Project: _____ B. City, State: _____
- C. General Contractor: _____
- D. Concrete Supplier: _____
 - 1. Address: _____
 - 2. Name to Contact: _____ 3. Phone No.: _____ 4. Fax No.: _____

II. Concrete Mix Information

- A. Concrete Mix Design Designation (Note 2): _____
- B. Minimum Concrete Strength f'c: _____ psi at _____ days and C. Maximum w/c Ratio: _____
- D. Concrete Type (check one) _____ NW _____ LW E. Required Wet Weight: _____ pcf
- F. Concrete Use (member type as specified in General Notes): _____
- G. Required Air Content: _____ %
- H. Method of Concrete Placement for this Mix: (check one) _____ Bucket _____ Pump _____ Chute _____ Tremie _____ Other (Specify) _____

III. Method of Concrete Mix Design Preparation: (Check One Method Below) (Note 3)

- A. _____ Field Experience Method B. _____ Trial Mixture Method

IV. Concrete Production Facility Information

- A. Production facility has field strength test records of specified class or within 1 ksi of class: _____ Yes _____ No
Answer B thru C only if answer to IV.A. is "yes". If answer to IV.A. is "no", go to V.B.:
- B. Test Record Information: (Check either 1, 2, or 3 below)
 - 1. _____ ≥ 30 consecutive tests 2. _____ Two groups of ≥ 30 tests 3. _____ 15 to 29 tests
- C. Standard Deviation S(PSI):
 - 1. Modification Factor (if B.3. checked only. Ref. Table 5.3.1.2 of ACI 318-02.) MF = _____
 - 2. Standard Deviation S = _____ psi 3. MF x S (if B.3. checked only) = _____ psi

Note: Combined aggregate gradation for slabs and other designated concrete shall be 8% -18% for large top size aggregates (1 1/2 in.) or 8%-22% for smaller top size aggregates (1 in. of 3/4 in.) retained on each sieve below the top size and above the No. 100 sieve.

V. Required Average Compressive Strength f'cr (psi)

- A. Calculation of f'cr from S (fill out only if IV.A. is "yes") (larger of 1 or 2 below controls)
 - 1. $f'cr = f'c + 1.34 \times S =$ _____ psi
 - 2. $f'cr = f'c + 2.33 \times S - 500 =$ _____ psi
- B. Calculation of f'cr from ACI 318-02 Table 5.3.2.2: (fill out if IV.A. is "No")
 - 1. $f'cr = f'c +$ _____ psi = _____ psi

VI. Concrete Mix Design by Field Experience Method: (fill out below only if III.A. is checked)

Note: This method requires one or more mix designs with a 45 day minimum field record of at least ten consecutive test results using similar materials and conditions as the proposed mix design.

- A. Available field record is based on how many mix designs? _____ (specify number)
- B. Average strength of field record is _____ psi (must be ≥ f'cr in V.)

VII. Concrete Mix Design by Trial Mixture Method: (fill out below only if III.B. is checked)

Note: This method requires using at least three different trial mixes with varying W/C ratios or cement contents with a plot of average strength vs. W/C ratio or cement content. Submit scale graph of results.

- A. Trial Mixes: (Note: All other ingredients as specified in VIII. below)

	Mix 1	Mix 2	Mix 3	Selected (interpolated) values
Cements (lbs.)	_____	_____	_____	_____
W/C Ratio	_____	_____	_____	_____
Compressive Strength (psi) at Specified Days	_____	_____	_____	_____

VIII. Proposed Mix Design

A. Sources of Materials:

- 1. Cement: Type: _____ Manufacturer _____ Lo-Alkali? Y N Sp.Gr. _____
- 2. Fly Ash: Type: _____ Manufacturer _____ Specific Gravity _____
- 3. Silica Fume: Manufacturer: _____ Type (check one): _____ Slurry _____ Powder
 Slurry: Specific Gravity _____ Water Content by Wt. _____ % Silica by Wt. _____ %
 Powder: Specific Gravity _____ Silica by Wt. _____ %
- 4. Coarse Aggregate: Size: _____ Type: _____ Source: _____ Owendry Sp. Gr. _____
 (Note 4) Owendry Rodded Density: _____ PCF Absorption: _____ % (moist. content at SSD cond.)
 (Over)

- 5. Lightweight Agg.: Size: _____ Type: _____ Source: _____ Ovendry Sp. Gr. _____
(Note 4) Ovendry Rodded Density: _____ PCF Absorption: _____% (moist. content at SSD cond.)
- 6. Fine Aggregate: Type: _____ Source: _____ Fineness Modulus: _____
(Note 4) Ovendry Sp. Gr. _____ Absorption (moisture content at SSD condition): _____%
- 7. Air Entraining Agent (AEA): Manufacturer and Name: _____ ASTM No. _____

Note: Specify below all types and combinations of admixtures anticipated to be used for all anticipated weather conditions. Explain in (12) below.

- 8. Water Reducers (WR):
 - a. (Plain) Manufacturer and Name: _____ ASTM No. _____
 - b. (w/Accelerator) Manufacturer and Name: _____ ASTM No. _____
 - c. (w/Retarder) Manufacturer and Name: _____ ASTM No. _____
- 9. Accelerators: Manufacturer and Name: _____ ASTM No. _____
- 10. Retarders: Manufacturer and Name: _____ ASTM No. _____
- 11. High Range Water Reducer (HRWR) (Superplasticizers):
 - a. (Plain) Manufacturer and Name: _____ ASTM No. _____
 - b. (w/Retarder) Manufacturer and Name: _____ ASTM No. _____
- 12. Comments: _____

B. Mix Proportions: (Per Cubic Yard)

Item	Wt. (lbs.)	Absolute Vol. (Cu. Ft.)
1. Cement	_____	_____
2. Fly Ash	_____	_____
3. Silica Fume	_____	_____
4. Coarse Agg. (SSD Wt.)	_____	_____
5. Lightweight Agg. (SSD Wt.)	_____	_____
6. Fine Agg. (SSD Wt.)	_____	_____
7. AEA	_____ oz/100# cement	Added at: _____ Batch Plant _____ Site
8. a. WR (Plain)	_____ oz/100# cement	Added at: _____ Batch Plant _____ Site
b. WR (W/Acc.)	_____ oz/100# cement	Added at: _____ Batch Plant _____ Site
c. WR (W/Ret.)	_____ oz/100# cement	Added at: _____ Batch Plant _____ Site
9. Accelerator:	_____ oz/100# cement	Added at: _____ Batch Plant _____ Site
10. Retarder:	_____ oz/100# cement	Added at: _____ Batch Plant _____ Site
11. a. HRWR (Plain)	_____ oz/100# cement	Added at: _____ Batch Plant _____ Site
b. HRWR (w/Ret.)	_____ oz/100# cement	Added at: _____ Batch Plant _____ Site
12. Other:	_____ (Specify Units)	
13. Water (including free water on aggregates)	_____ (lbs.) _____ (cu. ft.) _____ (gal.)	

C. Mix Design Characteristics: (Pozzolan = flyash and/or silica fume)

- 1. Water (including free water on aggregates)/(Cement + pozzolan): $W/C = \frac{\text{_____ (lbs.)}}{\text{_____ (lbs.)}} = \text{_____}$
(Not applicable for LW concrete)
- 2. Fine Aggregate/Total Aggregate = $\frac{\text{_____ (lbs.)}}{\text{_____ (lbs.)}} = \text{_____}$ 3. Pozzolan/Pozzolan+Cement) = $\frac{\text{_____ (lbs.)}}{\text{_____ (lbs.)}} = \text{_____}$
- 4. Concrete Density: a. Unit Wet Weight: _____ pcf b. Unit Dry Weight: _____ pcf (lbs.) _____
- 5. Air Content: _____%
- 6. Slump: a. Initial Slump (before adding WR or HRWR) _____ in.
b. Final Slump (after adding WR or HRWR) _____ in.

D. Chloride Ion Content: The Concrete Supplier certifies that total chloride ion content of the concrete mix, as tested by ASTM C 1218 does not exceed the amounts specified in Table 4.4.1 of ACI 318-02.

E. Alkali Content: The Concrete Supplier certifies, if required by specification section 3300, that the total alkali content contributed from cementitious materials does not exceed 4.0 lbs./cu. yd. of concrete or certifies that the aggregate contains no deleterious material that reacts with the alkali in the concrete mix.

F. Mix Water Purity: The Concrete Supplier certifies that the appropriate specified chemical concentration limits are not exceeded in the total volume of mix water.

Notes:

- 1. This form is required to be submitted to Engineer and Owner's Testing Laboratory for all concrete mixes on the job. When any mix ingredient changes during the course of the job, this submittal form shall be resubmitted for approval. All information must be filled in for approval of mix design. Submit all backup data for calculations.
- 2. The mix designation should be that used by the Contractor to order the concrete from the Supplier and as noted on the batch ticket.
- 3. Refer to ACI 318-02 for requirements of each concrete mix design preparation method.
- 4. Submit sieve analysis of fine and course aggregates. Include chart indicating combined aggregate retained on each sieve size.

X. Certification by Concrete Supplier

Signature: _____ Representing: _____ Date: _____

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of structural steel work is shown on drawings including schedules, notes and details that show size and location of members, typical connections, and type of steel required. Furnish all labor, materials, services, equipment and appliances required in conjunction with or related to the furnishing, fabrication, delivery, and erection of all structural steel defined below. Include all supplementary parts, members and connections necessary to complete the structural steel work, regardless of whether all such items are specifically shown or specified on the drawings.
- B. Structural steel shall be defined as that work prescribed in Section 2.1 of the AISC "Code of Standard Practice for Steel Buildings and Bridges".
- C. Miscellaneous metal fabrications, cold-formed metal framing, and steel deck are specified elsewhere in these Specifications.

1.03 QUALIFICATIONS

- A. Fabricator:
 - 1. The structural steel fabricator shall have not less than 5 years of experience in the successful fabrication of structural steel similar to this project.
 - 2. The structural steel fabricator must participate in the AISC Quality Certification Program and be designated an AISC Certified Plant in Category STD, Standard for Steel Building Structures.
 - 3. The structural steel fabricator must be registered and approved by the local building official to perform fabrication work without special inspection. Should the fabricator not be so approved, the fabricator shall reimburse the Owner for the cost of the special inspections required by the local building official.
- B. Detailer: The structural steel detailer shall have not less than 5 years of experience in the successful detailing of structural steel similar to this project including experience in selecting or completing structural steel connection details using information found in tables in the AISC "Steel Construction Manual".
- C. Erector: The structural steel erector shall have not less than 5 years of successful experience in the erection of structural steel of a similar nature to this project.
- D. Professional Engineer: A professional engineer who is licensed to practice engineering in the state where the project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material,
 - 1. The Professional Engineer employed by the Fabricator for connection design shall be experienced in the specific area of structural steel connection design with demonstrated experience of not less than three projects of similar scope and complexity.
 - 2. The Professional Engineer employed by the Erector for preparation of Erection Bracing Drawings shall be experienced in the specific area of structural frame bracing during erection design with demonstrated experience of not less than three projects of similar scope and complexity
- E. Independent Testing Laboratory: Any testing laboratory retained to perform tests that are required by this specification shall meet the basic requirements of ASTM E 329.

1.04 QUALITY ASSURANCE

- A. The Contractor is responsible for quality control, including workmanship and materials furnished by his subcontractors and suppliers.
- B. Codes and Standards: Comply with provisions of following, except as otherwise indicated. For codes and standards for which no specific version is referenced, the version that is referenced in the applicable building code shall govern, or, if there is no reference in the building code, the latest version of the code or standard shall govern except as otherwise noted in the AISC Steel Construction Manual, 13th edition. Certain sections in this specification contain requirements that are more restrictive and/or different than contained in the standards listed. In such cases, the requirements of this specification shall control.
 - 1. All federal (OSHA), state and local laws that govern safety requirements for steel erection and other requirements if more stringent than the codes and standards enumerated below. OSHA requirements include regulation 29 CFR 1926, Part R, "Safety Standard for Steel Erection".
 - 2. AISC, "Code of Standard Practice for Steel Buildings and Bridges," except as noted herein.
 - a. Certain sections in this specification contain requirements that are more restrictive and/or different than contained in this standard. In such cases, the requirements of this specification shall control.
 - 3. ANSI/AISC 360, "Specification for Structural Steel Buildings."
 - 4. Research Council on Structural Connections (RCSC) "Specification for Structural Joints using High-Strength Bolts."
 - 5. AISC, "Steel Construction Manual", Thirteenth Edition.
 - 6. ANSI/AWS D1.1, "Structural Welding Code – Steel."
 - 7. The Society of Protective Coatings, "SSPC Painting Manual", Volumes 1 and 2.
- C. Qualifications for Welding Work: Qualify welding processes and welding operators in accordance with AWS "Structural Welding Code - Steel".
- D. Questions about Contract Documents: The Contractor shall promptly notify the Architect/Engineer whenever design of members and connections for any portion of the structure are not clearly indicated or when other questions exist about the Contract Documents. Such questions shall be resolved prior to the submission of shop drawings.
- E. Owner's Testing Laboratory Services: Inspection or testing by the Owner does not relieve the Contractor of his responsibility to perform the Work in accordance with the Contract Documents

1.05 SUBMITTALS

- A. Product Data: Submit producer's or manufacturer's specifications and installation instructions for following products; include laboratory test reports and other data to show compliance with specifications (including the specified standards):
 - 1. Structural steel (each type), including certified copies of mill reports covering chemical and physical properties. For structural steel for which evidence exists that the steel may not conform to ASTM requirements, the contractor, where permitted by the engineer, shall engage the services of an independent testing laboratory to test the material according to ASTM A 6 and submit certified test reports that verify conformity to ASTM standards. Tests shall be made for each 10 tons of affected material unless otherwise directed by the Engineer.
 - 2. High-strength bolts (each type), including nuts and washers, including certified copies of mill reports covering physical and chemical properties.
 - 3. Unfinished bolts and nuts.
 - 4. Welding electrodes (each type).
 - 5. Structural steel primer paint.
 - 6. Inorganic or other protective paint.
 - 7. Direct tension indicators.

- B. Shop Drawing and Erection Drawings:
1. All drawings submitted for review shall have the approved shop drawing stamp of the Design Team as part of the title block. The shop drawing stamp will be provided in electronic format to the successful bidder.
 2. Definitions:
 - a. Shop Drawings: Drawings of the individual structural steel shipping pieces that are to be produced in the fabrication shop.
 - b. Erection Drawings: Field-installation or member-placement drawings that are prepared by the Fabricator to show the location and attachment of the individual shipping pieces.
 3. Shop Drawings: Submit for review and approval shop drawings showing complete details and schedules for fabrication and assembly of structural steel members. The licensed professional engineer responsible for the design of any of the connections shown on the shop drawings shall submit a letter that is sealed attesting that the connection design engineer has reviewed the shop drawings and that the connections detailed and shown on the shop drawings conform to the engineer's design.
 4. Structural steel shop drawings shall include the following minimum information:
 - a. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols, and show size, length, and type of each weld. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify the type of high-strength bolted connection (slip-critical, direct-tension, or bearing connections). Holes, flange cuts, slots and openings shall be made as required by the structural drawings, all of which shall be properly located by means of templates.
 - b. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed by others.
 5. Erection Drawings: Submit for review and approval complete erection drawings showing field-installation and member-placing instructions for locating and attaching the individual shipping pieces.
 6. The fabricator alone shall be responsible for all errors of detailing, fabrication, and for the correct fitting of the structural members.
 7. All fabricated material and connections shall fit within architectural constraints.
 8. Structural steel members for which shop drawings have not been reviewed and approved shall not be fabricated.
 9. The omission from the shop drawings of any materials required by the Contract Documents shall not relieve the Contractor of the responsibility of furnishing and installing such materials, even though the shop drawings may have been reviewed and approved.
- C. Calculations: The fabricator's engineer shall submit complete signed and sealed design calculations showing all information as specified in the "Connections" section under Part 2. The Engineer reserves the right to reject all shop drawings submitted without complete design calculations.
- D. Test Reports: Submit certified reports of tests required by this Specification Section. Include data on type(s) of tests conducted and test results.
- E. Qualification Data:
1. Submit qualification data, including required certifications, for firms and persons specified in the "Qualifications" section under Part 1, to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
 2. Submit Welding Procedure Specifications (WPS) in accordance with ANSI/AWS D1.1 for all welded joints. Submit test reports showing successful passage of qualification tests for all non-qualified WPSs.

3. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests as specified in the "Qualifications" section under Part 1. If recertification of welders is required, retesting will be at Contractor's responsibility.
 4. A fabricator that is registered with the local building official and is approved to perform fabrication without special inspection shall submit a certificate of compliance stating that the work was performed in accordance with the approved construction documents.
- F. Substitutions:
1. Substitutions for the member sizes, type(s) of steel connection details or any other modifications proposed by the Contractor will be considered by the Architect/Engineer only under the following conditions:
 - a. That the request has been made and accepted prior to the submission of shop drawings. All substitutions shall be clearly marked and indicated on the shop drawings as a substitute.
 - b. That there is a substantial cost advantage or time advantage to the Owner; or that the proposed revision is necessary to obtain the required materials or methods at the proper times to accomplish the work in the time scheduled.
 - c. That sufficient sketches, engineering calculations, and other data have been submitted to facilitate checking by the Architect/Engineer, including cost reductions or savings in time to complete the work.
 - d. In no case shall such revisions result in additional cost to the Owner.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to site at such intervals to ensure uninterrupted progress of work.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration. Do not store materials on structure in a manner that might exceed allowable loads on or cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed by Architect/Engineer.
- C. Furnish all fuel, maintenance, and equipment required for hoisting and placement of materials under this contract.
- D. Process, pay for and maintain all permits and certificates of on-site inspection required for derricks, cranes and hoisting equipment. No derrick, crane or hoisting equipment shall be operated without a certificate of operation and a certificate of on-site inspection, as required by governing authorities.
 1. In addition to the above, all hoisting equipment shall be installed, operated and maintained in accordance with all applicable regulations of authorities having jurisdiction.
 2. The Contractor shall furnish street storage and sidewalk crossing permits.

1.07 JOB CONDITIONS

- A. The Contractor shall coordinate the fabrication and erection of all structural steel work with the work of other trades.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Structural Steel: All hot rolled steel plates, shapes, sheet piling, and bars shall be new steel conforming to ASTM A 6.
- B. Structural steel shall comply with the provisions of the following ASTM Specifications as appropriate for the grades and types, and at the locations as specified on the drawings:
 1. Structural Steel Wide Flange and WT Shapes: High Strength Steel, ASTM A 992. ASTM A 572, Grade 50 is acceptable as a substitute for A992.
 2. Angle Shapes: Carbon Steel, ASTM A 36 unless noted otherwise on the drawings.

3. Structural Steel Plates and Bars: Carbon Steel, ASTM A 36.
 4. Connection Material: All connection material except as noted otherwise on the drawings including bearing plates, gusset plates, stiffener plates, filler plates, angles, etc. shall be A36 steel unless a higher or matching grade of steel with the members connected is required by strength or stiffness calculations and provided the resulting sizes are compatible with the members connected.
- C. Structural Bolts and Threaded Fasteners: Structural bolts and threaded fasteners shall comply with the following ASTM Specifications as appropriate for the types and at the locations as specified on the drawings:
1. ASTM A 325 Type 1.
 2. Bolts and Nuts, High Strength Bolts: Bolts and nuts for all high strength bolts shall be heavy hex head conforming to ANSI Standards B18.2.1 and B18.2.2 respectively. Nuts shall conform to ASTM A 563.
 3. Washers: All washers shall be circular, flat and smooth and shall conform to the requirements of Type A washers in ANSI Standard B23.1. Washers for high strength bolts shall be hardened and conform to ASTM F 436.
 4. Zinc-Coated Bolts: ASTM A 325 bolts, with their nuts and washers, that are used to connect steel called for on the drawings or in the specifications as hot-dip galvanized after fabrication shall be zinc-coated either by the hot-dip process in accordance with ASTM A 153, Class C or by the mechanical deposition process in accordance with ASTM B 695, Class 50, Type 1. The bolts, nuts, and washers shall all be zinc-coated using the same process and they shall be considered together as an assembly and shall be tested and shipped together as such. Comply with all the requirements of ASTM A 325 and ASTM A 563 as they relate to zinc-coated materials. ASTM F 1852 bolts with their nuts, and washers shall be zinc-coated only by the mechanical deposition process in accordance with ASTM B 695, Class 50, Type 1. Do not zinc-coat ASTM A 490 bolts.
 5. Bolt Lubrication: All bolts shall be well lubricated at time of installation. Dry, rusty bolts will not be allowed.
 6. New Bolts: All bolts shall be new and shall not be reused.
- D. Electrodes for Welding:
1. Provide electrodes that comply with AWS D1.1, "Structural Welding Code - Steel" and that can produce welds that have a minimum Charpy V-notch toughness of 20 ft-lbs at 40° F, unless noted otherwise in these specifications or on the drawings.
 2. Electrodes for various welding processes shall be as specified below:
 - a. SMAW:
 - (1) E70XX low hydrogen
 - b. SAW:
 - (1) F7X-EXXX
 - c. GMAW:
 - (1) ER70S-X
 - d. FCAW:
 - (1) E7XT-X
- E. Structural Steel Primer Paint:
1. Unless noted otherwise, primer paint shall be one of the following types with the indicated surface preparation:
 - a. SSPC-Paint 25.1, Type II; zinc oxide, raw linseed oil and alkyd primer, surface prepared according to SSPC-SP-2 (Hand Tool Cleaning) unless noted otherwise in this specification.
 - b. Fast-curing, lead- and chromate-free, universal modified-alkyd primer with good resistance to normal atmospheric corrosion, complying with performance requirements of FS TT-P-664, surface prepared according to SSPC-SP-2 (Hand Tool Cleaning) unless noted otherwise in this

- specification. The contractor is responsible for supplying a paint that complies with the VOC requirements of all local governing agencies.
- c. SSPC-Paint 23 acrylic primer, surface prepared according to SSPC-SP-6 (Commercial Blast Cleaning).
 - d. Hydrophobic Acrylic Polymer with dry film thickness of not less than 2.0 mils: Tnemec Series 30, Spra-Saf EN or Sherwin Williams, Spraylastic Exterior Waterborn Dryfall (SSPC-SP6 Commercial Blast Cleaning).
2. Refer to Architect's drawings and specifications for final paint finish requirements of structural steel. Primer paint shall be compatible with final paint requirements.

2.02 FABRICATION

- A. Shop Fabrication and Assembly:
 1. Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specification and as indicated on approved final shop drawings. Provide camber in structural members where indicated. Fabricator shall coordinate connection details, joint fit-up procedures, and field adjustment requirements with erector. The General Contractor shall coordinate provision of all erection bolts, lifting lugs or other devices required for erection with the fabricator and the erector and for interference with architectural finishes and constraints.
 2. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.
 3. Clearly mark the grade of steel on each piece, distinguishable in the field from floor surfaces, for purpose of field inspection and confirmation of grade of steel.
 4. Milled surfaces of built-up sections shall be completely assembled or welded before milling.
 5. Fitted stiffeners shall be fabricated neatly between flanges, and the ends of stiffeners shall be milled or ground to secure an even bearing against abutting surfaces. All milled or ground joints shall bear throughout their contact length.
- B. Dimensional Tolerances: Dimensional tolerances of fabricated structural steel shall conform to Section 6.4 of the AISC Code of Standard Practice.
- C. Splices in Structural Steel: Splicing of structural steel members in the shop or the field is prohibited without prior approval of the Engineer. Any member having a splice not shown and detailed on approved shop drawings will be rejected.
- D. Cutting: Manual oxygen cutting shall be done only with a mechanically guided torch. An unguided torch may be used provided the cut is not within 1/8 inch of the finished dimension and final removal is completed by means such as chipping or grinding to produce a smooth surface quality free of notches or jagged edges. All corners shall be smooth and rounded to a minimum 1/2" radius.
- E. Holes for Other Work: Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members as shown on the contract documents, and/or the final shop drawings.
 1. Provide specialty items as indicated to receive other work.
 2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.
- F. Lifting and Erection Devices: The fabricator shall be responsible for designing, detailing and furnishing all lifting devices and erection aids required for erection. Such devices shall be removed after erection if they interfere with architectural finish requirements.

2.03 WELDING

- A. Code: All shop and field welding shall conform to all requirements in the "Structural Welding Code - Steel", ANSI/AWS D1.1, as published by the American Welding Society (AWS).

- B. Welder Certification: All shop and field welders shall be certified according to all the applicable AWS procedures for the welding process and welding position used. Each welder shall be assigned an identifying symbol or mark and all shop and field welded connections containing complete or partial joint penetration welds, multi-pass fillet welds, and fillet welds greater than 5/16" shall be identified by the symbol or mark of the welder responsible for the connection.
- C. Minimum Size and Strength:
 - 1. Fillet Welds: Minimum size of fillet welds shall be as specified in Table J2.4 in AISC Specification, Chapter J.
- D. Welding Procedure Specification: All welding shall be performed in accordance with a Welding Procedure Specification (WPS) as required in AWS D1.1 and approved by the Owner's Testing Laboratory and the Architect/Engineer. The WPS variables shall be within the parameters established by the filler-metal manufacturer. Engage the services of an independent testing laboratory to provide the qualification testing required by AWS D 1.1, Chapter 4, part B to qualify any non-prequalified WPS needed for the project. The testing laboratory shall prepare Welding Procedure Qualification Records (WPQR) documenting the successful qualification of each Welding Procedure Specification.
- E. Welding Procedures:
 - 1. All welding processes shall comply with the requirements of ANSI/AWS D1.1 unless noted otherwise.
 - 2. Welds not specified shall, if possible, be continuous fillet welds developing the minimum strength, as specified above, using not less than the minimum fillet welds as specified by AISC.
 - 3. The toughness and notch sensitivity of the steel shall be considered in the formation of all welding procedures to prevent brittle and premature fracture during fabrication and erection.
 - 4. Before welding, particular attention shall be paid to surface preparation, fit up and cleanliness of surfaces to be welded.
 - 5. Minimum preheat and interpass temperatures for structural steel welding shall be as specified in ANSI/AWS D1.1, except that no welding shall be performed when the ambient temperature is lower than 0 degrees F. The temperature shall be measured from the side opposite that upon which the preheat is applied.
 - 6. The heat, input, length of weld and sequence of weld shall be controlled to prevent distortions. The surfaces to be welded and the filler metals to be used shall be subject to inspection before any welding is performed.
 - 7. Welds shall be sound throughout. There shall be no crack in any weld or weld pass. Welds shall be considered sound if they conform to AWS requirements, as confirmed by non-destructive testing.
 - 8. Welds shall be free from overlap.
 - 9. Craters shall be filled to the full cross section of the welds.
 - 10. For high-strength low-alloy steels, follow welding procedures as recommended by steel producer for exposed and concealed connections.
 - 11. Fabricator and erector shall coordinate welding responsibility at all welded joints.

2.04 BOLTING

- A. Bolt Diameter: Minimum bolt diameter shall be 3/4 inch. The difference in diameter between bolts of differing sizes used on the project shall be not less than 1/4".
- B. Connection Type: Unless noted otherwise on the drawings, all bolted connections shall be snug-tightened using high-strength bolts in standard holes (hole diameter nominally 1/16 inch greater than the nominal bolt diameter) with threads included in the shear planes. Notwithstanding, the contractor shall be responsible to adhere to provisions of AISC Specification Section J1.10, which lists circumstances under which certain connections require pretensioned high strength bolts.

- C. Oversize, Short Slotted and Long Slotted Holes: The dimensions and washer requirements of oversize, short slotted, and long slotted holes shall conform to the AISC "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Fastener Tension: High strength bolts in snug-tightened joints shall be tightened to a snug tight condition only. The snug-tightened condition is defined as the tightness that exists when all plies are in firm contact. This may usually be attained by a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench.
- E. Washers: Washers under the bolt head and/or nut shall be used as required by the AISC "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- F. Bolt Lubrication: All bolts shall be well lubricated at time of installation. Dry, rusty bolts will not be allowed.
- G. Impact Wrenches: Properly sized and lubricated air impact wrenches with adequate air pressure shall be utilized for all bolt installation.
- H. New Bolts: All bolts shall be new and shall not be reused.

2.05 CONNECTIONS

- A. Conceptual connection details with the required member design forces are shown on the drawings for bidding purposes and are applicable to all connections not designed and completely detailed on the drawings. The conceptual details are provided only to indicate the connection type required and may not fully represent the complexity of the connection as required by the final connection design for the forces they must resist. Except as noted below, the fabricator is responsible for engaging the services of a connection specialty engineer to prepare a final connection design for submission that meets the requirements of the conceptual connection details and resists the indicated design forces. Refer to the drawings and specifications for complete requirements.
- B. Typical Connection details are indicated on the drawings.
- C. Design and Detailing Procedure:
 - 1. Unless noted otherwise or specifically detailed on the drawings, end connections of beams, girders, and trusses shall be designed as flexible and the connection shall accommodate end rotations of the unrestrained beams. Restrained end connections, as indicated on the drawings, shall be designed for the combined effect of bending moment and shears induced by the rigidity of the connection. Forces to be used in the design are described below.
 - 2. The fabricator's licensed professional engineer shall design and submit sealed calculations documenting the design and showing details of the assembled joint with the bolts and welds required for the conditions noted below:
 - a. For each connection not otherwise completely detailed on the drawings
 - b. Where connections are encountered on the project that does not match those assumed in the AISC Manual or other similar publication.
 - 3. Where connections are of the type than can be selected or completed using information found in tables in the AISC "Steel Construction Manual" or related publications, sealed calculations need not be submitted provided the project design conditions precisely match those assumed in the referenced publications. For conditions encountered on the project that do not conform to the AISC Manual or other similar publication, a complete design shall be prepared and submitted for engineer's review.
 - 4. The fabricator's licensed professional engineer shall seal all design calculations.
 - 5. The Engineer reserves the right to reject all shop drawings submitted without complete design calculations if required. Failure to adhere to the requirements of this section obligates the Contractor to take responsibility for any and all resulting delays in the detailing and fabrication of structural steel.

- D. Design Intent: It is the intention of the plans and specifications that shop connections be welded or bolted and that field connections be bolted, unless detailed otherwise on the drawings.
- E. Flexible (Simple) Beam Connections:
 - 1. All typical beam simple connections shall conform to requirements of the AISC specifications. Refer to the drawings for typical connection types.
 - 2. Simple Beam Connection Capacity: Support a factored load reaction R equal to the reaction shown on the plans. Contact the Engineer if no reaction for a beam is shown on the plan. Each connection shall contain not less than the minimum number of bolts shown in the AISC connection tables for each beam size.
- F. Limitations on Use of A307 Bolts: ASTM A 307 bolts shall not be used in any permanent steel-to-steel or concrete-to-steel connection.
- G. Bolts in Combination with Welds: Bolts shall not be considered as sharing the load in combination with welds, except as allowed in AISC Specification Section J1.8.

2.06 SURFACE PREPARATION AND SHOP PRIME PAINTING

- A. Specification: Surface preparation, paint, and painting practices shall conform to the "SSPC Painting Manual", Volumes 1 and 2.
- B. Scope: All steel shall remain unpainted, except the following:
 - 1. Coordinate all shop painting of structural steel with Architect's painting requirements as specified on the architectural drawings and in the specifications. The Fabricator shall be responsible for determining all painting requirements (which surfaces are to be painted or left unpainted) on the project prior to fabrication.
- C. Surface Preparation and Primer Paint - Shop Painted Steel:
 - 1. Surface Preparation: Prepare the surface of all structural steel specified to be shop painted as required by the paint manufacturer or the Society for Protective Coatings specifications, but not less than the following:
 - a. SSPC-SP 2, "Hand Tool Cleaning" or SSPC-SP 3, "Power Tool Cleaning" unless otherwise specified.
 - b. SSPC-SP 6, "Commercial Blast Cleaning" shall be applied to the faying surfaces (including filler and member-end supplement plates, if any) of connections that are noted on the drawings as requiring a slip-critical coating. At a minimum, apply this surface preparation to the area between and surrounding all bolt holes including the area up to 2" outside the outer-most holes.
 - 2. Priming: Immediately after surface preparation, apply primer to all structural steel specified to be shop primed in strict accordance with manufacturer's instructions and the Society for Protective Coatings specifications. Apply paint at a rate to conform to the manufacturer's written instructions and to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, welds, and all exposed surfaces. Apply two coats to surfaces that are inaccessible after assembly or erection. Change the color of the second coat to distinguish it from the first coat.
 - 3. Finish Coat: Coordinate shop primer paint requirements with architectural drawings and specifications. The primer selected must be compatible with any specified finish coat.

PART 3 - EXECUTION

3.01 ERECTION

- A. The Erection work shall comply with the requirements of AISC Specification Section M4.
- B. Inspection: Erector shall examine areas and conditions under which structural steel work is to be installed and notify the Contractor and the Architect/Engineer in writing of conditions detrimental to proper and timely completion of the work.

- C. Wherever the erection equipment is supported by the structure, the Contractor shall be responsible for the retention of a licensed professional engineer to determine the adequacy of the member supporting the erection equipment in relation to the loads imposed thereon. The Contractor shall submit to the Architect/Engineer, for review, the loads that will be imposed by the erection equipment on the building structure. Where the imposed load exceeds the allowable strength, the Contractor shall be responsible for any additional materials, supports, bracing, connections and similar measures required to support the imposed load of the equipment while in use, subject to review by the Architect/Engineer.
- D. Splices: Splices will be permitted only where indicated on the contract drawings and approved shop drawings. Fastenings of splices of compression members shall be done after the abutting surfaces have been brought completely into contact within AISC tolerances. Bearing surfaces and surfaces that will be in permanent contact are to be cleaned before the members are assembled.
- E. Field Assembly of Structural Steel:
1. As erection of the steel progresses, the work shall be fastened securely to safely carry all dead load, wind and erection forces.
 2. Provide temporary planking and working platforms as necessary to effectively complete work.
 3. Set structural frames accurately to lines and elevations indicated. Align and adjust various members forming part of complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces which will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment. Level and plumb individual members of structure within specified AISC tolerances. The Contractor shall coordinate with Erector and Fabricator regarding possible discrepancies in member lengths between temperature at time of fabrication and temperatures during erection, and shall make necessary adjustments to ensure plumbness within AISC tolerances at 70°F. Compensate for cumulative welding draw, construction loadings, sequential applications of dead loads, or any other predictable conditions that could cause distortions to exceed tolerance limitations.
 4. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces receiving field welds.
 5. Comply with all bolting and welding requirements of Part 2 of this specification section.
- F. Field Modifications to Structural Steel: Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and structural fitting of parts shall be reported immediately to the Architect/Engineer, and approval of the method of correction shall be obtained. Approved corrections shall be made at no additional cost to the Owner. Do not use cutting torches, reamers, or other devices in the field for unauthorized correction of fabrication errors.
- G. Miscellaneous Framing: Provide supplemental structural steel support framing for steel deck where columns, or other framing members or floor openings interrupt normal deck bearing whether shown or not on the architectural, mechanical, or structural drawings.
- H. Removal of Erection Aids and Devices: The erector shall remove all erection aids and devices that interfere with architectural finish or MEP requirements.
- I. Field Touch-Up Painting:
1. Clean field welds, unpainted areas of bolted connections (including all exposed areas of nuts, bolts, washers, filler plates, member end supplement plates, and welds), and any shop painted areas that are abraded. Apply paint to all exposed areas using same material and surface preparation as used for shop painting. Apply by brush or spray to provide minimum dry film thickness of 1.5 mils.

2. Clean field welds, ungalvanized areas of bolted connections (including all exposed areas of nuts, bolts, washers, filler plates, member end supplement plates, and welds), and any galvanized areas that are abraded. Prepare surfaces and apply specified galvanizing repair paint in accordance with ASTM A 780.
 3. The Contractor shall ensure that, at the substantial completion of the project, all structural steel, bolted and/or welded, required to be painted shall have all necessary steel surfaces painted (including touch-up painting as required) to prevent corrosion bleeding.
- J. Clean Up: Clean up all debris caused by the Work of this Section, keeping the premises neat and clean at all times.

3.02 QUALITY ASSURANCE TESTING AND INSPECTION DURING CONSTRUCTION

- A. See Testing Laboratory Services section of these Specifications for structural steel materials and welding and bolting inspection and test requirements.

END OF SECTION

SECTION 05 31 13
STEEL FLOOR DECKING

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 work of this section.

1.02 SCOPE OF WORK

- A. Supplier: The steel deck supplier shall furnish all steel deck materials and accessories indicated on the Architectural, Structural, and Mechanical Drawings required to produce a complete job including but not necessarily limited to deck units, cover plates, pour stops, hanger slots or clips, steel deck edge closures, cell closures, and all related accessories.
- B. Erector: The Subcontractor responsible for erecting the steel deck shall provide all labor and equipment as required to place all steel deck components and accessories as described above.

1.03 QUALIFICATIONS

- A. The steel deck supplier shall be a manufacturer with a minimum of two years successful experience and with a minimum of two successful jobs of a comparable size and scope to this project.

1.04 QUALITY ASSURANCE

- A. The Contractor is responsible for quality control, including workmanship and materials furnished by his subcontractors and suppliers.
- B. Codes and Standards: Comply with provisions of the following codes and standards except as otherwise indicated or specified:
 - 1. SDI, "Design Manual for Composite Decks, Form Decks, and Roof Decks."
 - 2. AISI, "Specification for the Design of Cold Formed Steel Structural Members."
 - 3. AWS D1.3, "Structural Welding Code – Sheet Steel."
- C. Qualification of Field Welding: Qualify welding processes and welding operators in accordance with AWS procedures.
- D. Underwriters Label: Provide steel deck units which are listed and conform to Underwriters Laboratories "Fire Resistance Directory", with each deck unit bearing the UL label and marking for specific system detailed.

1.05 SUBMITTALS

- A. Product Certification: Submit manufacturer's specifications and installation instructions for each type of deck specified. Also submit a certificate of product compliance with SDI Standards as specified.
- B. Shop Drawings: Submit detailed shop drawings showing type of deck, complete layout, attachment details, closures, edge strips, pans, deck openings, special jointing, supplementary framing, and all other accessories.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. See the drawings for location of steel deck types and for depth of deck, design deck properties, design deck yield strength, concrete type, total slab thickness, slab reinforcing, and design superimposed loads. The average rib width to depth of deck ratio shall be greater than or equal to 2.0. The deck properties specified are the values used for the design of the deck shown on the drawings. Provide deck with the depth as noted and other properties equal to or greater than the values stated on the drawings except that a deck with properties less than those stated, other than depth, may be used provided that the deck manufacturer take responsibility for the design of the deck. The

design shall include the ability to carry the construction dead loads and design superimposed loads indicated for all the spans shown on the drawings and to meet all performance criteria as specified by the SDI. Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck".

- B. Acceptable manufacturers include the following
1. ASC Steel Deck.
 2. Canam Steel Corp.
 3. Consolidated Systems, Inc.
 4. Cordeck.
 5. DACS, Inc.
 6. Marlyn Steel Decks, Inc.
 7. New Millennium Building Systems, Inc.
 8. Roof Deck, Inc.
 9. United Steel Deck, Inc.
 10. Valley Joist, Inc.
 11. Verco Manufacturing Co.
 12. Vulcraft/Div. Nucor Corp.
 13. Wheeling Corrugating Co.
 14. Other manufacturers may be used only with Architect/Engineer approval.

2.02 GRADE OF STEEL

- A. Composite steel deck shall be cold formed from steel sheets conforming to ASTM A611 Grade C or D or ASTM A653, Structural Steel Grade, with a minimum yield strength as stated on the drawings but not less than 40 ksi. The delivered thickness of the uncoated steel shall not be less than 95% of design thickness. Sheet metal accessories shall conform to the same material specification as the deck product.

2.03 FINISH

- A. Galvanized: Composite steel deck shall be galvanized with a protective zinc coating conforming to ASTM A563 G60.
- B. Galvanizing Repair Paint: High zinc-dust content paint for repair of damaged galvanized surfaces complying with Department of Defense Specifications DOD-P-21035.

2.04 FABRICATION

- A. Steel deck Spans: The deck properties shown on the drawings are selected so that the spans do not exceed the maximum clear spans with unshored construction as required by SDI criteria unless indicated otherwise on the drawings. The deck manufacturer shall be responsible for supplying a deck that meets that criterion. Where possible, all steel deck shall extend over three or more spans. Simple span deck will not be permitted unless it is shored at midspan. Any additional concrete topping specified over the composite slab shall be placed after the slab has reached 75% of its design strength.
- B. Cell Closure at Ends of Steel deck Flutes: Fabricate metal closure strips of not less than 0.0358" minimum (20 gage) cold formed sheet steel. Form to provide tight fitting cell closures at open ends of cells or flutes to prevent wet concrete from leaking through open cells.
- C. Pour Stop Closures at Slab Edges: Provide sheet metal pour stop closures at all slab edges, columns, walls, and openings unless steel angles or bent plates are specified in details on the drawings. The closures shall be fabricated from light gage steel not less than the thickness shown in the table below when the slab edge is parallel to the deck span. Provide a return lip on the vertical leg in accordance with the SDI Design Manual. The overhang dimension is measured from the edge of the flange to the edge of the slab.

Overhang Slab Thickness	=	0"-2"	2"-4"	4"-6"	6"-8"	8"-10"
5.25		18	16	14	12	10
6.25		16	14	12	12	10
6.5		16	14	12	12	10
8.0		12	12	10	10	NA

2.05 COMPOSITE SLAB REINFORCEMENT

- A. See drawings for reinforcement in composite slabs.

2.06 OPENINGS IN STEEL DECK

- A. For unframed openings, provide block out in slab for opening with deck uncut. Cut deck at opening after concrete has reached 75% of its design strength. See Section 033000, "Cast-in-Place Concrete", for reinforcing in the slab around all unframed openings in steel deck that are greater than 10" in width in either direction.

2.07 CHLORIDE ADMIXTURES

- A. The use of admixtures in concrete containing chloride salts shall not be permitted for steel deck concrete.

2.08 EXTRA CONCRETE REQUIRED BY DECK DEFLECTION

- A. The General Contractor shall include in his bid additional concrete required for steel deck slabs to account for deck deflection.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General: Install deck units as accessories in accordance with manufacturers recommendations and approved shop drawings, and as specified herein:
1. Place deck units on supporting framework and adjust to final position with ends accurately aligned and bearing 1 1/2" minimum on supporting members before being permanently fastened. Do not stretch or contract side lap interlocks.
 2. Place deck units in straight alignment for entire length of run of cells and with close alignment between cells at ends of abutting units.
 3. Place deck units flat and square, secured to adjacent framing without warp or excessive deflection.
 4. Do not place deck units on concrete supporting structure until concrete has cured and is dry.
 5. Coordinate and cooperate with structural steel erector in locating decking bundles to prevent overloading of structural members.
 6. Typical Welding of Deck: Steel deck units shall be welded to the structural support members with 5/8" diameter puddle welds at each end of sheet and each intermediate support at each low flute, unless more frequent attachment is specified on the drawings. Where two deck units abut each other, each unit shall be so welded. Puddle welds may be replaced with welded shear studs when applicable. The Contractor is responsible for temporary deck fastening to meet OSHA requirements to use the floor deck unit as a storage or working platform before final attachment is installed.
 7. Side Laps: Unless noted otherwise on the drawings, side laps of adjacent units shall be fastened by welding (1-1/2 inch long), sheet metal screws (No. 10 or larger) or button punching at maximum intervals not exceeding the lesser of 1/2 of the span or 36".
 8. Welding to Girder: Steel deck units shall be welded to girders (steel framing that is parallel to span of deck) with 5/8" ø puddle welds at 12" o.c. If the steel deck is not continuous across the girder, the deck on each side of the girder shall each be welded to the girder with 5/8" ø puddle welds at 12" o.c.

9. Welding Washers: Welding washers shall be used when welding steel deck units less than 0.028" thickness.
 10. Minimum Bearing: Provide a minimum deck bearing of 1 1/2" over all supports with butted end joints.
- B. Welding Requirements: Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work.
 - C. Cutting and Fitting: Cut and neatly fit deck units and accessories around other work projecting through or adjacent to the decking.
 - D. Reinforcement at Openings: Provide additional metal reinforcement and closure pieces as required for strength, continuity of decking, and support of other work.
 - E. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated. Provide minimum 2" bearing over steel support.

3.02 TOUCH-UP PAINTING

- A. After deck installation, wire brush, clean and paint scarred areas, welds and rust spots on top and bottom surfaces of decking units and supporting steel members.
- B. Touch-up galvanized surfaces with galvanizing repair paint applied in accordance with manufacturer's instructions.

3.03 QUALITY ASSURANCE INSPECTION DURING CONSTRUCTION

- A. The method of attaching the deck to the frame is subject to inspection by the Owner's designated Testing Laboratory. The Contractor shall, at its own expense, remove work found to be defective and replace with new acceptable work.
- B. See Testing Laboratory Services of these Specifications for deck attachment inspection requirements.

END OF SECTION

SECTION 07 81 00
APPLIED FIREPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fireproofing of interior structural steel not exposed to damage or moisture.
- B. Fireproofing of structural steel exposed to damage or moisture.

1.02 RELATED REQUIREMENTS

- A. Section 05 12 00 - Structural Steel.
- B. Section 05 31 00 - Steel Decking.
- C. Section 07 84 00 - Firestopping.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- B. ASTM E605 - Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members; 1993 (Reapproved 2011).
- C. ASTM E736 - Standard Test Method For Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members; 2000 (Reapproved 2011).
- D. ASTM E760 - Standard Test Method for Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members; 1992 (Reapproved 2011).
- E. ASTM E761 - Standard Test Method for Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members; 1992 (Reapproved 2011).
- F. ASTM E859 - Standard Test Method for Air Erosion of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members; 1993 (Reapproved 2011).
- G. ASTM E937 - Standard Test Method for Corrosion of Steel by Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members; 1993 (Reapproved 2011).
- H. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with placement of ceiling hanger tabs, mechanical component hangers, and electrical components.

1.05 PERFORMANCE REQUIREMENTS

- A. Sprayed-On Fireproofing System: Provide a fire rated assembly rating of one hour for roof assembly to UL Design No. P732.
- B. Sprayed-On Fireproofing Systems: Provide UL fire-rated assemblies to hourly ratings as follows:
 - 1. Interior columns: 2 hours.
 - 2. Interior girders: 2 hours.
 - 3. Interior joists: 2 hours.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
- B. Product Data: Provide data indicating product characteristics.
- C. Test Reports: Reports from reputable independent testing agencies for proposed products, indicating compliance with specified criteria, conducted under conditions similar to those on project, for:
 - 1. Bond Strength.
 - 2. Bond Impact.

3. Compressive Strength.
4. Fire tests using substrate materials similar those on project.

D. Manufacturer's Installation Instructions: Indicate special procedures.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, and:
 1. Having minimum five years of experience.

1.08 REGULATORY REQUIREMENTS

- A. Conform to applicable code for fire resistance ratings.
- B. Provide certificate of compliance for fireproofing materials to authority having jurisdiction, indicating approval for use on this project.

1.09 FIELD CONDITIONS

- A. Do not apply spray fireproofing when temperature of substrate material and surrounding air is below 40 degrees F or when temperature is predicted to be below said temperature for 24 hours after application.
- B. Provide ventilation in areas to receive fireproofing during application and 24 hours afterward, to dry applied material.
- C. Provide temporary enclosure to prevent spray from contaminating air.

1.10 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
 1. Include coverage for fireproofing to remain free from cracking, checking, dusting, flaking, spalling, separation, and blistering.
 2. Reinstall or repair failures that occur within warranty period.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sprayed-On Fireproofing:
 1. Grace Construction Products; _____: www.na.graceconstruction.com.
 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS

- A. Sprayed Fire-Resistive Material for Interior Applications, Concealed: Manufacturer's standard factory mixed material, which when combined with water is capable of providing the indicated fire resistance, and conforming to the following requirements:
 1. Bond Strength: 150 pounds per square foot, minimum, when tested in accordance with ASTM E736 when set and dry.
 2. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760.
 3. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E937.
 4. Surface Burning Characteristics: Maximum flame spread index of 0 (zero) and maximum smoke developed index of 0 (zero), when tested in accordance with ASTM E84.
- B. Sprayed Fire-Resistive Material: Manufacturer's standard factory mixed material, which when combined with water is capable of providing the indicated fire resistance, and conforming to the following requirements:
 1. Composition: Portland cement-based; not mineral fiber-based.
 2. Bond Strength: 1000 pounds per square foot, minimum, when tested in accordance with ASTM E736 when set and dry.

3. Dry Density: 21 lb/cu ft, minimum, when tested in accordance with ASTM E605.
4. Compressive Strength: 100 pounds per square inch, minimum.
5. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760.
6. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E937.
7. Air Erosion Resistance: Weight loss of 0.025 g/sq ft, maximum, when tested in accordance with ASTM E859 after 24 hours.
8. Surface Burning Characteristics: Maximum flame spread index of 0 (zero) and maximum smoke developed index of 0 (zero), when tested in accordance with ASTM E84.
9. Products:
 - a. Grace Construction Products; Monokote Z-106/HY: www.na.graceconstruction.com.

2.03 ACCESSORIES

- A. Primer Adhesive: Of type recommended by fireproofing manufacturer.
- B. Overcoat: As recommended by manufacturer of fireproofing material.
- C. Water: Clean, potable.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive fireproofing.
- B. Verify that clips, hangers, supports, sleeves, and other items required to penetrate fireproofing are in place.
- C. Verify that ducts, piping, equipment, or other items that would interfere with application of fireproofing have not been installed.
- D. Verify that voids and cracks in substrate have been filled. Verify that projections have been removed where fireproofing will be exposed to view as a finish material.

3.02 PREPARATION

- A. Perform tests as recommended by fireproofing manufacturer in situations where adhesion of fireproofing to substrate is in question.
- B. Remove incompatible materials that could affect bond by scraping, brushing, scrubbing, or sandblasting.
- C. Prepare substrates to receive fireproofing in strict accordance with instructions of fireproofing manufacturer.
- D. Protect surfaces not scheduled for fireproofing and equipment from damage by overspray, fall-out, and dusting.
- E. Close off and seal duct work in areas where fireproofing is being applied.

3.03 APPLICATION

- A. Apply primer adhesive in accordance with manufacturer's instructions.
- B. Apply fireproofing in thickness and density necessary to achieve required ratings, with uniform density and texture.
- C. Apply overcoat at the rate recommended by fireproofing manufacturer.

3.04 FIELD QUALITY CONTROL

- A. Inspect the installed fireproofing after application and curing for integrity, prior to its concealment. Ensure that actual thicknesses, densities, and bond strengths meet requirements for specified ratings and requirements of the Authority Having Jurisdiction.
- B. Re-inspect the installed fireproofing for integrity of fire protection, after installation of subsequent Work.

3.05 CLEANING

- A. Remove excess material, overspray, droppings, and debris.
- B. Remove fireproofing from materials and surfaces not required to be fireproofed.

END OF SECTION

SECTION 07 84 00
FIRESTOPPING

PART 2 PRODUCTS

1.01 FIRESTOPPING - GENERAL REQUIREMENTS

- A. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

1.02 FIRESTOPPING SYSTEMS

- A. Firestopping at Control Joints (without Penetrations): Any material meeting requirements.
 - 1. Between top of fire rated walls and bottom of slab above: UL Design No. _____, F Rating 1-1/2 hour.

END OF SECTION

SECTION 07 95 13
EXPANSION JOINT COVER ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Expansion joint cover assemblies for floor, wall, and ceiling surfaces.

1.02 REFERENCE STANDARDS

- A. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2014.
- B. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; 2013.
- C. ASTM B308/B308M - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles; 2010.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Installation Templates: For frames and anchors to be embedded in concrete or masonry, furnish templates to relevant installers; include installation instructions and tolerances.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide joint assembly profiles, profile dimensions, anchorage devices and available colors and finish.
- C. Manufacturer's Installation Instructions: Indicate rough-in sizes and required tolerances for item placement.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Expansion Joint Cover Assemblies:
 - 1. Architectural Art Mfg., Inc; _____: www.archart.com.
 - 2. Construction Specialties, Inc: www.c-sgroup.com.
 - 3. Inpro: www.inprocorp.com.
 - 4. MM Systems Corp: www.mmsystemscorp.com.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 EXPANSION JOINT COVER ASSEMBLY APPLICATIONS

- A. Interior Floor Joints Subject to Seismic Movement:
 - 1. Products:
 - a. Inpro; 316 Series (flush, minimal single sightline): www.inprocorp.com.
- B. Interior Wall/Ceiling Joints Subject to Thermal Movement:
 - 1. Products:
 - a. Inpro; 113 Series (for gwb, resilient seal): www.inprocorp.com.

2.03 EXPANSION JOINT COVER ASSEMBLIES

- A. Expansion Joint Cover Assemblies - General: Factory-fabricated and assembled; designed to completely fill joint openings, sealed to prevent passage of air, dust, water, smoke; suitable for traffic expected.
 - 1. Joint Dimensions and Configurations: As indicated on drawings.
 - 2. Joint Cover Sizes: Selected to suit joint width and configuration, based on manufacturer's published recommendations and limitations.
 - 3. Lengths: Provide covers in full lengths required; avoid splicing wherever possible.
 - 4. Anchors, Fasteners, and Fittings: Provided by cover manufacturer.
- B. Floor Joint Covers: Coordinate with indicated floor coverings.

2.04 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper; or ASTM B308/B308M, 6061 alloy, T6 temper.
 - 1. Exposed Finish Outdoors: Natural anodized.
- B. Backing Paint for Aluminum Components in Contact with Cementitious Materials: Asphaltic type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joint preparation and dimensions are acceptable and in accordance with manufacturer's requirements.

3.02 INSTALLATION

- A. Install components and accessories in accordance with manufacturer's instructions.
- B. Align work plumb and level, flush with adjacent surfaces.
- C. Rigidly anchor to substrate to prevent misalignment.

END OF SECTION

SECTION 08 11 16
ALUMINUM DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aluminum door frames for doors specified in other section(s).

1.02 RELATED REQUIREMENTS

- A. Section 08 14 16 - Flush Wood Doors: Wood doors to be installed in aluminum frames specified in this section.
- B. Section 08 71 00 - Door Hardware: Hardware for aluminum doors.

1.03 REFERENCE STANDARDS

- A. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document); 2015.
- B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2012.
- C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- D. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- E. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2014.
- F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2014.
- G. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; 2013.
- H. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association; 2012.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's descriptive literature for each type of door; include information on fabrication methods.
- C. Shop Drawings: Include elevations of each opening type.
- D. Verification Samples: Actual pieces of products in each finish specified, not less than 6 inches square or 6 inches long for linear components. For finishes subject to color variation, include not less than two samples illustrating extreme range to be anticipated.
- E. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Not less than 5 years of experience in manufacturing components of the types specified.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver aluminum components in manufacturer's standard protective packaging, palletted, crated, or banded together.
- B. Inspect delivered components for damage and replace. Repaired components will not be accepted.
- C. Store components under cover in manufacturer's packaging until installation.

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide ten year manufacturer warranty for defects in workmanship and materials.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Aluminum Door Frames for Doors of Another Material:
 - 1. Wilson Partitions: www.wilsonpart.com.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COMPONENTS

- A. Frames: Extruded aluminum shapes, not less than 0.062 inch thick, reinforced at hinge and strike locations.
 - 1. Corner Brackets: Extruded aluminum, fastened with stainless steel screws.
 - 2. Trim: Extruded aluminum, not less than 0.062 inch thick, removable snap-in type without exposed fasteners.

2.03 MATERIALS

- A. Aluminum Sheet: ASTM B209 (ASTM B209M), alloy 5005-H14, stretcher leveled.
- B. Extruded Aluminum: ASTM B221 (ASTM B221M), alloy 6063-T5 or alloy 6463-T5.
- C. Natural Anodized Finish: Clear anodic coating; AAMA 611 AA-M12C22A31 Class II, minimum thickness 0.4 mil.

2.04 ACCESSORIES

- A. Fasteners: Aluminum, non-magnetic stainless steel, or other material warranted by manufacturer as non-corrosive and compatible with aluminum components.
- B. Brackets and Reinforcements: Manufacturer's high-strength aluminum units where feasible, otherwise, non-magnetic stainless steel or steel hot-dip galvanized in compliance with ASTM A123/A123M.
- C. Bituminous Coating: Cold-applied asphaltic mastic, compounded for 30-mil thickness per coat.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that wall surfaces and openings are ready to receive frames and are within tolerances specified in manufacturer's instructions.

3.02 PREPARATION

- A. Perform cutting, fitting, forming, drilling, and grinding of frames as required for project conditions.
- B. Replace components with damage to exposed finishes.
- C. Separate dissimilar metals to prevent electrolytic action between metals.

3.03 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and approved shop drawings.
- B. Set frames plumb, square, level, and aligned to receive doors. Anchor frames to adjacent construction in strict accordance with manufacturer's recommendations and within specified tolerances.
- C. Where aluminum surfaces contact metals other than stainless steel, zinc, or small areas of white bronze, protect from direct contact by painting dissimilar metal with heavy coating of bituminous paint.
- D. Hang doors and adjust hardware to achieve specified clearances and proper door operation.

- E. Install door hardware as specified in Section 08 71 00.

3.04 CLEANING

- A. Upon completion of installation, thoroughly clean door and frame surfaces in accordance with AAMA 609 & 610.
- B. Do not use abrasive, caustic, or acid cleaning agents.

3.05 PROTECTION

- A. Protect products of this section from damage caused by subsequent construction until Date of Substantial Completion.
- B. Replace damaged or defective components that cannot be repaired to a condition indistinguishable from undamaged components.

END OF SECTION

SECTION 08 14 16
FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flush wood doors; flush and flush glazed configuration; fire rated, non-rated, acoustical, special function, and _____.

1.02 RELATED REQUIREMENTS

- A. Section 08 71 00 - Door Hardware.
- B. Section 08 80 00 - Glazing.

1.03 REFERENCE STANDARDS

- A. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009.
- B. ASTM E413 - Classification for Rating Sound Insulation; 2010.
- C. AWI (QCP) - Quality Certification Program, www.awiqcp.org; current edition at www.awiqcp.org.
- D. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2014.
- E. AWMAC (GIS) - Guarantee and Inspection Services Program; current edition at www.awmac.com/gis.php.
- F. ICC (IBC) - International Building Code; 2015.
- G. NEMA LD 3 - High-Pressure Decorative Laminates; National Electrical Manufacturers Association; 2005.
- H. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2013.
- I. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association; 2012.
- J. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- K. UL 1784 - Standard for Air Leakage Tests of Door Assemblies; Current Edition, Including All Revisions.
- L. WDMA I.S. 1A - Interior Architectural Wood Flush Doors; Window and Door Manufacturers Association; 2013. (ANSI/WDMA I.S. 1A)
- M. WI (CCP) - Certified Compliance Program (CCP); current edition at www.woodworkinstitute.com/certification.
- N. WI (MCP) - Monitored Compliance Program (MCP); current edition at www.woodworkinstitute.com/certification.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- C. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
 - 1. Provide the information required by AWI/AWMAC/WI (AWS).
- D. Specimen warranty.
- E. Test Reports: Show compliance with specified requirements for the following:
 - 1. Sound-retardant doors and frames; sealed panel tests are not acceptable.
- F. Samples: Submit two samples of door construction, six by six inch in size cut from top corner of door.

- G. Samples: Submit two samples of door veneer, six by six inch in size illustrating plastic laminate pattern and color.
- H. Manufacturer's Installation Instructions: Indicate special installation instructions.
- I. Warranty, executed in Owner's name.

1.05 QUALITY ASSURANCE

- A. Maintain one copy of the specified door quality standard on site for review during installation and finishing.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years of documented experience.
 - 1. Company with at least one project in the past 5 years with value of woodwork within 20 percent of cost of woodwork for this Project.
- C. Installed Fire Rated Door and Transom Panel Assembly: Conform to NFPA 80 for fire rated class as indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Package, deliver and store doors in accordance with specified quality standard.
- B. Accept doors on site in manufacturer's packaging. Inspect for damage.
- C. Protect doors with resilient packaging sealed with heat shrunk plastic. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges with tinted sealer if stored more than one week. Break seal on site to permit ventilation.

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Interior Doors: Provide manufacturer's warranty for the life of the installation.
- C. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. High Pressure Decorative Laminate Faced Doors:
 - 1. Ampco Products, Inc; ____: www.ampco.com.
 - 2. Poncraft Door Co; ____: www.poncraft.com.
 - 3. VT Industries, Inc; ____: www.vtindustries.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DOORS

- A. All Doors: .
 - 1. Quality Level: Premium Grade, Extra Heavy Duty performance, in accordance with WDMA I.S. 1A.
 - 2. High Pressure Decorative Laminate Faced Doors: 5-ply unless otherwise indicated.
- B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
 - 1. Provide solid core doors at all locations.
 - 2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with ICC (IBC) - Positive Pressure; Underwriters Laboratories Inc. (UL) or Intertek/Warnock Hersey (WHI) labeled without any visible seals when door is open.
 - 3. Smoke and Draft Control Doors as indicated on Life Safety Plan: In addition to required fire rating, provide door assemblies tested in accordance with UL 1784 with maximum air leakage of 3.0 cfm per sq ft of door opening at 0.10 inch w.g. pressure at both ambient and elevated temperatures for "S" label; if necessary, provide additional gasketing or edge sealing.

4. Sound Retardant Doors: Minimum STC of 38, calculated in accordance with ASTM E413, tested in accordance with ASTM E90.
5. High pressure decorative laminate finish where indicated on drawings.

2.03 DOOR AND PANEL CORES

- A. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated.
- B. Fire Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.
- C. Sound Resistant Doors: Equivalent to Type particleboard core (PC) construction with core as required to achieve STC rating specified; plies and faces as indicated.

2.04 DOOR FACINGS

- A. High Pressure Decorative Laminate Facing for Non-Fire-Rated Doors: NEMA LD 3, HGS; _____ color; textured, low gloss finish.
- B. Facing Adhesive: Type I - waterproof.

2.05 ACCESSORIES

- A. Glazing Stops: Wood, of same species as door facing, butted corners; prepared for countersink style tamper proof screws.

2.06 DOOR CONSTRUCTION

- A. Fabricate doors in accordance with door quality standard specified.
- B. Cores Constructed with stiles and rails:
 1. Provide solid blocks at lock edge for hardware reinforcement.
 2. Provide solid blocking for other throughbolted hardware.
- C. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- D. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
- E. Provide edge clearances in accordance with the quality standard specified.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.02 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
 1. Install fire-rated doors in accordance with NFPA 80 requirements.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Use machine tools to cut or drill for hardware.
- D. Coordinate installation of doors with installation of frames and hardware.
- E. Coordinate installation of glazing.

3.03 TOLERANCES

- A. Conform to specified quality standard for fit and clearance tolerances.
- B. Conform to specified quality standard for telegraphing, warp, and squareness.

3.04 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.

3.05 SCHEDULE - SEE DRAWINGS

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

PART 2 PRODUCTS

1.01 MANUFACTURERS

- A. Allegion Brands; Ives, LCN, Schlage, Steelcraft, or Von Duprin: www.allegion.com/us.
- B. Assa Abloy Brands; Corbin Russwin, Curries, McKinney, Norton, Sargent, or Yale: www.assaabloydss.com.
- C. Best Access Systems, division of Stanley Security Solutions: www.bestaccess.com.
- D. C. R. Laurence Co., Inc: www.crl-arch.com.
- E. DORMA USA, Inc: www.dorma.com.
- F. Hager Companies: www.hagerco.com.
- G. Substitutions: See Section 01 60 00 - Product Requirements.

1.02 MANUFACTURERS - BASIS OF DESIGN

- A. Hager Companies products as specified in Section 08 71 10, for hinges, locks, closers, and other items specified: www.hagerco.com.
- B. Substitutions: See Section 01 60 00 - Product Requirements.

1.03 DOOR HARDWARE - GENERAL

- A. Provide hardware specified or required to make doors fully functional, compliant with applicable codes, and secure to the extent indicated.
- B. Provide items of a single type of the same model by the same manufacturer.
- C. Provide products that comply with the following:
 - 1. Applicable provisions of federal, state, and local codes.
 - 2. Accessibility: ADA Standards and ICC A117.1.
 - 3. Applicable provisions of NFPA 101, Life Safety Code.
 - 4. Fire-Rated Doors: NFPA 80.
 - 5. Hardware on Fire-Rated Doors: Listed and classified by UL as suitable for the purpose specified and indicated.
 - 6. Hardware for Smoke and Draft Control Doors indicated on Life Safety Plan: Provide hardware that enables door assembly to comply with air leakage requirements of the applicable code.
- D. Finishes: Provide door hardware of the same finish unless otherwise indicated.
 - 1. Primary Finish: Satin chrome plated over nickel on brass or bronze, 626 (approx US26D).
 - 2. Secondary Finish: Satin chrome plated over nickel on brass or bronze, 626 (approx US26D).
 - a. Use secondary finish in kitchens, bathrooms, and other spaces containing chrome or stainless steel finished appliances, fittings, and equipment; provide primary finish on one side of door and secondary finish on other side if necessary.
 - 3. Finish Definitions: BHMA A156.18.
 - 4. Exceptions:
 - a. Where base metal is specified to be different, provide finish that is an appearance equivalent according to BHMA A156.18.
 - b. Hinges for Fire-Rated Doors: Steel base metal with plated finish.
 - c. Door Closer Covers and Arms: Color to be selected by Architect from manufacturer's standard colors.
 - d. Aluminum Surface Trim and Gasket Housings: Anodized to match door, not to match other hardware.
 - e. Hardware for Aluminum Storefront Doors: Finished to match door, except hand contact surfaces to be satin stainless steel.

- E. Fasteners:
 - 1. Mineral Core Wood Doors: Sex bolts.

1.04 LOCKS AND LATCHES

- A. Locks: Provide a lock for every door, unless specifically indicated as not requiring locking.
 - 1. Hardware Sets indicate locking functions required for each door.
 - 2. If no hardware set is indicated for a swinging door provide an office lockset.
 - 3. Trim: Provide lever handle or pull trim on outside of all locks unless specifically stated to have no outside trim.
 - 4. Lock Cylinders: Provide key access on outside of all locks unless specifically stated to have no locking or no outside trim.
 - 5. In door sections, where a lock cylinder referenced to this Section is specified, furnish and install a mortise lock cylinder keyed to the building keying system.
- B. Electrically Operated Locks: Fail secure unless otherwise indicated.
- C. Lock Cylinders: Manufacturer's standard tumbler type, six-pin interchangeable core.
 - 1. Provide cams and/or tailpieces as required for locking devices required.
- D. Keying: Grand master keyed.
 - 1. Include construction keying.
 - 2. Supply keys in the following quantities:
 - a. Three master keys.
 - b. Three grand master keys.
 - c. Ten construction keys.
 - d. Two change keys for each lock.
 - 3. When providing keying information, comply with DHI Handbook "Keying systems and nomenclature".
- E. Latches: Provide a latch for every door that is not required to lock, unless specifically indicated "push/pull" or "not required to latch".

1.05 HINGES

- A. Hinges: Provide hinges on every swinging door.
 - 1. Provide five-knuckle full mortise butt hinges unless otherwise indicated.
 - 2. Provide ball-bearing hinges at all doors having closers.
 - 3. Provide hinges in the quantities indicated.
 - 4. Provide non-removable pins on outswinging interior doors at access controlled doors.
 - 5. Where electrified hardware is mounted in door leaf, provide power transfer hinges.
- B. Butt Hinges: Comply with BHMA A156.1 and A156.7; standard weight, unless otherwise indicated.
 - 1. Provide hinge width required to clear surrounding trim.
- C. Quantity of Hinges Per Door:
 - 1. Doors up to 60 inches High: Two hinges.
 - 2. Doors From 60 inches High up to 90 inches High: Three hinges.
 - 3. Doors 90 inches High up to 120 inches High: Four hinges.

1.06 PUSH/PULLS

- A. Push/Pulls: Comply with BHMA A156.6.
 - 1. Provide push and pull on doors not specified to have lockset, latchset, exit device, or auxiliary lock.
 - 2. On solid doors, provide matching push plate and pull plate on opposite faces.

1.07 CYLINDRICAL LOCKSETS

- A. Locking Functions: As defined in BHMA A156.2, and as follows.
 - 1. Office: F82 Grade 1, key not required to lock, unlocks upon exit.

1.08 CLOSERS

- A. Closers: Complying with BHMA A156.4.
 - 1. Provide surface-mounted, door-mounted closers unless otherwise indicated.
 - 2. Provide a door closer on every exterior door.
 - 3. Provide a door closer on every fire- and smoke-rated door. Spring hinges are not an acceptable self-closing device unless specifically so indicated.
 - 4. On pairs of swinging doors, if an overlapping astragal is present, provide coordinator to ensure the leaves close in proper order.
 - 5. At corridors, locate door-mounted closer on room side of door.

1.09 STOPS AND HOLDERS

- A. Stops: Complying with BHMA A156.8; provide a stop for every swinging door, unless otherwise indicated.
 - 1. Provide wall stops, unless otherwise indicated.
 - 2. If wall stops are not practical, due to configuration of room or furnishings, provide overhead stop.
 - 3. Stop is not required if positive stop feature is specified for door closer; positive stop feature of door closer is not an acceptable substitute for a stop unless specifically so stated.

1.10 KEY CONTROLS

- A. Key Management System: For each keyed lock on project, provide one set of consecutively numbered duplicate key tags with hanging hole and snap catch.
- B. Facility Manager's Key Cabinet: Sheet steel construction, piano hinged door with key lock.
 - 1. Mounting: Wall-mounted.
 - 2. Capacity: Actual quantity of keys, plus 25 percent additional capacity.
 - 3. Size key hooks to hold 6 keys each.
 - 4. Finish: Baked enamel, manufacturer's standard color.
 - 5. Key cabinet lock to building keying system.

PART 3 EXECUTION

2.01 EXAMINATION

- A. Verify that doors and frames are ready to receive work; labeled, fire-rated doors and frames are present and properly installed, and dimensions are as indicated on shop drawings.

2.02 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and applicable codes.
- B. Use templates provided by hardware item manufacturer.
- C. Install hardware on fire-rated doors and frames in accordance with code and NFPA 80.
- D. Mounting heights for hardware from finished floor to center line of hardware item. As indicated in the following list; unless noted otherwise on the drawings.
 - 1. For Wood Doors: Comply with DHI "Recommended Locations for Architectural Hardware for Wood Flush Doors."

2.03 FIELD QUALITY CONTROL

- A. Provide an Architectural Hardware Consultant to inspect installation and certify that hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified.

2.04 ADJUSTING

- A. Adjust work under provisions of Section 01 70 00.
- B. Adjust hardware for smooth operation.
- C. Adjust gasketing for complete, continuous seal; replace if unable to make complete seal.

2.05 CLEANING

- A. Clean adjacent surfaces soiled by hardware installation. Clean finished hardware per manufacturer's instructions after final adjustments has been made. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.

2.06 PROTECTION

- A. Protect finished Work under provisions of Section 01 70 00.
- B. Do not permit adjacent work to damage hardware or finish.

END OF SECTION

SECTION 08 71 10
BASIS OF DESIGN DOOR HARDWARE - HAGER

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Product requirements for certain door hardware, supplementing specifications in Section 08 71 00.

1.02 RELATED REQUIREMENTS

- A. Section 08 71 00 - Door Hardware: General administrative and installation requirements applicable to this Section; descriptions of individual door hardware sets.

PART 2 PRODUCTS

2.01 HINGES

- A. Butt Hinges: Complying with ANSI/BHMA A156.1 and ANSI/BHMA A156.7; square corner five-knuckle design; flat button tips and ball bearings.
 - 1. Width of Leaves: 4-1/2 inch high, minimum, and as required to clear surrounding trim.
 - 2. Thickness:
 - a. Doors up to 36 inch wide and up to 1-3/4 inch thick; 0.134 inch thick, minimum.
 - b. Doors 37 inch to 48 inch wide and 1-3/4 inch thick, and hinges 0.180 inch thick, minimum.
 - c. Doors greater than 1-3/4 inch thick: Hinge material 0.180 inch thick, minimum.
 - 3. Base Material:
 - a. Exterior Doors: Stainless steel, Type 304.
 - b. Interior Doors: Steel.
 - c. Fire Rated Doors: Steel.
 - 4. Quantity of Hinges Per Door:
 - a. Doors From 60 inches High up to 90 inches High: Three hinges.
 - b. Doors 90 inches High up to 120 inches High: Four hinges.
 - 5. Non-Removable Pins (NRP): At out-swinging exterior and out-swinging access controlled doors.
 - 6. Doors Requiring Full Width Clear Openings: Hinges swing door clear of opening when open 95 degrees from wall.
 - 7. Shimming: Where required to correct frame or door irregularities, provide metal shims only.
 - 8. Products:
 - a. Hager Companies: Standard Weight Hinges, BB1191 / BB1279.
 - b. Hager Companies: Heavy Weight Hinges, BB1168 / BB1199.
- B. Power Transfer Hinges: Where indicated as Electric Through Wire (ETW), provide hinges certified to handle an amperage rating of 3.5 A continuous duty with 16.0 A intermittent duty; with appropriate number of wires to transfer power through door frame to door and then to electrified door hardware.
 - 1. Product: McKinney T4A3786 QC8.

2.02 LOCKS AND LATCHES

- A. Provide cylindrical locksets, Grade 1 wherever locksets are called for, unless otherwise indicated.
- B. Lock and latch functions are specified in Section 08 71 00.
- C. Locksets - General:
 - 1. On fire-rated and smoke-rated doors, provide products complying with:
 - a. UL/ULC Labeled and listed for functions up to 3 hours for "A" label and for single doors up to 48 inches in width and up to 96 inches in height.
 - b. UL 10C Positive Pressure Rated.

2. Doors: Comply with ADA Standards and ICC A117.1.
 3. Lock and Latch Chassis: Zinc dichromate.
 4. Latch Bolts: Stainless steel; 1/2 inch minimum throw and deadlocking.
 - a. Standard Backset: 2-3/4 inches.
 - b. Faceplate: Adjustable for square door edge or 1/8 inch beveled door edge.
 5. Keyed Functions: Freewheeling, vandal-resistant.
 6. Handing: Non-handed, field reversible.
 7. Mounting: Through-bolted with no exposed screws.
- D. Trim:
1. Levers: Cast zinc; plated to match finish designation specified in Section 08 71 00.
 2. Roses: Solid brass.
- E. Strikes: 1-1/4 inches x 4-7/8 inches; select lip length to protect surrounding trim.
- F. Electric Locks:
1. Fail Safe (power lock) (EL): Outside trim unlocked when power is switched off or fails.
 2. Fail Secure (power unlock) (EU): Outside trim locked when power is switched off or fails.
 3. Continuous duty solenoids.
 4. 24VDC, 24VAC, 150ma.

2.03 CYLINDRICAL LOCKSETS

- A. Cylindrical Locksets: Grade 1; complying with ANSI/BHMA A156.2, Series 4000, Certified to Grade 1; requirements specified above; and as follows:
1. Single-Swing, Out-Swinging Doors: Provide products tested to ANSI/BHMA A250.13:
 - a. Door Assembly Impact Load: 1150 pounds.
 - b. Door Assembly Design Load:
 - 1) 36 inches wide by 84 inches high: 100 pounds per square foot.
 - 2) 48 inches wide by 84 inches high: 70 psf.
 2. Products:
 - a. Sargent: 10 Line.
 - 1) Lever Design: B.
 - 2) Rose: L.

2.04 CLOSERS

- A. Surface-Mounted, Door-Mounted Closers: Non-handed, comply with ANSI/BHMA A156.4 Grade 1, with aluminum body and full plastic covers.
1. Comply with the following:
 - a. ICC A117.1 and ADA Standards.
 - b. UL/cUL; listed up to 3 hours.
 - c. UL 10C; Positive Pressure Fire Rated.
 2. Springs: Double heat-treated, tempered steel.
 3. Piston: Precision-machined, heat-treated steel.
 4. Spindle: Triple heat-treated steel.
 5. Operation: Full rack and pinion.
 6. Adjustment: Separate, staked, adjustable valve screws for latch speed, sweep speed, and backcheck.
 7. Arms and Brackets:
 - a. Arm Type: Manufacturer's standard.
 - b. Mounting Types: Manufacturer's standard "Tri-Pack" of regular arm, top jamb arm and parallel arm.
 8. Size: Comply with referenced standard for accessibility, including following maximum opening force requirements.
 - a. Interior hinged openings: 5.0 pounds.
 - b. Exterior hinged openings: 8.5 pounds.

- c. Fire Rated Openings: Minimum opening force allowable by authority having jurisdiction.
- 9. Fasteners: Provide self-reaming and self-tapping wood and machine screws and sex nuts and bolts for each closer.
- B. Products: Aluminum Body.
 - 1. Norton: 8000/1600 Series.

2.05 STOPS AND HOLDERS

- A. Provide products complying with ANSI/BHMA A156.8 Grade 1.
- B. Products: Wall Stops.
 - 1. McKinney: WS01.

2.06 SILENCERS

- A. Silencers: Gray rubber, shaped for specific door type and application.
 - 1. Wood Doors: 3/8 inch wide by 3/4 inch long.
 - 2. Silencers: Three silencers per single door frame, two per double door frame and four per Dutch door frame where smoke, light, weather or acoustical seals not otherwise required.
- B. Products:
 - 1. Hager Companies: 307D/308D.
 - 2. Rockwood: 608/609.
 - 3. Trimco: 1229A/1229B.
 - 4. McKinney: S1M.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with Hardware Schedule and manufacturer's instructions.
- B. See Section 08 71 00 for additional requirements.

END OF SECTION

SECTION 09 21 16
GYPNUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Metal stud wall framing.
- C. Metal channel ceiling framing.
- D. Acoustic insulation.
- E. Gypsum wallboard.
- F. Joint treatment and accessories.
- G. Textured finish system.

1.02 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.
- C. Section 07 84 00 - Firestopping: Top-of-wall assemblies at fire rated walls.
- D. Section 07 92 00 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.

1.03 REFERENCE STANDARDS

- A. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2012.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- C. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2015.
- D. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2014.
- E. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2012.
- F. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2015.
- G. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2013.
- H. 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. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2015.
- I. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2014.
- J. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2014a.
- K. ASTM C1278/C1278M - Standard Specification for Fiber-Reinforced Gypsum Panel; 2007a (Reapproved 2011).
- L. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2014.
- M. ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels; 2015.
- N. ASTM C1658/C1658M - Standard Specification for Glass Mat Gypsum Panels; 2013.

- O. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2012.
- P. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009.
- Q. ASTM E413 - Classification for Rating Sound Insulation; 2010.
- R. GA-216 - Application and Finishing of Gypsum Board; Gypsum Association; 2013.
- S. GA-226 - Application of Gypsum Board to Form Curved Surfaces; Gypsum Association; 2008.
- T. GA-600 - Fire Resistance Design Manual; Gypsum Association; 2015.
- U. ICC (IBC) - International Building Code; 2015.
- V. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.
- C. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing gypsum board application and finishing, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
 - 1. See PART 3 for finishing requirements.
- B. Interior Partitions, indicated as Acoustic ("S" suffix in Partition Type Indicator): Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- C. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
 - 1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
 - 2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- D. Shaft Walls at Elevator Shafts: Provide completed assemblies with the following characteristics:
 - 1. Air Pressure Within Shaft: Intermittent loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
 - 2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- E. Fire Rated Assemblies: Provide completed assemblies with the following characteristics:
 - 1. ICC IBC Item Numbers: Comply with applicable requirements of ICC IBC for the particular assembly.
 - 2. Gypsum Association File Numbers: Comply with requirements of GA-600 for the particular assembly.
 - 3. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).

2.02 METAL FRAMING MATERIALS

- A. Manufacturers - Metal Framing, Connectors, and Accessories:

1. Clarkwestern Dietrich Building Systems LLC; ____: www.clarkdietrich.com.
 2. Marino; ____: www.marinoware.com.
 3. Phillips Manufacturing Company; ____: www.phillipsmfg.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.
1. Studs: "C" shaped with flat or formed webs with knurled faces.
 2. Runners: U shaped, sized to match studs.
 3. Ceiling Channels: C-shaped.
 4. Furring: Hat-shaped sections, minimum depth of 7/8 inch.
 5. Resilient Furring Channels: 1/2 inch depth, for attachment to substrate through one leg only.
 - a. Products:
 - 1) Same manufacturer as other framing materials.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
- C. Shaft Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 and specified performance requirements.
1. Products:
 - a. Same manufacturer as other framing materials.
- D. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
- E. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.
1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI SG02-1.
 2. Material: ASTM A653/A653M steel sheet, SS Grade 50/340, with G60/Z180 hot dipped galvanized coating.
 3. Provide components UL-listed for use in UL-listed fire-rated head of partition joint systems indicated on drawings.
 4. Deflection and Firestop Track:
 - a. Provide mechanical anchorage devices as described above that accommodate deflection while maintaining the fire-rating of the wall assembly.
 - b. Products:
 - 1) FireTrak Corporation; Posi Klip.
 - 2) Metal-Lite, Inc.; The System.

2.03 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
1. American Gypsum Company; ____: www.americangypsum.com.
 2. CertainTeed Corporation; ____: www.certainteed.com.
 3. Georgia-Pacific Gypsum; ____: www.gpgypsum.com.
 4. National Gypsum Company; ____: www.nationalgypsum.com.
 5. USG Corporation; ____: www.usg.com.
 6. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 2. Glass mat faced gypsum panels as defined in ASTM C1658/C1658M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
 3. Unfaced fiber-reinforced gypsum panels as defined in ASTM C1278/C1278M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.

4. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 5. At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 6. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
 - b. Ceilings: 5/8 inch.
 - c. Multi-Layer Assemblies: Thicknesses as indicated on drawings.
 7. Paper-Faced Products:
 - a. American Gypsum Company; FireBloc Type X Gypsum Wallboard.
 - b. American Gypsum Company; FireBloc Type C Gypsum Wallboard.
 - c. Georgia-Pacific Gypsum; ToughRock Fireguard X.
 - d. Georgia-Pacific Gypsum; ToughRock Fireguard C.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
 8. Mold Resistant Paper Faced Products:
 - a. American Gypsum Company; M-Bloc.
 - b. National Gypsum Company; Gold Bond XP Gypsum Board .
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 9. Unfaced Products:
 - a. USG Corporation; Fiberock Aqua-Tough Interior Panels.
 - b. USG Corporation; Fiberock Brand Panels--Abuse-Resistant.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Impact Resistant Wallboard:
1. Application: High-traffic areas indicated.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 3. Paper-Faced Type: Gypsum wallboard as defined in ASTM C1396/C1396M.
 4. Unfaced Type: Interior fiber-reinforced gypsum panels as defined in ASTM C1278/C1278M.
 5. Type: Fire resistance rated Type X, UL or WH listed.
 6. Thickness: 5/8 inch.
 7. Edges: Tapered.
 8. Products:
 - a. American Gypsum Company; M-Bloc IR Type X.
 - b. National Gypsum Company; Gold Bond HI-Impact XP Gypsum Board.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 ACCESSORIES

- A. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, unfaced. Thickness: ___ inch.
- B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
- C. Finishing Accessories: ASTM C1047, galvanized steel or rolled zinc, unless noted otherwise.
 1. Types: As detailed or required for finished appearance.
 2. Special Shapes: In addition to conventional corner bead and control joints, provide U-bead at exposed panel edges.
 3. Products:
 - a. Same manufacturer as framing materials.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.
 1. Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
 2. Ready-mixed vinyl-based joint compound.
 3. Chemical hardening type compound.

- E. High Build Drywall Surfer: Vinyl acrylic latex-based coating for spray application, designed to take the place of skim coating and separate paint primer in achieving Level 5 finish.
- F. Textured Finish Materials: Latex-based compound; plain.
- G. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inch in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion resistant.
- H. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion resistant.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.
- B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
 - 1. Level ceiling system to a tolerance of 1/1200.
 - 2. Laterally brace entire suspension system.
- C. Studs: Space studs as scheduled.
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
 - 3. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
- D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- E. Standard Wall Furring: Install at concrete walls scheduled to receive gypsum board, not more than 4 inches from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches on center.
 - 1. Orientation: Horizontal.
 - 2. Spacing: At 24 inches on center.
- F. Blocking: Install wood blocking for support of:
 - 1. Framed openings.
 - 2. Wall mounted cabinets.
 - 3. Plumbing fixtures.
 - 4. Toilet partitions.
 - 5. Toilet accessories.
 - 6. Wall mounted door hardware.

3.03 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Acoustic Sealant: Install in accordance with manufacturer's instructions.
 - 1. Place two beads continuously on substrate before installation of perimeter framing members.
 - 2. Place continuous bead at perimeter of each layer of gypsum board.
 - 3. Seal around all penetrations by conduit, pipe, ducts, and rough-in boxes, except where firestopping is provided.

3.04 BOARD INSTALLATION

- A. Comply with ASTM C 840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Non-Rated: Install gypsum board parallel to framing, with ends and edges occurring over firm bearing.
 - 1. Exception: Tapered edges to receive joint treatment at right angles to framing.
- C. Double-Layer Non-Rated: Use gypsum board for first layer, placed perpendicular to framing or furring members, with ends and edges occurring over firm bearing. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.
- D. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.

3.05 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
 - 1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

3.06 JOINT TREATMENT

- A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, bedded and finished with chemical hardening type joint compound.
- B. Paper Faced Gypsum Board: Use fiberglass joint tape, bedded with ready-mixed vinyl-based joint compound and finished with ready-mixed vinyl-based joint compound.
- C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 - 2. Level 1: Fire rated wall areas above finished ceilings, whether or not accessible in the completed construction.
- D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch.
 - 2. Taping, filling and sanding is not required at base layer of double layer applications.
- E. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

3.07 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION

SECTION 09 51 00
SUSPENDED ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.
- C. Supplementary acoustical insulation above ceiling.

1.02 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 07 21 00 - Thermal Insulation: Acoustical insulation.
- C. Section 08 31 00 - Access Doors and Panels: Access panels.
- D. Section 21 13 00 - Fire Suppression Sprinklers: Sprinkler heads in ceiling system.
- E. Section 23 37 00 - Air Outlets and Inlets: Air diffusion devices in ceiling.
- F. Section 26 51 00 - Interior Lighting: Light fixtures in ceiling system.
- G. Section 27 51 17 - Public Address Systems: Speakers in ceiling system.
- H. Section 28 31 00 - Fire Detection and Alarm: Fire alarm components in ceiling system.

1.03 REFERENCE STANDARDS

- A. ASTM C635/C635M - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2013a.
- B. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels; 2013.
- C. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2014.
- D. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2014.
- E. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Samples: Submit two samples six by six inch in size illustrating material and finish of acoustical units.
- C. Samples: Submit two samples each, 12 inches long, of suspension system main runner.
- D. Manufacturer's Installation Instructions: Indicate special procedures.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.05 QUALITY ASSURANCE

- A. Fire-Resistive Assemblies: Complete assembly listed and classified by UL (FRD) for the fire resistance indicated.
- B. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.01 ACOUSTICAL UNITS

- A. Acoustical Tile: Painted mineral fiber, ASTM E1264 Type III, with the following characteristics:
 - 1. VOC Content: As specified in Section 01 61 16.
 - 2. Size: 12 by 12 inches.

END OF SECTION

SECTION 09 68 13
TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Carpet tile, fully adhered.
- B. Removal of existing carpet tile.

1.02 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 01 74 19 - Construction Waste Management and Disposal: Reclamation/Recycling of new carpet tile scrap and removed carpet tile.

1.03 REFERENCE STANDARDS

- A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2006 (Reapproved 2011).
- B. CRI 104 - Standard for Installation of Commercial Carpet; Carpet and Rug Institute; 2015.
- C. CRI (GLP) - Green Label Plus Testing Program - Certified Products; Carpet and Rug Institute; Current Edition.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- C. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
- D. Manufacturer's Installation Instructions: Indicate special procedures.
- E. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum five years documented experience.
- B. Installer Qualifications: Company specializing in installing carpet tile with minimum five years experience.

1.06 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide carpet tile from manufacturers listed on the Finish Schedule on the Drawings.

2.02 MATERIALS

- A. Tile Carpeting: as indicated on the drawings, manufactured in one color dye lot.

2.03 ACCESSORIES

- A. Sub-Floor Filler: White premix latex; type recommended by flooring material manufacturer.
- B. Edge Strips: Rubber, color as selected by Architect.

- C. Adhesives:
 - 1. Compatible with materials being adhered; maximum VOC content of 50 g/L; CRI (GLP) certified; in lieu of labeled product, independent test report showing compliance is acceptable.
- D. Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that sub-floor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive carpet tile.
- C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to sub-floor surfaces.
- D. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for flooring installation by testing for moisture and pH.
 - 1. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.
- E. Verify that concrete sub-floor surfaces are ready for carpet tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within the following limits:
 - 1. Moisture emission rate: Not greater than 3 lb per 1000 sq ft per 24 hours when tested using calcium chloride moisture test kit for 72 hours.
 - 2. Alkalinity: pH range of 5-9.
- F. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Remove existing carpet tile.
- B. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- C. Remove sub-floor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with sub-floor filler.
- D. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.
- E. Vacuum clean substrate.

3.03 INSTALLATION

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions and CRI 104 (Commercial).
- C. Blend carpet from different cartons to ensure minimal variation in color match.
- D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.
- F. Locate change of color or pattern between rooms under door centerline.
- G. Fully adhere carpet tile to substrate.
- H. Trim carpet tile neatly at walls and around interruptions.
- I. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

- A. Remove excess adhesive without damage, from floor, base, and wall surfaces.

B. Clean and vacuum carpet surfaces.

END OF SECTION

SECTION 09 90 00
PAINTING AND COATING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints, stains, varnishes, and other coatings.
- C. Do Not Paint or Finish the Following Items:
 - 1. Items fully factory-finished unless specifically so indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
 - 5. Floors, unless specifically so indicated.
 - 6. Glass.
 - 7. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.

1.03 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.
- B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2014.
- C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials; 2007.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide complete list of all products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
 - 2. MPI product number (e.g. MPI #47).
 - 3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
- C. Samples: Submit two paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
- D. Manufacturer's Instructions: Indicate special surface preparation procedures.
- E. Maintenance Data: Submit data including care and cleaning instructions, touch-up procedures, and repair of painted and coated surfaces.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum three years documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum three years experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.07 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.
- D. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.
- B. Provide all paint and coating products from the same manufacturer, no exceptions.
- C. Paints:
 - 1. Sherwin-Williams Company: www.sherwin-williams.com.

2.02 PAINTS AND COATINGS - GENERAL

- A. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.
 - 1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Supply each coating material in quantity required to complete entire project's work from a single production run.
 - 3. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
- B. Primers: As follows unless other primer is required or recommended by manufacturer of top coats; where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.
- C. Volatile Organic Compound (VOC) Content:
 - 1. Provide coatings that comply with the most stringent requirements specified in the following:
 - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - 2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

2.03 PAINT SYSTEMS - INTERIOR

- A. Paint I-OP - All Interior Surfaces Indicated to be Painted, Unless Otherwise Indicated: Including gypsum board.
 - 1. Two top coats and one coat primer.
 - 2. Primer(s): As recommended by manufacturer of top coats.
- B. Paint GI-OP-3LA - Gypsum Board/Plaster, Latex-Acrylic, 3 Coat:
 - 1. One coat of alkyd primer sealer.
 - 2. Semi-gloss: Two coats of latex-acrylic enamel; _____.

- C. Paint GI-P-1A - Gypsum Board/Plaster, Alkyd Primer, 1 Coat:
 - 1. One coat of alkyd primer sealer; _____.

2.04 ACCESSORY MATERIALS

- A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required to achieve the finishes specified whether specifically indicated or not; commercial quality.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- C. Test shop-applied primer for compatibility with subsequent cover materials.
- D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Gypsum Wallboard: 12 percent.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to coating application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or repair existing coatings that exhibit surface defects.
- D. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- E. Seal surfaces that might cause bleed through or staining of topcoat.
- F. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- G. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.

3.03 APPLICATION

- A. Apply products in accordance with manufacturer's instructions.
- B. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- D. Apply each coat to uniform appearance.
- E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- F. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection.
- B. Owner will provide field inspection.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

- A. Protect finished coatings until completion of project.
- B. Touch-up damaged coatings after Substantial Completion.

3.07 SCHEDULE - PAINT SYSTEMS

- A. Gypsum Board: Finish all surfaces exposed to view.
 - 1. Exterior Soffits: GE-OP-3A, flat.
 - 2. Interior Ceilings and Bulkheads: GI-OP-3L, flat.
 - 3. Interior Walls: GI-OP-3A, semi-gloss.

END OF SECTION

SECTION 12 21 13
HORIZONTAL LOUVER BLINDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Horizontal slat louver blinds.
- B. Operating hardware.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating physical and dimensional characteristics.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Horizontal Louver Blinds Without Side Guides:
 - 1. Hunter Douglas; ____: www.hunterdouglas.com.
 - 2. Levolor Contract; ____: www.levolorcontract.com.
 - 3. SWFcontract, a division of Spring Window Fashions, LLC.; ____: www.swfcontract.com.

2.02 BLINDS WITHOUT SIDE GUIDES

- A. Description: Horizontal slat louvers hung from full-width headrail with full-width bottom rail.
- B. Manual Operation: Control of raising and lowering by cord with full range locking; blade angle adjustable by control wand.
- C. Metal Slats: Spring tempered pre-finished aluminum; square slat corners, with manufacturing burrs removed.
 - 1. Width: 1/2 inch.
- D. Slat Support: Woven polypropylene cord, ladder configuration.
- E. Head Rail: Pre-finished, formed aluminum box, with end caps; internally fitted with hardware, pulleys, and bearings for operation; same depth as width of slats.
- F. Headrail Attachment: Wall brackets.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install blinds in accordance with manufacturer's instructions.
- B. Secure in place with flush countersunk fasteners.

END OF SECTION

SECTION 15002

MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15002, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: This Division requires the furnishing and installing of all items Specified herein, indicated on the Drawings or reasonably inferred as necessary for safe and proper operation; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, equipment, transportation, storage, utilities and all required permits and licenses. All work performed under this Section shall be in accordance with the Drawings and Specifications and subject to the terms and conditions of the Contract. For purposes of these Specifications, "provide" and "furnish and install" shall be synonymous. Owner's Representative (OR) shall refer to the individual designated by the owner to receive and distribute correspondence with the contractor.
- B. Work Included: This Work includes the furnishing of all labor, materials, equipment, fixtures, apparatus and appurtenances required for complete installation of operating heating, ventilating, air conditioning, plumbing and fire protection systems as specified, in place and ready for service. Refer to Section 15004, "Mechanical Scope of Work" for additional requirements.
- C. Drawings: Refer to the Mechanical and Plumbing Drawings for graphic representations, schedules, and notations showing mechanical and plumbing work.
- D. Specifications: Refer to this Division for the primary technical specifications of mechanical and plumbing work.
- E. Work of Other Sections: Requirements given within this Section apply to the Work of all Sections of this Division. The actual performance of the Work stays within the Section in which it occurs; but subject to the requirements of this Section to the extent applicable.
 - 1. All prime and protective painting for all areas and finished painting of mechanical systems in areas not exposed to the view of building occupants shall be provided under this Division.
 - 2. Installation of electrical control power which is not specified as an integral part of equipment specified under this Division is specified under Division 16 and where shown on the Electrical Drawings. Necessary conduit, wiring, boxes, and fittings are specified under Division 16.
 - 3. Access doors in finished surfaces are provided under this Division and installed by the Contractor installing the finished surface. Locations are as shown on the Drawings and as required for proper equipment access.
 - 4. Owner and General Contractor-furnished equipment is furnished and installed under other Divisions. Proper HVAC and Plumbing provisions, including rough-in and final equipment connections, are included in the Work of this Division.
- F. Workmanship: All mechanical and plumbing work shall be constructed and finished in every respect in a workmanlike and substantial manner. Furnish and install all work as may be necessary to complete systems in accordance with the best trade practice and to the satisfaction of the OR and Engineer. The entire installation shall be ready in every respect for satisfactory and efficient operation when completed. The OR and Engineer will interpret the meaning of the drawings and specifications and will reject all work and materials which, in their judgment, is not in full accordance therewith.

- G. Certification: Submit a single certification stating that all portions of the work are in accordance with contract requirements. Warranty all work against faulty and improper material and workmanship for a period of one year from date of final acceptance by the OR, except that where guarantees or warranties for longer terms are specified by contract, such longer term shall apply. At no additional cost to Owner, within 24 hours after notification, correct any deficiencies which occur during the warranty period, to the satisfaction of the Owner.
- H. Safe Work Place: The Contractor covenants and agrees that he and his Subcontractors and his and their agents and employees will provide and maintain a safe place to work and will comply with all laws and regulations of any governmental authorities having jurisdiction thereof, and the contractor agrees to indemnify, defend and hold harmless, the Engineer and Owner from and against any liability, loss, damage or expense, including attorneys' fees, arising from a failure or alleged failure on the part of the contractor, his subcontractors and his and their agents and employees to provide and maintain a safe place to work or to comply with laws and regulations of governmental authorities having jurisdiction thereof.
- I. Indemnification: The Contractor and each Subcontractor covenants and agrees to indemnify, defend and hold harmless the Engineer and Owner against any liability, loss, damage or expenses, including reasonable attorneys' fees, arising from a failure or alleged failure on the part of the contractor, his subcontractor or his or their agents and employees properly to discharge the obligations assumed by him or them in the performance of the work, including any act or omission allegedly resulting in death or personal injury or property damage on improper construction, construction techniques, or the use of improper or inappropriate material or tools.

1.3 CODES, PERMITS AND FEES:

- A. General: Comply with the most recently revised versions of applicable laws, rules, regulations and ordinances of federal, state, and local utilities and authorities. Where alterations to and deviations from the Contract Documents are required by said authority, report the requirements and secure approval before starting work. Obtain all applicable permits, licenses and inspections and pay all fees charged by above authorities.
- B. Codes and Standards: All work shall be done in full compliance with all applicable state and local codes, requirements and ordinances and applicable requirements of NFPA, UL and other applicable standards.
- C. Industry Standards: All equipment and materials shall be new and listed by the Underwriters' Laboratories, inc., Manufactured in full accordance with applicable ASME, NEMA, ANSI or IEEE standards.
- D. Approvals, Permits and Inspections: Secure and pay for all necessary approvals, permits, inspections, etc., and deliver the official records of the granting of permits to the Owner without additional cost to the Owner.
- E. Code Design Basis: The following codes and ordinances were used in the design of the project and shall be complied with during construction of the project.
 - 1. Building Code - International Building Code 2009 Edition and NFPA 101 Life Safety Code 2009 Edition.
 - 2. Fire Code - International Fire Code 2009 Edition.
 - 3. Electrical Code - National Electrical Code 2014 Edition.
 - 4. Mechanical Code - International Building Code 2009 Edition.
 - 5. Plumbing Code - International Plumbing Code 2009 Edition.
 - 6. Accessibility Code- Texas Accessibility Standards (TAS), 1994 and Americans with Disabilities Act of 1990.

- F. Precedence: Where Contract Document requirements are in excess of Code requirements and are permitted under the Code, the Contract Documents shall govern. None of the terms or provisions of the Drawings or specification shall be construed as waiving any of the rules, regulations or requirements of these authorities. In the event of conflict between the Contract Documents and the local enforcing authority, the latter shall rule. Any modifications resulting therefrom shall be made without additional cost to the Owner or Engineer. This Contractor shall report any such modifications to the Engineer and secure his approval before proceeding.

1.4 **QUALITY ASSURANCE AND STANDARDS:**

- A. Materials/Methods: Manufacturers, materials, and methods described in the various sections of the Specifications, and indicated on the Drawings are intended to establish a standard of quality only. It is not the intention of the Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturers standard product will meet the requirements of the project design, Specifications and space constraints. **The Engineer shall be the sole judge of quality and equivalence of equipment, materials and methods.**
- B. Alternative Products/Materials/Methods: Products by other reliable manufacturers, other materials and other methods may be accepted provided they have equivalent capacity, construction and performance. **Under no circumstances shall any substitution be made without the prior written approval of the Engineer.** Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Engineer that the specified product, material or method is the only one that shall be used without prior approval. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be provided, it is the intention of the Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without prior written approval. Contractors/Vendors shall submit a written request to use a substitute vendors or material not listed in the specifications to the Engineer shall no less than three days prior to the last possible project Addendum date. Written requests shall include sufficient information to allow the Engineer to evaluate the substitute vendor/material for approval. Approved substitute vendors and materials will be added to the project specifications by Addendum. No other method of Engineer approval of alternative vendors and materials will be used.
- C. Alternative Equipment: Where substituted or alternative equipment is used on the project, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available, including all required Code and maintenance clearances, and to coordinate all equipment requirements and provisions with the Mechanical (HVAC) and Plumbing Design and all other Contractors.
- D. Standards: Refer to Division 1 for general administrative/procedural requirements related to compliance with applicable standards. This Work and all materials shall meet the standards set forth in the applicable portions of the following recognized standards:
 - 1. ADC Air Diffusion Council.
 - 2. AGA American Gas Association.
 - 3. AMCA American Movement and Control Association.
 - 4. ANSI American National Standards Institute.
 - 5. ARI American Conditioning and Refrigeration Institute.
 - 6. ASHRAE American Society of Heating, Refrigerating & Air-Conditioning Engineers.
 - 7. ASME American Society of Mechanical Engineers.
 - 8. ASPE American Society of Plumbing Engineers.

- 9. ASSE American Society of Sanitary Engineering.
- 10. ASTM American Society for Testing and Materials.
- 11. AWS American Welding Society.
- 12. AWWA American Water Works Association.
- 13. CDA Copper Development Association.
- 14. CISPI Cast Iron Soil Pipe Institute.
- 15. ETL Electrical Testing Laboratory.
- 16. FM Factory Mutual Engineering Corporation.
- 17. FS Federal Specification (General Services Administration).
- 18. IRI Industrial Risk Insurers.
- 19. MCAA Mechanical Contractors Association of America.
- 20. MSS Manufacturers Standardization Society of the Valve and Fittings Industry.
- 21. NEC National Electrical Code (by NFPA).
- 22. NEMA National Electrical Manufacturers Association.
- 23. NFPA National Fire Protection Association.
- 24. OSHA Occupational Safety Health Administration (US Department of Labor).
- 25. PDI Plumbing and Drainage Institute.
- 26. SMACNA Sheet Metal & Air Conditioning Contractors' National Association.
- 27. UL Underwriters' Laboratories, Inc.

1.5 SITE VISIT AND FAMILIARIZATION:

- A. General: Become familiar with the Drawings and Specifications, examine the premises, and understand the conditions under which the Contract shall be performed, prior to submitting a bid.
- B. Site: Be informed of the site conditions, verify locations of new and existing equipment, and determine exact requirements for connections.
- C. Coordination: Submission of a bid for this project infers that the Contractor has visited the site and has become familiar with the Drawings and site conditions and has included in his proposal, all work necessary to properly install the systems on the project.
- D. Pre-Bid Conference: Refer to Division 1.

1.6 DRAWINGS AND SPECIFICATIONS:

- A. General: The Drawings are schematic in nature and indicate approximate locations of the heating, ventilating and air conditioning systems, plumbing equipment, fixtures and piping systems, except where specific locations are noted and dimensioned on the Drawings. All items are shown approximately to scale. The intent is to show how these items shall be integrated into the construction. Locate all items by on the job measurements and in accordance with the Contract Documents. Cooperate with other trades to ensure project completion as indicated.
- B. Location: Prior to locating diffusers, grilles, other exposed air devices, plumbing fixtures, fire hose cabinets, and plumbing items, obtain the Engineer's approval as to exact location. Locations shall not be determined by scaling Drawings. Mount plumbing fixtures, fire hose racks, and cabinets at the heights directed by the Engineer. Contractor shall be responsible for costs of redoing work of trades necessitated by failure to comply with this requirement.

- C. Specifications: The specifications are intended to supplement the Drawings and it is not in the scope of the specifications to mention any part of the work which the Drawings are competent to fully explain. Conversely, any part of the work which the specifications are competent to fully explain, may not be mentioned on the Drawings.
- D. Disagreement: Disagreement between the Drawings or specifications or within the Drawings or specifications shall be estimated using the better quality or greater quantity of material or installation, and a request for information shall be made in writing to the Engineer.

1.7 DISCREPANCIES:

- A. Clarification: Clarification shall be obtained before submitting a proposal for the Work under this Division as to discrepancies or omissions from the Contract Documents or questions as to the intent thereof. All questions and requests for clarifications shall be submitted in writing to the Engineer.
- B. Detailed Instructions: Should it appear that the work hereby intended to be done or any of the materials relative thereto, is not sufficiently detailed or explained in the Drawings or Specifications, then the Contractor shall apply to the Engineer for such further Drawings or explanations as may be necessary, allowing a reasonable time for the Engineer to respond. The Contractor shall conform to this additional information as a part of the Contract without additional cost to the Owner or Engineer.
- C. Interpretations: Should any doubt or question arise respecting the true meaning of Drawings or Specifications, reference shall be made to the Engineer, whose written decision shall be final and conclusive. No alleged statement by the Engineer will be accepted as an excuse for inferior work.
- D. Contractor Agreement: Consideration will not be granted for misunderstanding of the amount of work to be performed. Submission of a bid conveys full Contractor agreement of the items and conditions specified, shown, scheduled, or required by the nature of the project.
- E. Discrepancy Notification: Immediately notify engineer in writing when existing field conditions differ from the conditions shown on the contract documents.

1.8 SAFETY REGULATIONS:

- A. General: All mechanical and plumbing work shall be performed in compliance with all applicable and governing safety regulations. All safety lights, guards, signs, and other safety materials and provisions required for the performance of the mechanical work shall be provided by and operated by the Mechanical contractor.
- B. OSHA: It shall be the duty and responsibility of the Contractor and all of its subcontractors to be familiar and comply with all requirements of Public Law 91596, 29 U.S.C. Secs. 651 et seq., the Occupational Safety and Health Act of 1970, (OSHA) and all amendments thereto, and to enforce and comply with all of the provisions of this Act.
- C. Emergencies: In any emergency affecting the safety of persons or property, the Contractor shall act, at its direction, to prevent threatened damage, injury or loss.

1.9 UTILITIES:

- A. General: Utility information shown on the Drawings has been shown based upon data obtained from the site survey and the agencies having jurisdiction and are accurate to the best of the knowledge of the Engineer.
- B. Coordination: The Contractor shall be responsible for field verification of the actual location of site and/or building utilities and shall make modifications necessary for connection to or construction around those utilities at no additional cost to the Owner or Engineer.

1.10 CHANGE ORDERS:

- A. General: Refer to Uniform General Conditions and Division 1 for requirement concerning Change Orders.

1.11 PRECONSTRUCTION CONFERENCE:

- A. Conference: Upon the award of this Contract and prior to commencing any work, the Contractor and his designated major subcontractors, shall confer with the Architect, Engineer and Owner concerning the Work under this Contract. The conference shall be at a mutually agreeable place and time.

1.12 SITE OBSERVATION:

- A. General: Observation at the site to verify general compliance with Contract Documents will be made periodically by the Engineer or his representative. Written observation comments will be submitted to the General Contractor for review and a written response.
- B. Notification: Contractor shall contact Engineer at project milestones so that Engineer can schedule site visit after most of the mechanical and plumbing installation is complete, but before the installations are covered by ceilings, walls, etc.

1.13 REQUESTS FOR INFORMATION (RFI):

- A. General: All Contractor Requests for Information (RFI's) shall be submitted to the Engineer in writing, for response.
- B. Format: All RFI's shall be submitted on a form which has a space for the requested information and the Engineer's response and signature.
- C. RFI Numbering: The method of numbering for RFI's shall be approved by the Architect and Engineer and shall be formatted as follows

RFI-xx.yyy

Where xx = An agreed to text string to identify project and yy.=.The RFI sequence number.

- D. RFI Log: The Contractor shall compile and maintain an RFI Status log which shall be transmitted to the Engineer on a weekly basis in either hardcopy or e-mailed electronic format.
- E. RFI Electronic Submission and Responses: RFI's shall be submitted in electronic form as a .Word or Excel file submitted as an attachment to an e-mail with the RFI name specifically included in the e-mail subject line. Supplemental information associated with an RFI shall be specifically addressed by file name in the RFI and shall be included in PDF file format as an attachment to the RFI e-mail. RFI file names shall match the RFI number. The Engineer's response to an RFI will be a PDF file renamed "E&C Response to RFI-xx.yy" and locked for printing only.
- F. Responses: The Engineer will endeavor to provide RFI response time in the Engineer's office of **five** working days after receipt of the RFI by the Engineer.

1.14 SUBMITTALS:

- A. General: Submittals required for this project shall include, but not be limited to:
 - 1. Shop Drawings and Product Brochure Submittals.
 - 2. Certifications and Test Reports.
 - 3. Operating and Maintenance Manuals.
 - 4. Warranties (Guarantees).
- B. Additional Requirements: Refer to Division 1 for additional submittal requirements.
- C. Shop Drawings and Product Brochure Submittals: The terms "Submittal" and "Shop Drawing" in this Specification are defined as either product literature, samples of equipment or actual Shop Drawings.
- D. Submittal Schedule: The Contractor shall provide a Schedule of Submittals to the Engineer within two weeks of bid award. This document shall list the submittal number and name for all required

submittals for the project and shall include the proposed date on which each required initial submittal will be issued to the Engineer for review. The schedule shall allow adequate time to complete the submittal process at times appropriate to the construction schedule while allowing for delivery time to and from the Engineer and Engineer review time. The schedule shall also allow for submittal resubmissions and related delivery and Engineer review time, as may be required. The Engineer shall not be held responsible for delays or costs incurred due to excessive Shop Drawing review time where the initial submittal is received after the scheduled issue date or is not in compliance with submittal requirements contained herein.

- E. Submittal Log: The Contractor shall compile and maintain a Submittal Status log which shall be transmitted to the Engineer on a weekly basis in either hardcopy or e-mailed electronic format.
- F. Shop Drawings and Product Brochure Submittals: The Contractor shall submit one electronic (unprotected pdf format) copy or a sufficient number of complete bound hardcopy sets of Shop Drawings and complete data covering each item of equipment or material. The terms "Submittal" and "Shop Drawing" in this Specification are defined as either product literature, samples of equipment, or actual Shop Drawings. The first submittal of each item requiring a submittal must be received by the Engineer within 90 days of contract award. The Engineer shall not be responsible for any delays or costs incurred due to excessive Shop Drawing review time where the first submittal is received more than 90 days after contract award. The Architect and Engineer will each retain one copy of all hardcopy Shop Drawing submittals for their files. The Contractor is required to include a copy of all final electrical Shop Drawing submittals in Electrical O&M manuals.
- G. Shop Drawings and Product Brochure Submittal Requirements: The Contractor shall prepare complete submittals that include all pertinent information about the product. **A single Shop Drawing shall not contain information from more than one Specification section, but a single Specification section may be subdivided into separate submittals for items or equipment that are specified in that section.** Shop Drawings shall be separately bound by complete or partial Specification section. Where a single Shop Drawing contains information from more than one Specification section, it will be marked "REVISE AND RESUBMIT" and returned. Each Shop Drawing shall include the following items enclosed in a suitable binder, Shop Drawings that do not comply with the above requirements will be marked " REVISE AND RESUBMIT " and returned to the Contractor:
 - 1. Cover Sheet: The cover sheet shall include the Project Name and the names and addresses of the Owner, Project, Architect, M/E/P Engineer, General Contractor and the Subcontractor making the submittal. The cover sheet shall also contain the Specification section number applicable to the item or items submitted, the item nomenclature and description and the submittal number. HVAC, plumbing and fire protection submittals shall be numbered sequentially by Specification section with a sequence suffix (e.g. 15640-1, 15640-2, 15700-1, etc.). Resubmittals shall be numbered with the original submittal number plus an R in the sequence suffix (e.g. the resubmittals of submittal 15640-1 would be 15640-1R1, 15640-1R2, ...).
 - 2. Index: The index page shall include a listing of all data included in the submittal.
 - 3. List of Variations: This page shall list all variations, including unfurnished or additional items or features between the submitted equipment and the specified equipment. If there are no variations, then this page shall state "No Variations". Where variations affect the work of other contractors, then the contractor shall certify on this page that these variations have been fully coordinated with the affected contractors and that all additional costs to the affected contractors associated with the variations shall be paid by the submitting contractor.
 - 4. Specification Review. A copy of the appropriate specification section shall be included in the submittal with each specification paragraph marked in the right margin with a "C" for Submitted Product/Material/Installation Complies or an "N" for Submitted Product/Material/Installation Not In Compliance. All paragraphs marked with a "N" shall be specifically addressed in the Submittal List of Variations.

5. Equipment Information: Submittal shall include equipment information including manufacturer's name and designation, size, performance and capacity data. All applicable listings, labels, approvals and standards shall be clearly indicated.
 6. Dimensional Data: Submittal shall include dimensional data and actual sketches as applicable to show that the submitted equipment will fit the space available with all required Code and maintenance clearances.
 7. Identification Information: Submittal shall include Identification/designation for each item of material or equipment matching that indicated in the Specifications or on the Drawings.
 8. Product Data: Submittal shall include sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Drawings and Specifications. Any options or special requirements shall be so indicated. All applicable information shall be clearly indicated with arrows or another approved method. Any non-applicable information shall be crossed out.
 9. Contractor Certification: Submittal shall include certification by the General Contractor and Subcontractor that the material submitted is in accordance with the Contract Documents, signed and dated.
 10. Manufacturer Certification: Where specified, submittals shall include reports or information requiring certification which shall be certified by an authorized officer of the manufacturer or testing agency.
 11. Certified Shop Drawings: Submittals shall include Certified Shop Drawings showing dimensions, loading details, anchor bolt locations and inserts required for each piece of equipment set on concrete in sufficient time to cause no delay in the Work.
 12. Equipment/Material Data: Equipment and material submittals shall show sufficient data including all performance curves, sound data, recommended installation details, and sufficient data to indicate complete compliance with the Contract Documents, including proper sizes, clearances, capacities, materials, and finishes.
 13. Additional Information: Submittal shall include additional information as required in other sections of this Division.
- H. Required Shop Drawing Submittals: Submit Shop Drawings, including, but not limited to the following items:
1. Schedule of Submittals Refer to Section 15002.
 2. Testing, Adjustment and Balancing Refer to Section 15020.
 - a. Before starting the actual Test and Balance procedure submit:
Personnel qualifications, Equipment to be used on the project and
Testing and Balancing Forms.
 3. Basic Materials and Methods Refer to Section 15100.
 4. System Insulation Refer to Section 15200.
 5. Wet-Pipe Fire Sprinkler System Refer to Section 15510.
 6. Ductwork Refer to Section 15840.
 7. Ductwork Accessories Refer to Section 15845.
 8. HVAC Terminal Units Refer to Section 15836.
 9. Air Distribution Devices Refer to Section 15867.
 10. Building Controls and Automation Refer to Section 15900.
 11. Sequence of Operation Refer to Section 15950.

- I. Samples: Submit two samples, upon request, of mechanical/plumbing devices and materials for review by the Architect/Engineer. Samples will be returned upon written request of the Contractor.
- J. Fabrication Drawings: Fabrication Drawings shall be made at no additional charge to the Owner or the Architect/Engineer. Submit Fabrication Drawings whenever:
 - 1. Equipment proposed varies in physical size and arrangement from that indicated on the Drawings, thus causing rearrangement of equipment space.
 - 2. Where tight spaces require extreme coordination between ductwork, piping, conduit and other equipment.
 - 3. Where called for elsewhere in these Specifications.
 - 4. Where specifically requested by the Architect/Engineer.
- K. Equipment List: Within thirty days after the date of contract award or work order, whichever is later, and before purchasing or starting installation of materials or equipment, the Contractor shall submit for review, a complete list of suppliers, contractors and manufacturers for all materials and equipment which will be submitted for incorporation into the project. The list shall be arranged in accordance with the organization of the Specifications.
 - 1. This initial list shall include the manufacturer's name and type or catalog number as required to identify the quality of material or equipment proposed.
 - 2. This initial list shall include the proposed submittal schedule to allow the design team to schedule the required time for reviews.
 - 3. This list will be reviewed by the Engineer and the Owner and will be returned to the Contractor with comments as to which items are acceptable without further submittal data and which items will require detailed submittal data for further review and subsequent approval.
 - 4. The initial list shall be submitted as herein specified. Materials and equipment requiring detailed submittal data shall be submitted with sufficient data to indicate that all requirements of these Specifications have been met and samples shall be furnished when requested. All manufacturer's data used as part of the submittal shall have all inapplicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished.
- L. Shop Drawing Submittal Review: Shop Drawings will be reviewed for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action shown in review comments is subject to the requirements of the Contract Documents. The submitting Contractor is responsible for: dimensions which shall be confirmed at the job site; fabrication processes and techniques of construction; coordination of his work with that of all other trades; and the satisfactory performance of his work.
 - 1. The Engineer will endeavor to provide Shop Drawing review time in the Engineer's office of 2 weeks per review, exclusive of transmittal time, and this review time shall be considered by the Contractor when scheduling his work on the project. Submittals received outside the scheduled delivery dates may require additional time for review.
 - 2. The Architect's review or approval and the Engineer's review of Shop Drawings shall not relieve the Contractor of the responsibility for errors, omissions or deviations that may be contained in the submittals. If the Contractor proceeds on the basis of undetected errors, omissions or deviations in reviewed Shop Drawings, it shall be at his sole responsibility and the review does not allow deviations from the requirements of the Contract Documents. Noting some errors, omissions, and deviations but overlooking other errors, omissions, and deviations does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawing or the Engineer's review thereof, the Contract Documents shall govern the Work and are neither waived or superseded by the Shop Drawing review.
 - 3. It shall be the responsibility of the submitting Contractor to check all equipment and materials for conformance with the Contract Documents and a "REVIEWED WITH NO EXCEPTIONS TAKEN"

- or "MAKE CORRECTIONS NOTED" submittal at the time such equipment and materials are delivered to the job site, and to notify the Engineer of any deviations.
4. Inadequate or incomplete Shop Drawings will not be reviewed by the Architect or the Engineer and will be returned to the Contractor marked "REVISE AND RESUBMIT" for completion and resubmittal.
 5. Shop Drawings will be marked "REVIEWED WITH NO EXCEPTIONS TAKEN", "MAKE CORRECTIONS NOTED AND SUBMIT WRITTEN RESPONSE", "REVISE AND RESUBMIT", or "REJECTED" when reviewed by the Engineer. The definitions of these terms for submittal review purposes is as follows:
 - a. **REVIEWED WITH NO EXCEPTIONS TAKEN** - The Shop Drawing was reviewed and no exceptions from the general conformance with the design concept and general compliance with the information given in the Contract Documents were noted.
 - b. **MAKE CORRECTIONS NOTED AND SUBMIT WRITTEN RESPONSE** - The Shop Drawing was reviewed and found to have either minor deviations from the requirements of the Contract Documents or information missing from the submittal, as noted. A complete Shop Drawing resubmittal is not required, however, a written response to all review comments shall be submitted in the format used for a resubmittal.
 - c. **REVISE AND RESUBMIT** - The Shop Drawing was reviewed and major deviations from general conformance with the design concept and general compliance with the information given in the Contract Documents were observed, as noted. The Shop Drawing shall be revised to eliminate the deviations noted and resubmitted.
 - d. **REJECTED** - The Shop Drawing was reviewed and is not in general conformance with the design concept or in compliance with the information given in the Contract Documents, as noted. A revised Shop Drawing submittal for the specified equipment or materials shall be resubmitted.
 6. Division 1 and General Conditions requirements concerning Shop Drawing submittal review are not applicable to this Division.
 7. Materials and equipment which are purchased or installed without an "REVIEWED WITH NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" Shop Drawing review shall be at the risk of the Contractor and the cost for removal and replacement of such materials and equipment and related work which is judged unsatisfactory by the Architect/Engineer for any reason, shall be at the expense of the Contractor.
 8. Shop Drawings shall be complete and checked prior to submission to the Engineer for review. **Where more than two reviews are required for a given Shop Drawing to reach "REVIEWED WITH NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED AND SUBMIT WRITTEN RESPONSE" status, the Contractor will be invoiced for additional review services at a cost of \$150.00 per hour for review of the third and subsequent submittals.** If the Contractor fails to pay any legitimate additional review services invoice in full within 30 days, then that invoice will be forwarded to the Architect/Owner requesting that to withhold payment of the amount invoiced from the next General Contractors request for payment, as allowed for under the General Conditions of the Contract for Construction (AIA Document A-201). Incomplete submittals will be returned to the Contractor unchecked.
- M. Certifications and Test Reports: The Engineer may, at their option, witness any or all of the on and off site acceptance and operational testing. Submit a detailed listing of certification and testing for each system indicating estimated dates for completion of system installation. This listing of certification and testing shall be submitted at least 30 days before any testing is conducted.
1. Test procedures and test result reporting forms shall be submitted for review no later than the date of the certification and testing listing submittal.

2. Notify the Engineer in writing two weeks prior to any scheduled testing to allow time for Engineer to schedule witnessing of testing, where elected by the Engineer.
 3. Submit six copies of all certifications and test reports to the Engineer for review adequately in advance of completion of the Work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.
 4. Certifications and test reports to be submitted shall include, but not be limited to those items outlined in Section 15020, "Testing, Adjustment and Balancing".
- N. Operating and Maintenance Manuals: Submit two copies of Operating and Maintenance Manuals to the Engineer for approval prior to the beginning of operator training. Provide four approved Operating and Maintenance Manuals for use in operator training. Manuals shall be bound in rigid cover, 3-ring binders with spine and cover labels and shall provide operating and maintenance information for every piece of equipment furnished under this Specification. All sections shall be typed and indexed into sections and labeled for easy reference. Bulletins containing information about equipment which is not installed on the project shall be properly marked up or stripped and reassembled. All pertinent information required by the Owner for proper operation and maintenance of equipment supplied by Division 15 shall be clearly and legibly set forth in memoranda which shall, likewise, be bound with bulletins. As a minimum, the following information shall be provided as applicable:
1. Complete description of each system, item of equipment, and apparatus provided under this Division, including ratings, capacities, performances, data and curves, characteristics identifying name and number, locations, and wiring diagrams, including sources for all parts.
 2. Fully detailed parts lists, including all numbered parts and recommended spare parts, of each item of equipment and apparatus provided under this Division.
 3. Manufacturer's printed instructions describing operation, service, maintenance, and repair of each item of equipment and apparatus.
 4. Typewritten record of tests made of materials, equipment, and systems included under this Division. Such records shall state the dates the tests were conducted, name(s) of person(s) making and witnessing the tests, and citing any unusual conditions relevant to the tests. Temperature control wiring diagrams complete with instructions outlining each sequential step in the start up and shutdown of the heating/cooling system. Include precautions and instructions for servicing each item of the system.
 5. Identifying names, name tags designations and locations for all equipment.
 6. Valve tag lists with valve number, type, color coding, location and function.
 7. Equipment and motor nameplate data.
 8. Copies of all approved Shop Drawing submittals and testing and balancing reports.
 9. Fabrication drawings.
 10. Equipment and device bulletins and cutsheets clearly highlighted to show equipment installed on the project and including performance curves and data as applicable.
 11. Maintenance instructions clearly highlighted to show all required periodic maintenance and lubrication.
 12. Wiring diagrams.
 13. Operating instructions clearly highlighted to show proper operating procedures for all equipment.
 14. Exploded parts views and parts lists for all equipment and devices.
 15. Color coding charts for all painted equipment and conduit.
 16. Location and listing of all spare parts and special keys and tools furnished to the Owner.

- O. Tools: Provide and deliver to the Owner's authorized representative any special tools required for maintenance of systems, equipment, and apparatus installed under this Division prior to requesting final acceptance of the installation.

1.15 PROJECT RECORD DOCUMENTS:

- A. Site Prints: Maintain a set of clearly marked black line prints of the Contract Drawings at the job site which shall be used for recording the work details, final size, location, interrelation, and similar items of all work under this Division. This set of Drawings shall be corrected daily as the Work progresses and shall clearly indicate all changes to suit field conditions, changes made by "Field Order" or "Change Order", accurate dimensions of all buried or concealed work, precise locations of all concealed work, locations of all concealed valves, controls and devices and any deviations from the work shown on the Construction Documents which are required for coordination. All dimensions shall be to at least two permanent structure points.
- B. Upon completion of the work, the Contractor shall transfer all marks from the site prints to a set of reproducible record "as-built" Drawings using red pencil. The reproducible record "as-built" Drawings shall have the Engineers name and seal removed or blacked out and shall be clearly marked and signed on each sheet as follows:

CERTIFIED RECORD DRAWINGS
DATE:

(NAME OF GENERAL CONTRACTOR)

BY: (SIGNATURE)

(NAME OF SUBCONTRACTOR)

BY: (SIGNATURE)

- C. Approval: Prior to final acceptance of the Work of this Division, the Contractor shall submit one reproducible and two black line prints of properly certified Record Drawings to the Engineer for review and shall make changes, corrections, or additions as the Engineer may require to the Record Drawings.

1.16 COORDINATION OF MECHANICAL WORK:

- A. General: Refer to Division 1 for general coordination requirements applicable to the entire work. It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships which must be established within the mechanical work, and in its interface with other work including utilities and electrical work and that such establishment is the exclusive responsibility of the Contractor. The Drawings show diagrammatically the sizes and locations of the various ductwork and piping systems and equipment items and the sizes of the major interconnecting ducts and pipes, without showing exact details as to elevations, offsets, control lines, and installation details.
 - 1. Arrange mechanical work in a neat, well organized manner with services running parallel with primary lines of the building construction and with a minimum of 7' overhead clearance where possible.
 - 2. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to avoid obstructions and to provide proper grading of lines. Exact locations of outlets, apparatus and connections thereto shall be determined by reference to detail Drawings, equipment Drawings, roughing-in Drawings, etc., by measurements at the building and in cooperation with other Contractors and in all cases shall be subject to the approval of the Engineer. Relocations necessitated by the conditions at the site or directed by the Engineer shall be made without any additional cost to the Owner or Engineer.

3. All ducts and pipes except those in the various equipment rooms, in unfinished spaces or where specifically designated herein or on the Drawings shall be run concealed in furrings, plenums and chases. Wherever conditions exist which would cause any of these items to be exposed in finished spaces, the Contractor whose work is involved shall immediately call the situation to the attention of the Engineer and shall stop work in those areas until the Owner's Representative or General Contractor directs the resumption of the work. Submit for approval a Shop Drawing for any change in piping, equipment placement, ductwork, etc.
 4. Equipment has been chosen to fit within the available space with all required Code and maintenance clearances and shall be installed as shown. Every effort has been made to also accommodate equipment of other approved manufacturers, however since equipment and access space requirements vary, the final responsibility for installation access and proper fit of substituted equipment rests with the Contractor.
 5. Piping interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Where space requirements conflict, the following order of precedence shall, in general, be observed:
 - a. Building lines.
 - b. Structural members.
 - c. Soil and drain piping.
 - d. Steam and condensate piping.
 - e. Sprinkler piping.
 - f. Vent piping.
 - g. Supply ductwork.
 - h. Exhaust ductwork.
 - i. Chilled water and heating hot water piping.
 - j. Domestic water piping.
 - k. Electrical conduit.
 6. Locate operating and control equipment properly to provide easy access. Arrange entire mechanical work with adequate access for operation and maintenance.
 7. Advise other trades of openings required in their work for the subsequent move in of large units of mechanical work.
 8. Coordinate all items which will affect the installation of the work of this Division. This coordination shall include, but not be limited to, voltage, ampacity, capacity, electrical and piping connections, space requirements, sequence of construction, building requirements and special conditions.
 9. When submitting Shop Drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other Contractors and Subcontractors.
- B. Sequencing Plan/Coordination Drawings:
1. This project involves modifications to the chilled water system and electrical distribution in an operating building which will require sequencing of the construction and multiple scheduled utility outages to construct.
 2. A proposed project construction sequence for critical project work is included on the drawings for Contractor reference.

3. All work related to chillers, chilled water pumps and chilled water piping modifications shall be sequenced such that adequate chiller capacity is available between shutdowns to properly cool the building.
4. Contractor shall submit a proposed project construction sequencing plan and coordination drawings outlining the specific steps for project construction including the proposed date and duration of all required utility outages to the UTHSC-H Project Manager and A/E team for review prior to beginning any work at the site.
5. The proposed project construction sequencing plan and coordination drawings shall sequence and coordinate the work of the General Contractor and all Subcontractors and shall be organized to minimize the quantity and duration of utility outages.
6. The requirement for a "Sequencing Plan" and "Coordination Drawings" shall not be construed as releasing the General Contractor or Subcontractors from their responsibility to Plan and Coordinate the installation of the work or as authorization for the General Contractor or Subcontractors to make unauthorized changes to the Construction Documents or the project design concepts.

1.17 MATERIALS AND WORKMANSHIP:

- A. General: Materials and equipment shall be new, of best grade and quality, and standard products of reputable manufacturers regularly engaged in the production of such materials and equipment.
- B. Workmanship: Work shall be executed and materials installed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent workmen, presenting a neat appearance when completed.
- C. Manufacturer's Recommendations: With exceptions as specified or indicated on the Drawings or in the Specifications, apply, install, connect, erect, use, clean, and condition manufactured articles, materials, and equipment per manufacturer's current printed recommendations. Copies of such printed recommendations shall be kept at the job site and made available as required.

1.18 SPACE REQUIREMENTS:

- A. General: Determine in advance of purchase that the equipment and materials proposed for installation will fit into the confines indicated, leaving adequate clearances for adjustments, repair, or replacement.
- B. Clearance: Allow adequate space for clearance in accordance with requirements of the Code and local inspection department.
- C. Scheduled Equipment: The design shown on the Drawings is based on the equipment scheduled.
- D. Responsibility: Since space requirements and equipment arrangement vary for each manufacturer, the responsibility for initial access and proper fit rests with the Contractor.
- E. Review: Final arrangements of equipment to be installed shall be subject to the Architect's review.

1.19 SAFETY REGULATIONS:

- A. All mechanical work shall be performed in compliance with all applicable and governing safety regulations. All safety lights, guards, signs, and other safety materials and provisions required for the performance of the mechanical work shall be provided by and operated by the Mechanical contractor.

1.20 DELIVERY, STORAGE AND HANDLING OF MATERIALS:

- A. General: Protect all materials and equipment to be installed under this Division from physical and weather damage.
- B. Scope: Work under this Division shall include, but not limited to:
 1. Shipping from point of manufacture to job site.

2. Unloading, moving, and storage on site with proper protection as required.
 3. Hoisting and scaffolding of materials and equipment included in this Division.
 4. Ensuring safety of employees, materials, and equipment using such hoisting equipment and scaffolding.
- C. Installation Coordination: All large pieces of apparatus which are to be installed in the building and which are too large to permit access through doorways, corridors, stairways or shafts shall be brought to the job by the Contractor and shall be placed in the spaces before enclosing partitions and structure are completed.
- D. Protection: All equipment, materials and apparatus stored outdoors, in unenclosed spaces or in enclosed spaces at the jobsite or at the Subcontractor's facilities shall be protected against temperatures ranging from 20°F to 105°F, rain, wind, hail and all other weather conditions that are common to the site location.
1. Storage Outdoors: All equipment, materials and apparatus stored outdoors shall be cribbed up from the ground by Contractor and shall be covered with tarpaulins or other protective covering as required for protection. Provide temporary space conditioning inside protective enclosures as required to properly protect equipment, materials and apparatus.
 2. Storage in an Unenclosed Building: All equipment, materials and apparatus stored in an unenclosed building shall be cribbed up from the floor by Contractor and shall be covered with tarpaulins or other protective covering as required for protection. Provide temporary space conditioning inside protective enclosures as required to properly protect equipment, materials and apparatus.
 3. Storage in and Enclosed Building: All equipment, materials and apparatus stored in an enclosed building shall be cribbed up from the floor by Contractor and shall be covered with tarpaulins or other protective covering as required for protection. Provide temporary space conditioning as required to properly protect equipment, materials and apparatus which are stored in unconditioned buildings from damage.

1.21 NOISE AND VIBRATION:

- A. General: Warrant the heating, ventilating, air conditioning systems, and their component parts to operate without objectionable noise or vibration. Noise from systems or equipment which results in noise within occupied spaces above the recommended NC curves (refer to ASHRAE Standard) shall be considered objectionable. Vibration shall not be apparent to the senses in occupied areas of the building. Objectionable noise, vibration, or transmission thereof to the building shall be corrected.
- B. Sound Testing: Equipment shall be sound tested as specified in the individual Sections. The test data shall be expressed in sound power levels with decibels referenced to 10^{-12} watts and in octave bands as set forth in current ANSI Standards. The sound testing shall be performed in a reverberant room. The room effect shall be defined as the sound power level (decibels referenced to 10^{-12} watts) minus sound pressure level (decibels referenced to 0.0002 microbar) shall be established at 10 dB. The additive "allowance for multiple air outlets" for the purpose of the sound test shall be considered as 5 dB in determining the sound power level per air terminal. The final sound pressure level test results shall be based on the above requirements unless noted or specified otherwise and shall not exceed the noise criteria curve limitations specified.
- C. Noise Level: Except in special areas listed separately, the noise level in occupied spaces shall be equal to, or less than, the "lowest value in the range" of the noise criteria curves for the particular space in accordance with Chapter 7, Table 11 of the 2001 Fundamentals Edition of the ASHRAE Handbook. The noise criteria curves shall be based on current ANSI Standard octave bands and a sound pressure level in decibels referenced to 0.0002 microbars. Sound levels within the occupied spaces must meet the criteria described above and with all building, wall partition, floor, and ceiling construction in place as they exist for the individual spaces. The attenuation through boundary

construction of equipment rooms must be considered in selecting equipment for acceptable noise level.

- D. Verification: Should a question arise of whether noise and vibration in a particular space or piece of equipment meet the above criteria, the Contractor shall be responsible for providing the services of an approved vibration or acoustic consultant to verify criteria compliance.

1.22 ADJUSTING AND START-UP:

- A. Start-up Services: Where specified for any individual item of heating, ventilating, air conditioning, and plumbing equipment, provide a factory-authorized representative for testing, start-up of equipment, and instruction of Owner's operating personnel. Certify that these services have been performed by including a properly executed invoice for these services or a letter from the manufacturer.
- B. Lubrication: Provide a readily accessible means for lubricating all bearings and other machine parts. Extend a lubrication tube with suitable fitting to an accessible location and suitably identify it where lubrication fittings are concealed or inaccessible. Lubricate all parts requiring lubrication and keep them adequately lubricated until final acceptance by the Owner.
- C. Air Filters: Air filters shall be installed on all equipment so equipped prior to initial start-up. In addition, blanket filters shall be installed over coils, filters and over fan powered terminal unit inlets as a pre-filter during construction. Final filters shall be installed prior to the owner's beneficial use (substantial completion)
- D. Testing, Adjusting and Balance: Refer to Section 15020 for requirements.
- E. Operation Prior to Completion: When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Engineer's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or the date of substantial completion, whichever occurs first. Regardless of whether or not the equipment has or has not been operated the Contractor shall properly clean the equipment, install clean filter media, properly adjust and complete all deficiency list items before final acceptance by the Owner. The date of final acceptance and the start of the warranty may not be the same date.

1.23 SITE CLEAN-UP:

- A. Clean-up: Each Contractor shall clean away from the job site all debris, surplus material and similar items, resulting from his work or operations, leaving the job and equipment in a clean condition. Each Contractor shall thoroughly clean all pieces of equipment, ductwork, fixtures and similar items, leaving the installation in a first class, clean, operable condition.
- B. Clean Work Space: If the facility will remain occupied during the construction process, each Contractor shall clean up and maintain, at all times, areas visible to the public to prevent the appearance of a sloppy or careless work space. Employee trash shall be disposed of in a designated trash receptacle maintained by the contractor. All demolition or construction debris not designated for salvage by the Project Manager shall daily be collected and temporarily held in an area designated by, and in quantities allowed by, the owner or the general contractor, or the contractor shall be removed from the site by this contractor and disposed of properly off site.
- C. Salvageable Materials: Materials designated by the OR to be salvaged shall be stored in the building, at a location as directed by the OR and the contractor shall verify with the OR which materials are to be salvaged.
- D. Continuing Facilities Maintenance: In areas that contain equipment or systems that must be serviced, inspected, or maintained, no construction debris shall be allowed to block normal access paths or inhibit the required maintenance or service of those systems. This contractor shall immediately remove any debris that constitutes a hindrance to normal service.
- E. Directed Clean-Up: If the facility will remain occupied during the construction process, should, for any reason, the OR, the Architect or the Engineer notify the contractor of his failure to comply with a clean

work space requirement, and the contractor ignores this requirement, the Owner shall retain the services of a clean-up crew to maintain a clean public work space and back charge the contractor for such contract costs.

- F. Daily Clean-Up: Each Contractor shall clean away from the job site all debris, surplus material, and similar items, resulting from his work or operations, on a daily basis leaving the job and equipment in a clean condition. Each Contractor shall thoroughly clean all pieces of equipment, fixtures, and similar items, leaving the installation in a first class, clean, operable condition.
- G. Equipment Operation: When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the OR's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first. Regardless of whether or not the equipment has or has not been operated the Contractor shall properly clean the equipment, install clean filter media, properly adjust and complete all deficiency list items before final acceptance by the Owner. The date of final acceptance and the start of the warranty may not be the same date.

1.24 POLICIES AND PROCEDURES

- A. Employees: Employees of the contractor that are assigned to this project shall be competent, experienced personnel who have received training for their related tasks and in the operation of any equipment that they are to operate.
- B. Identification: Employees shall be uniformed or wear clothing that clearly distinguishes them as employees of the contractor or subcontractors authorized to provide services at this facility. In addition, employees shall have picture identification badges of a type acceptable to the Owner.
- C. Supervision: Each work crew on the project shall include a full time site foreman or supervisor.
- D. Contact: The contractor shall provide a contact point, available by phone or pager, who will respond immediately to problems, questions or concerns reported by the OR.
- E. Training: Employees shall be trained in any required safety precautions related to the equipment and materials that they are using.

1.25 FINAL REVIEW:

- A. General: Upon completion of the Work, perform a final test of the entire system.
 - 1. The system shall be operating properly with all water and air volumes balanced and all temperature controls adjusted.
 - 2. After the final test, any changes or corrections noted as necessary for the Work to comply with these Specifications or the Drawings shall be accomplished without delay in order to secure final acceptance of the Work.
 - 3. The date for the final test shall be sufficiently in advance of the Contract completion date to permit execution, before expiration of the Contract, of any adjustments or alterations which the final acceptance tests indicate as necessary for the proper functioning of all equipment. Any such modifications shall be completed within the time allotted for completion of the Contract. Retests shall be conducted as directed and shall be of such time duration as necessary to ensure proper functioning of adjusted and altered items. Retests shall not relieve the Contractor of completion date responsibility.
 - 4. Certificates, including certificates of occupancy from local authorities and documents required herein, shall be completely in order and presented to the Engineer at least one week prior to the review.
- B. Qualified Person: Individuals knowledgeable of the systems and persons approved by the Engineer, shall be present at this final inspection to demonstrate the system and prove the performance of the equipment.

1.26 OWNER INSTRUCTION:

- A. General: This Contractor and appropriate factory-trained representatives shall provide to the Owner's representative the specified or manufacturer recommended training and instruction in the proper operation and maintenance of all systems and equipment and shall explain all warranties.
- B. Outline: Prior to instruction of Owner Personnel, prepare a typed outline, listing the subjects that will be included in this instruction, and submit the outline for review by the Engineer.
- C. Certification: At the conclusion of the instruction period obtain the signature of each person being instructed on each copy of the approved outline to signify that he has a proper understanding of the operation and maintenance of the systems and resubmit the signed outlines.
- D. Other Requirements: Refer to other Division 15 Sections for additional operator training requirements.

1.27 CONTRACTOR WARRANTIES AND GUARANTEES:

- A. General: Contractor shall guarantee all material and equipment installed by him against defects in workmanship and material for a period of 12 months after final acceptance of the work by the Owner and he shall repair or replace any materials or equipment developing such defects within that time, promptly on due notice given him by the Owner and at Contractor's sole cost and expense.
- B. Equipment: All equipment bearing a manufacturer's guarantee, such as motors, compressors, condensers, heat exchangers, water heaters, blowers, controls, and similar items, shall be construed to have an extended guarantee to the Owner by the manufacturer. Any such equipment that proves defective in materials or workmanship within the guarantee period is to be replaced by the Contractor in accordance with the manufacturer's guarantee.
- C. Start-up: The Mechanical Contractor shall provide instructions and equipment starting service on new equipment for one complete year after date of final acceptance of the work by the Owner, at Contractor's sole cost and expense.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

SECTION 15004

MECHANICAL SCOPE OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15002, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: Provide labor, materials, tools, machinery, equipment, appliances, and services necessary to complete the specified mechanical work of this Division. Coordinate Work with other trades to prevent conflicts without impeding job progress.
- B. Project Sequencing: This project involves power distribution and chilled water system modifications in an existing operating building which will require sequencing of the construction and multiple scheduled utility outages to construct. A proposed project construction sequence for critical project work is included on the drawings for Contractor reference. Contractor shall submit a proposed project construction sequence outlining the specific steps for project construction including the proposed date and duration of all required utility outages to the UTHealth Project Manager and A/E team for review prior to beginning any work at the site.
- C. Utility Charges: The Contractor shall pay fees, tap charges, meter charges, and special fees assessed by the local utilities or local authorities.
- D. Work Included: The Work includes, but is not limited to, the following systems, equipment, and services:
 - 1. Air Distribution Systems including, but not limited to:
 - a. HVAC Terminal units.
 - b. Sheet metal ductwork.
 - c. Balancing dampers and accessories.
 - d. Grilles, registers and ceiling outlets.
 - e. Insulation.
 - f. Acoustical treatment of ducts.
 - g. Sound attenuating equipment, lined elbows and transfer ducts.
 - h. Additional items as specified, indicated or implied on the Drawings.
 - i. Additional items as shown on the Drawings as specified or required to provide the specified controls and sequences.
 - 2. Modifications and additions to the existing Building Automation and Control System (BAS).
 - 3. Modifications to the existing wet-pipe fire sprinkler system including, but not limited to:
 - a. Sprinkler heads.
 - b. Fire protection piping.
 - c. Additional items specified, indicated, or implied on the Drawings.
 - 4. Connections to equipment furnished by the General Contractor or other Divisions.
 - 5. Connections for Owner-furnished equipment where shown on the Drawings or specified.

6. Testing, balancing and adjusting of mechanical systems as specified.
7. Additional items as shown on the Drawings or specified.
8. Structural Openings:
 - a. The Mechanical and Plumbing Contractors shall provide the Structural Engineer with locations, dimensions, and weights of his equipment to be supported by the floor structural systems immediately following the awarding of the Contract. The final locations of his equipment shall be subject to the approval of the Structural Engineer. The Electrical Contractor shall provide accessories necessary to hang his equipment from structure at locations and in a manner approved by the Structural Engineer.
 - b. The Mechanical and Plumbing Contractors shall be responsible for coordinating all required openings in existing construction with the General Contractor and Structural Engineer and shall be responsible for cutting or drilling required openings in a manner which is acceptable to the Owner. Cutting and drilling operations shall be performed at times which are acceptable to the Owner.
 - c. Except as otherwise indicated on the Drawings, all holes of area less than 50 square inches required through concrete floors, precast concrete, masonry, and similar items, shall be provided by the Electrical Contractor. All holes required through post-tensioned concrete floors and roof and all other holes that proper electrical installation require to be of a larger area than 50 square inches will be provided by the General Contractor at locations determined by this Contractor. Any cutting and patching for holes required for proper electrical installation where information on sizes and locations is not provided to the General Contractor in sufficient time shall be the responsibility of the Electrical Contractor. All cutting and patching shall be subject to the direction and approval of the Architect.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. Refer to specific Sections of the Specifications for equipment.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Installation shall be in accordance with the Specification section pertaining to the individual equipment.

END OF SECTION

SECTION 15020

TESTING, ADJUSTMENT AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15002, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: All HVAC, plumbing and fire protection systems and equipment on this project shall be successfully proof, acceptance and operationally tested and balanced, as applicable prior to acceptance of the project by the Owner.
- B. Proof and Acceptance Testing: The Division 15 Contractor shall provide proof and acceptance testing of HVAC, plumbing and fire protection systems and equipment during the construction process to verify that systems are installed and function as specified. Piping systems shall not be insulated, covered up, or placed in service until piping has been successfully tested, flushed, cleaned and water-treated, as applicable. Ductwork shall not be externally insulated, covered up or placed in service until it has been successfully tested. Equipment shall not be placed in service until it has been checked out, tested and adjusted, as applicable. The Division 15 Contractor shall provide all required proof and acceptance testing, as specified hereinbelow.
- C. System Adjustments/Operational Certification: The Division 15 Contractor shall provide required system adjustments and certify that each HVAC, plumbing and fire protection system is operational, as specified hereinbelow.
- D. Operational Testing and Balancing: All new and modified existing HVAC air, water and control systems on the project shall be operationally tested and balanced prior to acceptance by the Owner. Systems shall be made operational and prepared for operational testing and balancing by the Division 15 Contractor. Operational testing and balancing is specified in Section 15021 and shall be provided by an independent Testing and Balancing (TAB) Consultant who shall be contracted directly to and paid by the Owner and shall have no contractual relationship or obligation to the General Contractor or Division 15 Contractor. The Owner will provide the services of designated Owner's Representatives (OR) who will observe selected testing and balancing for the systems installed on the project. The Division 15 Contractor shall provide coordination with and preparations for the TAB Consultant's operational testing and balancing work as specified hereinbelow.
- E. Project Completion: The Division 15 contractor shall provide project completion services as specified hereinbelow.

1.3 QUALITY ASSURANCE:

- A. References: Comply with applicable requirements and recommendations of the following:
 - 1. AABC - 1989 Fifth Edition: National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems.
 - 2. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
 - 3. ASHRAE - 1991 HVAC Applications Handbook: Chapter 34, Testing, Adjusting and Balancing.
 - 4. SMACNA - HVAC SYSTEMS Testing, Adjusting and Balancing.
- B. Personnel: Submit evidence to show that the personnel who will actually test systems and equipment are qualified. Evidence showing that the personnel have passed the tests required by the Associated

Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB) will be sufficient. The Engineer reserves the right to require that the originally approved personnel be replaced with other qualified personnel if, in their opinion, the original personnel are not qualified or are not properly conducting the system testing.

1.4 SUBMITTALS:

- A. Testing Procedures: Submit six copies of all proposed proof and acceptance testing and operational certification procedures to the Engineer for review at least 30 days prior to conducting any testing or certification.
- B. Reporting Forms: Submit four copies of proposed forms to be used in recording test and certification data and results to the Engineer for review at least 30 days prior to conducting any testing on the project. Data forms from AABC or NEBB will be acceptable.
- C. Test and Certification Data and Results: Submit six copies of complete data and certified test results for each test performed, including, but not limited to:
 - 1. Title Page: Provide the following information on a title page:
 - a. Title
 - b. System(s) tested
 - c. Testing Company Name
 - d. Testing Company Address
 - e. Testing Company Telephone Number
 - f. Testing Company Contact Person
 - g. Project Name
 - h. Project Location
 - i. Project Architect
 - j. Project Engineer
 - k. Project General Contractor
 - l. Other pertinent information
 - 2. Instrument List: Provide the following information on an instrument listing page:
 - a. Instruments
 - b. Manufacturers
 - c. Models
 - d. Serial Numbers
 - e. Ranges
 - f. Calibration Dates
 - 3. Test/Certification Data and Results: Provide pages with applicable test and certification data and results including, but not limited to the following:
 - a. Test/certification performed.
 - b. Test/certification procedure.
 - c. System and area tested.
 - d. Date(s) and time(s) of test.
 - e. Weather conditions.
 - f. Test/certification criteria.
 - g. Test/certification results.
 - h. Additional pertinent information.
- D. Operational Certification: Submit six certified copies of an operational certification which documents that all equipment and systems have been fully tested to verify proper operation in accordance with the design shown in the Construction Documents and manufacturer's recommendations.
- E. Certification of TAB Preparations: The Division 15 Contractor shall certify in writing to the Engineer and TAB consultant, by system and area, when coordination is completed and systems have been

fully proof/acceptance tested and are operational and prepared for acceptance testing and balancing by the TAB consultant.

- F. Certification: Certifications stating that submitted data is true and correct shall be provided for all submittals under this Section. Certification shall be executed by an authorized officer if the Contractor is a corporation, by a partner if the Contractor is a partnership, by the Owner if the Contractor is a sole proprietorship or by the authorized representative if the Contractor is a joint venture.
- G. Calibration List: Submit four copies of a listing of testing devices to be used for the project to the Engineer for approval. Listing shall include documentation that devices are properly calibrated.
- H. Test/Certification Log: The Contractor shall maintain a test/certification log at the site to document the results of all successful and unsuccessful testing/certification as it is performed. This log shall be available for review by the Engineer and a copy of the log shall be submitted to the Engineer prior to the Substantial Completion inspection. A space shall be provided on the test/certification log for signoff by the OR/Engineer.
- I. Operating and Maintenance Manuals: Approved copies of Testing Procedures, Test and Certification Data and Results, Operational Certification and Test/Certification Log shall be included in the Operating and Maintenance Manuals specified in Section 15002.

1.5 NOTICE:

- A. General: Notify the Engineer in writing two weeks prior to all scheduled testing and certification to allow time for Engineer to schedule witnessing of testing and certification, where elected by the Engineer.

PART 2 - PRODUCTS

2.1 TESTING MATERIALS:

- A. General: Provide all materials, equipment and personnel for all required proof and acceptance testing and preparation for operational testing and balancing, including all required retesting and reparation.
- B. Products: Tested products which fail to provide acceptable test results shall be repaired or replaced with suitable materials and then retested until acceptable test results are obtained.

PART 3 - EXECUTION

3.1 PROOF AND ACCEPTANCE TESTING:

- A. General: Proof and acceptance tests shall be made during the course of construction as specified hereinbelow and in other Sections of this Division and as required by Authorities having jurisdiction. Such tests shall be conducted by this Division as a part of the Work and shall include all provisions, personnel, material and equipment required to perform tests until satisfactory results are obtained. Any defects detected during testing shall be satisfactorily repaired or the equipment involved shall be replaced and the tests re-executed.
- B. Tests: Testing shall include, but not be limited to, all items listed in other Sections of this Division, and the following:
 - 1. Plumbing System Hydrostatic Testing: All fire protection piping shall be hydrostatically tested as specified herein above and additional tests shall be performed as Specified in Sections 15400.
 - 2. Fire Protection System Hydrostatic Testing: All fire protection piping shall be hydrostatically tested as specified herein above and additional tests shall be performed as Specified in Sections 15510.
 - 3. Duct Leakage Testing: Provide duct integrity and leakage testing as specified in Section 15840.

4. Operational Testing: The Contractor shall test all systems and components installed in the building to verify proper operation is provided as described in the specifications and manufacturer's recommendations.

- C. Authorities Having Jurisdiction: The Division 15 Contractor shall also perform any additional proof and acceptance testing required by all applicable Authorities having jurisdiction over the project.

3.2 **SYSTEM ADJUSTMENTS:**

- A. General: Systems installed under this Division, except HVAC air and water balancing shall be adjusted by the Division 15 Contractor to provide proper operation.
- B. Adjustments: Systems to be adjusted shall include, but not be limited to:
 1. Miscellaneous Controls and Alarms: Adjust and test all miscellaneous pressure, temperature, flow, level, refrigerant and similar controls and related alarm systems and monitoring to provide proper operation.
 2. Control Balancing: All control systems and equipment installed on the project shall be programmed, calibrated and/or adjusted to provide proper operation or function in accordance with the drawings, specifications and manufacturer's recommendations. This programming, calibration and adjusting shall be completed as part of the preparations for air and water system balancing specified hereinbelow.

3.3 **OPERATIONAL CERTIFICATION:**

- A. General: Submit HVAC, plumbing and fire protection systems to operational tests to demonstrate satisfactory system operation.
- B. HVAC Systems: Operationally test project HVAC systems to demonstrate satisfactory operation. Operation tests shall include, but not be limited to:
 1. Test results for all ductwork leakage tests.
 2. Results of other HVAC system tests.
 3. Time, date and duration of each test.
- C. Fire Protection Systems: Operationally test project fire protection systems to demonstrate satisfactory operation. Operational testing shall include, but not be limited to:
 1. Test results for all piping system leakage tests.
 2. Results of other required fire protection system tests.
 3. Time, date and duration of each test.

3.4 **PREPARATION FOR OPERATIONAL TESTING AND BALANCING:**

- A. General: All air systems installed on the project shall be balanced and/or adjusted to provide proper operation or function in accordance with the drawings, specifications and manufacturer's recommendations. Refer to Section 15021 for HVAC air system operational testing and balancing. System startup and preparation for operational testing and balancing shall be provided under this Section.
- B. Provisions for Operational Testing and Balancing: The Division 15 Contractor shall install all provisions for operational testing and balancing as shown on the drawings, specified and required by the TAB Consultant. These provisions shall include, but not be limited to all control, regulating and readout devices necessary to operationally test and balance all air, water and control systems including, but not limited to: thermometers; pressure gauges; balancing valves; air volume, splitter and extractor dampers; pressure taps; temperature taps and wells; pitot tube ports; and other necessary provisions.
 1. The Division 15 Contractor shall notify the Engineer in writing and receive clarification in writing prior to submitting a bid, if in the Contractor's opinion, any required provisions have been omitted. Submission of a bid constitutes an agreement that all provisions required for operational testing and balancing shall be provided at no cost to the Owner or

Architect/Engineer, regardless of whether such provisions are specifically shown on the drawings or in the specifications.

- C. Coordination and Scheduling: The Division 15 Contractor shall coordinate and schedule preparations for operational testing and balancing with the TAB Consultant. This coordination and scheduling shall include, but not be limited to:
1. Coordinate exact locations of operational testing and balancing provisions with the TAB Consultant.
 2. Sequence completion of preparation for operational testing and balancing to allow adequate time for the TAB Consultant to complete operational testing and balancing prior to project substantial completion.
- D. TAB Consultant Noted Deficiencies: The Division 15 Contractor shall correct any deficiencies noted to the TAB Consultant during the operational testing and balancing process. Corrections shall be made in a timely manner so as not to impede the work of the TAB Consultant. These corrections shall include, but not be limited to:
1. Relocating test points and sensors/controllers which are installed or positioned in a manner which prevents correct measurement or sensing of temperatures, pressures, humidity, etc. and to provide sufficient access to these devices.
 2. Corrections to control functions which do not operate in accordance with the sequence of operation.
 3. Recalibration of control devices.
 4. Relocation of air and water taps which are installed or positioned in a manner which does not allow design flows to be obtained in the tap.
 5. Relocation of balancing and control devices to provide sufficient access to these devices.
 6. Addition of required balancing dampers and valves.
- E. Preparation for Air Balancing: All modified existing and new air systems shall be completely installed, operational and prepared prior to commencing with air balancing. The minimum steps required for preparation for air balancing shall include, but not be limited to:
1. Inspection: Inspect and certify in writing that the complete air system including, but not limited to: air handling equipment, fans, terminal units, coils, ductwork, air devices, dampers, controls, balancing devices, access doors, test ports, return air paths, partitions to deck and doors in partitions to deck are installed and operational, as applicable.
 2. Operation: Certify that the complete air system is operable and operates in a safe and normal manner.
 3. Dampers: Inspect and certify in writing, that all required volume, splitter, extractor, fire, smoke and fire/smoke dampers are installed, that all balancing dampers are in the open and locked position, that all fire dampers are open, that all fire/smoke, smoke and control dampers open and close properly in response to control sequences and that all access doors are closed and sealed.
 4. Fans: Adjust and verify in writing that all fans are operating properly, are rotating at design fan RPM in the proper direction, are free from vibration, have proper belt tension and that properly sized overload elements are installed in motor starters, where motors are not self-protected. Record motor nameplate data and measured voltage and amperage on each phase at initial motor startup.
 5. Controls: Verify in writing that all required air system controls, interlocks and safety devices are fully operational and that all controlling devices are calibrated and set for designed conditions.
 6. Testing: Verify in writing that all specified duct leakage and fire, smoke and fire/smoke damper testing has been successfully completed and that duct systems are clean and free of any dirt or debris.

7. Cleaning: Install clean air filters in all equipment and, where equipment has been operated, clean coils and vacuum equipment interior in preparation for balancing. Comb out any coiled fins damaged by construction or cleaning. The Engineer and OR shall be the final decision makers on whether coils and equipment must be cleaned prior to balancing.
8. Notification: Notify the Engineer and TAB Consultant in writing when all items required in paragraphs 3.04B, 3.04C, 3.04D 3.04E and 3.04F/1-8 have been completed for a specific air system and certify that the system is operational and prepared for operational testing and balancing.

3.5 **PROJECT COMPLETION:**

- A. General: Prior to Project Substantial Completion, the Contractor shall provide project completion services necessary to complete the project.

END OF SECTION

SECTION 15021

OPERATIONAL TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15002, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: All HVAC air systems and related equipment on this project shall be successfully operationally tested and balanced, as applicable prior to acceptance of the project by the Owner.
- B. Operational Testing and Balancing: All new and modified existing HVAC air systems on the project shall be operationally tested and balanced prior to acceptance by the Owner. Systems shall be made operational and prepared for operational testing and balancing by the Division 15 Contractor. Operational testing and balancing is specified herein and shall be provided by an independent Testing and Balancing (TAB) Consultant who shall be contracted directly to and paid by the Owner and shall have no contractual relationship or obligation to the General Contractor or Division 15 Contractor. The Owner will provide the services of designated Owner's Representatives (OR) who will observe selected operational testing and balancing for the systems installed on the project. The Division 15 Contractor shall provide coordination with and preparations for the TAB Consultant's operational testing and balancing work as specified in Section 15020.
- C. Follow-up Services: The TAB Consultant shall provide the following follow-up services related to operational testing and balancing, as a minimum:
 - 1. Provide one follow-up inspections within 90 days of occupancy for temperature verification. Make any required corrections and adjustments and submit documentation of findings and associated correction and adjustments made to the Owner's Representative and the Engineer.
- D. Coordination: The TAB Consultant shall cooperate and coordinate their work with the General Contractor and Division 15 and 16 Subcontractors who shall provide assistance.

1.3 QUALITY ASSURANCE:

- A. Experience: The TAB Consultant shall be a company specializing in the adjusting and balancing of systems of the types included on this project and shall have a minimum of five years of documented adjusting and balancing experience on systems similar to the types included on this project.
- B. Supervision: All operational testing and balancing work shall be performed under the supervision of an AABC or NEBB certified Test and Balance Engineer. The TAB Consultant shall have a minimum of one Professional Engineer registered in the State in which the services are to be performed.
- C. References: Comply with applicable requirements and recommendations of the following:
 - 1. AABC - Current Edition: National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems.
 - 2. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
 - 3. ASHRAE - 1991 HVAC Applications Handbook: Chapter 34, Testing, Adjusting and Balancing.
- D. Personnel: Submit evidence to show that the personnel who will actually test systems and equipment are qualified. Evidence showing that the personnel have passed the tests required by the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB) will be sufficient. The Engineer reserves the right to require that the originally approved personnel be replaced with

other qualified personnel if, in their opinion, the original personnel are not qualified or are not properly conducting the operational testing and balancing.

1.4 SUBMITTALS:

- A. Testing and Balancing Procedures: Submit four copies of all proposed operational testing and balancing procedures to the Engineer for review at least 30 days prior to conducting any testing or balancing.
- B. Reporting Forms: Submit four copies of proposed forms to be used in recording operational testing and balancing data and results to the Engineer for review at least 30 days prior to conducting any testing or balancing on the project. Data forms from AABC, NEBB or SMACNA will be acceptable.
- C. Operational Testing and Balancing Data and Results: Submit six copies of complete operational test and balance data and certified balance results for each system balanced, including, but not limited to:
 1. Title Page: Provide the following information on a title page.
 - a. Title
 - b. System(s) operationally tested and balanced
 - c. TAB Consultant Name
 - d. TAB Consultant Address
 - e. TAB Consultant Telephone Number
 - f. TAB Consultant Contact Person
 - g. Project Name
 - h. Project Location
 - i. Project Architect
 - j. Project Engineer
 - k. Project General Contractor
 - l. Other pertinent information
 2. Instrument List: Provide the following information on an instrument listing page.
 - a. Instruments
 - b. Manufacturers
 - c. Models
 - d. Serial Numbers
 - e. Ranges
 - f. Calibration Dates
 3. Operational Test/Balance Data and Results: Provide pages with applicable operational testing and balancing data and results including, but not limited to the following.
 - a. Operational test/balance performed
 - b. Operational test/balance procedure
 - c. System and area tested
 - d. Date(s) and time(s) of test
 - e. Weather conditions
 - f. Project altitude
 - g. Operational test/balance criteria
 - h. Additional pertinent information
 4. Duct Traverse Data: Provide pages with applicable duct traverse data including, but not limited to the following:
 - 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
5. Air Distribution Device Flow Data Sheets: Provide pages with applicable air distribution device flow data including, but not limited to the following:
- 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
6. Additional Data Sheets: Provide pages with additional data and information as required to present all data and information associated with the operational testing and balancing process.
- D. Certification: Certifications stating that submitted data is true and correct shall be provided for all submittals under this Section. Certification shall be executed by an authorized officer if the Contractor is a corporation, by a partner if the Contractor is a partnership, by the Owner if the Contractor is a sole proprietorship or by the authorized representative if the Contractor is a joint venture.
- E. Calibration List: Submit four copies of a listing of testing and balancing devices to be used for the project to the Engineer for approval. Listing shall include documentation that devices are properly calibrated.
- F. Operational Testing/Balancing Log: The Contractor shall maintain a test/balancing log at the site to document the results of all successful and unsuccessful testing/balancing as it is performed. This log shall be available for review by the Engineer and a copy of the log shall be submitted to the Engineer prior to the Substantial Completion inspection. A space shall be provided on the testing/balancing log for signoff by the OR/Engineer.
- G. Operating and Maintenance Manuals: Approved copies of Testing Procedures, Operational Testing and Balancing Data and Results and the Operational Testing/Balancing Log shall be included in the Operating and Maintenance Manuals specified in Section 15002.
- 1.5 **NOTICE:**
- A. General: Notify the Engineer in writing two weeks prior to all scheduled operational testing and balancing to allow time for Engineer to schedule witnessing of operational testing and balancing, where elected by the Engineer.

PART 2 - PRODUCTS

2.1 TESTING MATERIALS:

- A. General: Provide all materials, equipment and personnel for all required operational testing and balancing, including all required retesting and rebalancing.
- B. Products: Installed products which fail to provide acceptable balance results shall be repaired or replaced with suitable materials by the installing contractor and then rebalanced until acceptable test results are obtained.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Provisions for Balancing: Fully examine the Drawings and Specifications for this project and determine whether or not sufficient volume dampers, balancing valves, thermometers, gauges, pressure and temperature taps, means of reading static and total pressure in duct systems, means of determining water flow, and other means of taking data needed for proper testing and balancing are shown or specified. If, in the opinion of the Testing and Balancing Consultant, any required items have been omitted, notify the Engineer in writing and receive clarification before submitting a proposal for this project. Tender of a proposal conveys full agreement of the system as designed provides provisions for proper balancing.
- B. Preparation for Operational Testing and Balancing: The Division 15 Contractor shall install all systems, make them operational and prepare them for operational testing and balancing as specified in Section 15020. The TAB Consultant shall coordinate these preparations with the Division 15 Contractor including, but not limited to:
 - 1. Coordinate exact locations of operational testing and balancing provisions with the TAB Consultant.
 - 2. Sequence completion of preparation for operational testing and balancing to allow adequate time for the TAB Consultant to complete operational testing and balancing prior to project substantial completion.
- C. TAB Consultant Noted Deficiencies: The Division 15 Contractor shall correct any deficiencies noted to the TAB Consultant during the operational testing and balancing process. Corrections shall be made in a timely manner so as not to impede the work of the TAB Consultant. These corrections shall include, but not be limited to:
 - 1. Relocating test points and sensors/controllers which are installed or positioned in a manner which prevents correct measurement or sensing of temperatures, pressures, humidity, etc. and to provide sufficient access to these devices.
 - 2. Corrections to control functions which do not operate in accordance with the sequence of operation.
 - 3. Recalibration of control devices.
 - 4. Relocation of air and water taps which are installed or positioned in a manner which does not allow design flows to be obtained in the tap.
 - 5. Relocation of balancing and control devices to provide sufficient access to these devices.
 - 6. Addition of balancing dampers and valves.
- D. Scheduling: The TAB Consultant shall schedule their work so as to smoothly coordinate with the work of the General Contractors and Subcontractors and to minimize impact on completion and occupancy of the building.

3.2 AIR BALANCE:

- A. General: When preparations for air balancing have been completed and signed off by the Division 15 Contractor, verify that preparations have been completed and perform an air balance on all new and modified existing air systems in accordance with applicable AABC or NEBB Standards and record the results on applicable forms. The supply, return, outside air and exhaust volume to/from each piece of equipment, through each volume damper and through each air device shall be adjusted to within $\pm 5\%$ of the values shown on the Drawings and or scheduled. The minimum scope required for air balancing shall include, but not be limited to:
 - 1. Shop Drawings: Obtain copies of Shop Drawings and manufacturer's data for all equipment, dampers and air devices and temperature control diagrams.

2. Report Forms: Prepare report test sheets for each item of equipment, damper and air device type with appropriate data entry points, manufacturer's data and recommended test procedure.
3. HVAC Terminal Units: Measure and adjust hot and cold damper air volumes for unit, as applicable. Verify proper operation of unit monitoring, temperature controls and associated automatic dampers.
4. Ductwork: Verify that ductwork leakage is not excessive by comparing equipment duct traverse readings to air device and served equipment duct traverse readings.
5. Volume Dampers: Clearly and permanently mark the balanced position and balance date on all volume dampers.
6. Air Devices: Measure and adjust each air return or exhaust inlet and supply diffuser, register and grill to within $\pm 5\%$ of design air cfm. Dampers in diffusers, if provided, may be used for only 10% adjustment from full air flow.
7. Control Devices: Verify operation and adjustment of all control devices.
8. Balancing Methods: Where opposed-blade dampers (OBD's) are scheduled or specified, these dampers shall be used for final balancing only and shall be throttled a maximum of 10% closed.
9. Volume Measurements:
 - a. Ampere Readings: Measure and record full load amperes for motors.
 - b. Static Pressures: Static pressure gains or losses shall be measured across each supply fan, cooling coil, heating coil, return air fan, air handling unit filter and exhaust fan. These readings shall be graphically compared to the specific fan curve. Static pressures shall be measured and recorded for this report at the furthest air device or terminal unit from the air handler supplying that device. Static pressure readings shall also be provided for systems which do not perform as designed.
 - c. Equipment Airflow: Measure and record exhaust, return, outside and supply air cfm(s) and temperatures, as applicable, at each fan, blower and coil.
 - d. Coil Temperatures: Set controls for full cooling and for full heating loads. Measure and record entering and leaving dry bulb and wet bulb temperatures at each cooling coil, heating coil and HVAC terminal unit.
 - e. Zone Airflow: Measure and record airflow for each fan coil unit for design cfm.
 - f. Outlet Airflow: Measure and record air volume for each air return or exhaust inlet and supply diffuser, register and grille. Measure discharge temperature from the most remote supply air device served by each air handling unit, fan coil unit and terminal unit and record along with the serving equipment discharge air temperature and calculated duct heat gain delta T. Include all terminal points of air supply, all points of exhaust and all points of return air.
 - g. Pitot Tube Traverses: For use in future troubleshooting by maintenance personnel, all exhaust ducts, main supply ducts and return ducts shall have air velocity and volume measured and recorded by the traverse method. Locations of traverse measurements shall be clearly described on the sheet containing the data.
 - h. Pressure Reducing Stations: Measure and record the control air pressure before and after each pressure reducing station.
 - i. Zone Control: Measure and record the control air pressure at minimum and maximum cooling, calibration point, full bypass, and minimum and maximum heating when applicable.

END OF SECTION

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SECTION 15100

BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15002, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide basic materials and methods for mechanical construction as shown, scheduled, indicated, and specified.
- B. Types: The types of basic materials and methods required for the project include, but are not limited to:
 - 1. General piping installation.
 - 2. Hangers and supports.
 - 3. Miscellaneous steel.
 - 4. Sleeves.
 - 5. Escutcheon plates.
 - 6. Openings, cutting and patching.
 - 7. Access doors.
 - 8. Firestopping for piping and ductwork.
 - 9. Fire-rated partitions.
 - 10. Flame spread properties of materials.
 - 11. Penetrations, flashing, and seals.
 - 12. Cleaning and painting of mechanical work.
 - 13. Mechanical system identification.
 - 14. Warning signs and operational tags.
 - 15. Equipment connections.
 - 16. Equipment housekeeping pads and anchor bolts.
 - 17. Miscellaneous curbs and supports.
 - 18. Device mounting heights.
 - 19. Demolition and work within existing buildings.

1.3 SUBMITTALS:

- A. Shop Drawing submittals shall include, but not be limited to, the following:
 - 1. Pipe fabrication drawings.
 - 2. Cut sheets on pipe hangers and supports, escutcheons, access doors, fire stopping materials, and miscellaneous curbs and supports.
 - 3. Cut sheets and samples of mechanical identification products.
 - 4. Additional information as required in Section 15002.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver components in factory-fabricated water resistant packaging.
- B. Handle components carefully to avoid damage to components, enclosures, and finish.
- C. Store components in a clean, dry space and protect from weather.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. General: Refer to Part 3 of this Section and other Division 15 sections for basic mechanical products and materials.

PART 3 - EXECUTION

3.1 GENERAL PIPING INSTALLATION:

- A. General: The Contractor shall provide all piping system components as shown on the Drawings or necessary to complete the working system in accordance with the intent of the Drawings and Specifications, a complete system of piping, all valves as indicated or as necessary to completely control the entire apparatus and all appurtenances. The Piping Drawings are diagrammatic and indicate the general location and connections.
- B. Erection: Piping shall be properly supported and adequate provisions shall be made for expansion, contraction, slope and anchorage. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked in place without springing or forcing. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burr and cutting slag removed by reaming or other approved cleaning methods. All changes in direction shall be made with fittings, except that bending of pipe will be permitted provided a hydraulic pipe bender is used. Bent pipe showing kinks, wrinkles, or other malformation will not be acceptable.
- C. Concealed and Exposed Piping: All piping in finished areas shall be concealed, unless otherwise noted. Piping exposed in mechanical rooms and other locations as noted shall be installed in an orderly manner and parallel with or perpendicular to building lines. Exposed piping in occupied areas shall be routed tight to the structure or as high as is possible.
- D. Grading: All piping shall be carefully installed so as to eliminate traps and pockets in pressurized lines and to maintain flow in gravity flow lines. Where air pockets and traps cannot be avoided, provide valved hose connections for water traps and valved automatic air vents for air traps. The Contractor shall consider pipe grading requirements when coordinating pipe routing for the project. Pipe slope shall be maintained throughout the project. Waste and vent piping shall be sloped in accordance with the applicable codes. Pressurized plumbing piping systems shall be sloped to drain points. HVAC water piping systems shall be graded up 1/16" per 10 lineal foot of horizontal run to air vent locations and down 1/16" per 10 lineal feet of horizontal run to drain locations. Grade all steam piping 1/4" per 10 lineal feet of horizontal run toward steam traps and slope all steam condensate piping 1/4" per 10 lineal feet of horizontal run toward condensate receivers.
- E. Arrangement: Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment. All valves and specialties shall be placed to permit easy and proper operation and access, and all valves shall be regulated, packed and glands adjusted at the completion of the work before final acceptance. Tapered reducers shall be used wherever changes in pipe sizes occur in mains. Bushings will not be permitted. The use of bull head tees or other high pressure drop configurations will not be permitted.
- F. Welding: All welded joints in piping shall be continuous metallic arc or gas fusion welds connecting pipe ends which are beveled to 37-1/2 degrees before welding. The use of backing rings will not be acceptable. All taps shall be made using proper weld fittings. No "burn-ins" will be allowed. Gas torch cuts shall be true and free from burned metal. Clean pipe surfaces to be welded immediately prior to welding. Welded pipe joints shall be properly aligned with no weld material or bead projects in into the pipe. All weld procedures shall be in accordance with requirements of the American Welding Society and shall be performed by certified welders. Documentation of welder certification shall be available if requested. All welding operations shall conform to the latest recommendations of the American Welding Society and to Section Six of Power Piping, ANSI B31.1 1973; B31.3 for steam piping. All qualifying tests, welding and stress relieving procedures, shall, moreover, be in accord with Standard Qualification for WELDING PROCEDURES, WELDERS AND WELDING OPERATORS,

APPENDIX A, SECTION 6 of the Code, current edition. In no cases shall Schedule 40 pipe be welded with less than three passes including one tack, one filler, and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one tack, two fillers and one lacer. Welds lacking penetration shall be removed. Internal and external cracks shall be ground down and removed.

1. All weld fittings shall be USA factory made wrought carbon steel butt-welding fittings conforming to ASTM A234 and ASME/ANSI B16.9 latest edition, as made by aNVIL, Tube Turn, Hackney, Taylor Forge, or Ladish Company. Long radius fittings shall be provided for all 90 degree and 45 degree elbows. Each fitting shall be stamped as specified by ASME/ANSI B16.9 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties required for any fitting selected at random. Complete test reports may be required for any fittings selected at random. Only one manufacturer of weld fittings will be approved for each project. Fittings which have been machined, remarked, printed or otherwise produced domestically from imported forgings or materials will not be acceptable. Each fitting shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Markings shall be placed on the fittings at the farthest point from the edge to be welded to prevent disfiguring from the welding process. Submittal data for these fittings shall include a letter signed by an official of the manufacturing firm certifying compliance with these Specifications.
2. Piping and fittings shall be welded and fabricated in accordance with ASME/ANSI and the latest edition of Standard B31.1 from the Code for Pressure Piping for all systems, and B31.3 for Steam and Condensate systems. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.
3. Ensure complete penetration of deposited metal with base metal. Contractor shall provide filler metal suitable for use with base metal. Keep inside of fittings free from globules of weld metal.
4. Align piping and equipment so that no part is offset more than 1/16". Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.
5. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.
6. Contractor shall not split, bend, flatten or otherwise damage piping before, during or after installation. Remove dirt, scale, and other foreign matter from inside piping before tying in sections, fittings, valves or equipment.
7. In no case shall Schedule 40 pipe be welded with less than three passes including one stringer/root, one filler and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/root, two fillers and one lacer. In all cases, however, the weld must be filled before the cap weld is added.
8. All welds are subject to inspection, visual and/or X-ray, for compliance with specifications. The Owner will, at the Owners option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or X-ray testing. Initial visual and X-ray inspections will be provided by the Owner. The Contractor shall be responsible for all labor, material and travel expenses involved in the reinspection and retesting of any welds found to be unacceptable. In addition, the Contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME/ANSI Standards B31.1 and B31.3 due to the discovery of poor, unacceptable, or rejected welds.
9. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding, and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section 6 of the Code, current edition.

- G. Screw Pipe Fittings: All screw joints shall be made with taper threads, properly cut. Joints shall be made tight with teflon applied to the pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of pipe shall be upended and hammered to remove all shavings and foreign material.
- H. Assembling Other Joints: Procedures for assembling joints in cast iron and copper lines have been set forth elsewhere in these Specifications. For any special materials, consult the manufacturers for the recommended procedures in assembling the joints.
- I. Expansion and Contraction: Provisions for expansion and contraction of piping shall be provided by expansion loops, bends or expansion joints to prevent injury to connections, piping, equipment or the elements of the building.
- J. Anchors: Pipe anchors shall be provided and installed at each end of piping runs which require expansion loops or joints, and where indicated on Drawings. Anchors shall be fabricated of rigid structured steel members firmly secured to the building structure.
- K. Guides: Pipe guides shall be provided and installed on piping as shown on Drawings and as necessary to properly fulfill function of expansion loops.
- L. Unions: Shall be installed on all bypasses, ahead of all traps, at all connections to equipment, where shown on the Drawings or where required to facilitate removal of equipment.
- M. Escutcheons: Spring clamp plates (escutcheons) shall be provided where pipes are exposed in finish locations of the building and run through walls, floors, or ceilings. Plates shall be chrome plated spun brass of plain or approved pattern and shall be set tight on the pipe and to the building surface.
- N. Protection: All open ends of pipes and equipment shall be properly capped or plugged during construction to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton, waste or similar materials are not acceptable.
- O. Pipe Sizes: If the size of the piping is not clearly evident in the Drawings, the Contractor shall request instruction as to the proper sizing.
- P. Connections Between Copper and Steel Pipes: Connections shall be made with dielectric couplings, flanged dielectric unions, CTS copper flanged adapter or nylon bushings temperature and pressure rated for the service at the point of installation.
- Q. Exterior Underground Piping: All exterior underground piping shall be installed with a minimum of 30" of earth or equivalent cover, except where specifically shown otherwise or permitted by the Architect/Engineer. Generally more cover shall be provided if the grades of the lines involved and the finished grade elevations established at the site will permit.
- R. Pipe Layout: All piping shall be installed in accordance with Plans and Specifications and according to all applicable local and state codes. Minor piping revisions due to substituted equipment are acceptable provided they are indicated on piping fabrication drawings. All the various piping systems shall be made up straight and true and run at proper grades to permit proper flow of the contained material. Lines shall also be graded for proper drainage. Piping shall follow as closely as possible the routes shown on Drawings which take into consideration conditions to be met at the site. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which the lines are connected. All piping shall be clean when it is installed. Before installation it shall be checked, upended, swabbed, if necessary, and all rust or dirt from storage or from laying on the ground shall be removed.
- S. Piping fabrication drawings shall be submitted for all piping in the Central Plant, mechanical rooms, and for equipment connections and all other areas requiring coordination with other trades.

1. Pipe fabrication drawings shall be double line drawings to scale on 1/4" scale building floor plans and shall indicate pipe size, fittings, valves, accessories, connections, system type, insulation, hangers, support requirements, anchors, guides, expansion joints and loops, pipe elevations and other information required for coordination with other trades and fabrication of piping.
2. Pipe fabrication drawings shall be coordinated with other trades and building construction prior to submittal for approval. Refer to Section 15002 for additional shop drawing requirements.

3.2 HANGERS AND SUPPORTS:

- A. General: Provide pipe hangers and supports as specified. All horizontal and vertical piping shall be thoroughly and substantially supported in ANSI B31.1 Standard Code for Pressure Piping and Manufacturers' Standardization Society MSS SP-69 Pipe Hangers and Supports - Selection and Application. Comply with local codes and standards for pipe and equipment support and anchorage. Pipe supports shall be of material that will prevent electrolytic action. The design, type, spacing and application of all hangers, supports, anchors and guides shall comply with the above standards. Hanger rod clamps and inserts shall be as recommended by the clamp or insert manufacturer for the intended use and shall be approved in writing by the Structural Engineer. All methods of attachment to the structure and the use of afterset inserts shall be approved in writing by the Structural Engineer. **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.
- B. MSS Standard Compliance: Provide pipe hangers and supports of materials, design, and manufacture which comply with ANSI/MSS SP-58, SP-59, SP-89, and SP-90.
- C. Acceptable Manufacturers: The model numbers listed in the Specification establish a level of quality and material. The following manufacturers are acceptable subject to compliance with the requirements of this Specification:
 1. Anvil International.
 2. B-Line.
 3. Central Iron Manufacturing Company.
 4. F & S Manufacturing Company.
 5. Hubbard Enterprises/Holdrite
 6. The Michigan Hanger Company.
- D. Inserts: Provide Anvil Fig. 282 or equal inserts for all pipe, ductwork and equipment suspended from new concrete construction. 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, and similar items 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. All inserts shall be galvanized. Cast-in-place concrete inserts are preferred over powder-actuated fasteners or expansion anchors, especially in post-tension slab applications. Place cast-in-place anchors prior to concrete pour. For small-bore piping, use Hubbard Enterprises/HOLDRITE #125 series brackets or owner approved equipment.
- E. Fasteners: Fastening of pipes, conduits, and similar items in the building shall be as follows: To wood members - by wood screws; to masonry - by threaded metal inserts, metal expansion screws, or toggle bolts, whichever is appropriate for the particular type of masonry; to steel - machine screws or welding (when specifically permitted or directed), or bolts, and to new concrete by suitable inserts anchored to reinforcing steel, and poured in place unless other means are indicated on the plans. All fasteners shall be cadmium plated or galvanized. **Power-actuated fasteners (shooting) will not be acceptable under any circumstances.**

- F. Piping in Multiple Parallel Runs: Provide galvanized structural channels or angles with Anvil Fig. 137/137 C or equal galvanized U-bolt clamps, supported as trapeze hangers where multiple parallel runs of piping are shown. Coated U-bolts shall be provided for uninsulated glass or copper pipe. Select and size members for weights to be carried and span dimensions between supports.
- G. Piping in Single Runs: Provide Anvil Fig. 260 or equal adjustable clevis hangers with a nut above and below the hanger on the hanger rod. All hangers shall be galvanized.
- H. Copper Pipe Hangers: Hangers supporting and contacting brass or copper lines 3" in size and smaller shall be Anvil Fig. CT 99C or equal, adjustable plastic coated, copper-plated tubing rings. Hangers supporting and contacting brass or copper lines 4" and larger shall be Grinnell Fig. 260 or equal, galvanized, adjustable clevis, with a nut above and below the hanger on the support rod and approved neoprene isolating material between pipe (or tubing) and hanger. For insulated copper or brass domestic water lines, hangers for all sizes of pipe shall be Anvil Fig. 260 or equal, galvanized, adjustable clevis, with a nut above and below the hanger on the support rod and sized to fit the outside diameter of the insulation and hanger. Isolate all copper or brass lines from ferrous metals with approved dielectric materials.
- I. Hanger Rod: Provide cadmium-coated or galvanized hanger rods and nuts of required length. Rods shall be coated or galvanized after threading. Rods shall be cold galvanized after cutting. All hanger rods shall be trimmed neatly so that no more than one inch (1") 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. Rod diameters shall be as follows:

Pipe Sizes	Rod Diameter
3/4 - 2"	3/8"
2-1/2 - 3"	1/2"
4 - 5"	5/8"
6"	3/4"
8 - 12"	7/8"
14 - 18"	1"

- J. Riser Clamps: Provide Anvil Fig. 261/261 C or equal galvanized riser clamps with equal bearing on each end. Riser clamps for copper tube shall be plastic coated.
 - 1. Riser clamps shall be isolated from the structure by use of Hubbard Enterprises Holdrite #274 or #278 riser pad or equal.
- K. Pipe Supports in Chases and Partitions: Horizontal and vertical piping chases and partitions shall be supported by hangers or other suitable support. Pipes serving plumbing fixtures and equipment shall be securely supported near the point where pipes penetrate the finish wall. Supports shall be steel plate, angles or special channels such as Unistrut mounted in vertical or horizontal position. Pipe clamps such as Unistrut P2426, P2008, P1109 or other approved clamps shall be attached to supports. Supports shall be attached to wall or floor construction with clip angles, brackets, or other approved method. Supports may be attached to cast iron pipe with pipe clamp or other approved method. All copper or brass lines shall be isolated from ferrous metals with electrical tape or other dielectric materials to prevent electrolytic action.
- L. Saddles and Shields:
 - 1. Saddles for Horizontal Insulated Piping Without Vapor Barrier: At each hanger or support on horizontal runs, provide Anvil Fig. 160 or equal black steel saddles, as applicable. Shields as described below may be used instead of the saddles.
 - 2. Shields for Horizontal Insulated Water Piping With Vapor Barrier: At each hanger or support for water piping, provide a half section of preformed cellular glass or rigid calcium silicate blocking, with jacket of adjacent insulation brought across unbroken, supported on Anvil Fig. 167 or Anvil

260 ISS or equal semicircular galvanized steel shields. Shields for pipe 4" and smaller shall be 12" long; shields for pipe 5 to 8" shall be 18" long; and shields for larger pipe shall be 24" long.

- M. Roller Supports: Provide Anvil Fig. 171/177 or equal adjustable, cast iron pipe roll supports for support of horizontal piping installed in racks, beam supports, suspended and where shown on the Drawings.
- N. Guides: Install pipe guides complying with the manufacturer's published product literature. Where not otherwise indicated, install pipe guides near expansion loops, expansion joints, and ball joints.
- O. Anchors: Install anchors at the proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent the transfer of loading and stresses to connected equipment. Anchors shall include vibration isolation in accordance with the pipe support system specified. Where the piping system is floating, the anchors shall be termed restraints or braces.
 - 1. Where expansion compensators are indicated, install anchors in accordance with the expansion unit manufacturer's written instructions, to limit movement of piping and forces to the maximums recommended by the manufacturer of each unit.
 - 2. Where not otherwise indicated, install anchors at the ends of principal pipe runs and at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.
- P. Provisions for Movement:
 - 1. Movement: Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends, and similar units.
 - 2. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement will not be transmitted to any pipe or connected equipment. Pipe supports shall properly transmit the weight of the pipe and its contents to the building structure, or to independent posts, piers, or foundations.
 - 3. Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes so maximum pipe deflections allowed by ANSI B31 are not exceeded.
- Q. Spacing: Install hangers and supports in piping systems to remove stress from equipment flanges and rotating equipment. The following table gives maximum hanger spacing for copper and steel lines. Hangers shall be more closely spaced where required by the conditions of the installation in order to prevent sagging, excess load on structure and hangers, undue strain on equipment, noise transmission, etc. A hanger shall be placed within 2' of each elbow or tee with a minimum support of one hanger per joint or fitting and at each rise, drop, and trap. Maximum hanger and support spacing shall be as follows and as specified elsewhere:

Trade Pipe Size	Maximum Spacing
1/2"*	5'
3/4"	6'
1" and 1-1/4"	7'
1-1/2"	9'
2"	10'
2-1/2"	11'
3"	12'
4"	14'
5"	16'
6"	17'
8"	19'
10"	22'
12"	23'

* Includes all sizes of cast iron and nonmetallic piping. Cast iron pipe sections exceeding 5 feet in length can be supported on maximum 10 foot centers provided hangers are installed within 18 inches of each joint and fitting. Provide rolled, galvanized sheet metal pipe shields between nonmetallic pipe hangers as required to prevent any visible nonmetallic pipe sag between hangers.

- R. Sway Bracing: Where hanger lengths for cast iron piping exceed 18 inches, sway bracing shall be provided per CISPI recommendations, to prevent pipe shear.
- S. Leveling: Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.
- T. Midspan Support: For vertical midspan support of piping 4" and under, use Hubbard Enterprises/Holdrite Stout Brackets TM in conjunction with Hubbard Enterprises/HOLDRITE Stout clamps or two hole pipe clamps (MSS Type 26).
- U. Vibration Isolation: Refer to Section 15250, "Vibration Isolation", for additional information and support requirements. Pipe hangers made of wood, wire, or sheet iron shall not be permitted.
- V. Riser Supports: Vertical piping shall be secured at sufficiently close intervals to keep the pipe in alignment and carry the weight of the pipe and contents.
 - 1. Cast iron soil pipe shall be supported at the base and at each story level, but in no case at intervals greater than 25'.
 - 2. Steel pipe shall be supported at the base and at not less than every other story level, but in no case at intervals greater than 30', except that grooved-piping systems shall be supported at each pipe section.
 - 3. Copper tube shall be supported at each story level, but in no case at intervals greater than 25'.
 - 4. Plastic pipe shall be supported at mid point between floors to prevent movement, but in no case at intervals greater than 10'.
- W. Finish: All steel and iron hangers on piping including clevis hangers, rods, inserts, clamps, stanchions, brackets, shall be hot dip or electro-galvanized after fabrication for indoor applications and hot dip galvanized after fabrication for exterior applications. Rods shall be electro-galvanized or cadmium plated after threading, for indoor applications and hot dip galvanized after fabrication for outdoor applications. Universal concrete inserts shall be galvanized.
- X. Fire Protection Piping Support: Support fire sprinkler and standpipe piping independently of other piping in accordance with NFPA-approved methods and local codes and standards, using UL-listed and labeled support components. Refer to Section 15500 for additional requirements.
- Y. Secondary Pipe Positioning and Supports: Makeshift, field devised methods of plumbing pipe support, such as with the use of scrap framing materials, are not allowed. Support and positioning of piping shall be by means of engineered methods that comply with IAPMO PS 42-96. These shall be Hubbard Enterprises/HOLDRITE support system or owner approved equipment.

3.3 MISCELLANEOUS STEEL:

- A. All miscellaneous steel members, angles, rods, supports, and similar items specified or required for this project shall be galvanized for indoor use or hot dipped galvanized for exterior use and where exposed to ambient conditions. All required miscellaneous steel shall be provided by this Division..

3.4 SLEEVES:

- A. General: Provide sleeves around all piping passing through masonry, CMU and concrete walls and partitions, suspended slabs, plaster or dry wall ceilings, structural members, other building features and where shown on the drawings. No sleeves shall be installed through any concrete beam or other deep projections without written approval of the Architect/Engineer.
- B. Partitions: Sleeves shall be required for piping passing through rated dry wall and plaster partitions. Sleeves shall be set in dry wall mud or plastered in and the pipe passing through the sleeve shall be

sealed as outlined in Piping Fire Stops and Seals. Sleeves are not required for piping passing through nonrated dry wall or plaster partitions. Non-isolated piping shall be mudded in and isolated piping shall have the opening mudded to within 1/2" of the pipe and an elastomeric caulk shall be installed in the opening around the pipe or insulation.

- C. Plumbing Storm, Waste and Vent: Sleeves shall not be required for storm, waste or vent piping through slabs on grade or for piping passing through precast structure. Where piping passes vertically through precast structures without sleeving, adequate provisions shall be made to prevent water leakage through slabs where applicable.
- D. Placement: This Contractor shall be responsible for the timely placement of sleeves in construction. If sleeves are not placed during construction, this Contractor shall secure written permission to perform a core drill or cut and patch installation at no cost to the Owner. No piping shall pass through the above obstructions without sleeves, unless noted otherwise.
- E. Sizing: Sleeves shall be one size larger than the pipe passing through the sleeve, except where larger sizes are required for mechanical seals. Where insulated piping passes through construction, sleeves shall be one size larger than the outside diameter of the insulation. All sleeves in floors shall extend 2" above the finished floor. Sleeves through vertical construction shall be minimum 18 gauge galvanized steel. Sleeves through horizontal construction shall be minimum 16 gauge galvanized steel except at pipe riser supports. Sleeves at riser supports for 3" and smaller pipe shall be Schedule 40 galvanized pipe sleeves. Sleeves for riser supports for 4" and larger pipe and for pipe passing through exterior building construction below grade shall be Thunderline Corporation Type WS or an approved equal.
- F. Installation: At no point shall the pipe or its insulation touch the sleeve it passes through. Seal all sleeves which are not in exterior construction below grade or rated construction with an approved non-hardening mastic. Seal sleeves through fire rated construction as specified under "FIRE STOPPING FOR PIPING AND DUCTWORK" and as detailed on the Drawings. Sleeves below grade shall be sealed with segmented annular seal, refer to Paragraph 3.14.
- G. Existing Construction: Sleeves are not required where new openings are core-drilled into existing construction, unless noted otherwise on the Drawings.

3.5 **ESCUTCHEON PLATES:**

- A. General: Except as otherwise noted, provide chrome-plated brass floor and ceiling escutcheon plates around all pipes, and similar items passing exposed through walls, floors, or ceilings, in any finished spaces except under floor and attic spaces. Plates shall be sized to fit snugly against the outside of the conduit. Plates will not be required for piping where pipe sleeves extend above finished floor. Provide sheet metal trim plates at all penetrations exposed to view of building occupants, unless directed otherwise by the Architect. All equipment rooms are classified as finished spaces.
- B. Type: Escutcheon plates shall be Dearborn Brass Company, Fig. No. 1149 through 1152.

3.6 **OPENINGS, CUTTING AND PATCHING:**

- A. General: The Contractor shall be responsible for coordinating openings in the building construction for installation of mechanical systems. Coordinate penetrations and place equipment in time to avoid cutting new construction. Comply with the requirements of Division 1 for the cutting and patching of other work to accommodate the installation of mechanical work. Except as individually authorized by the Architect/Engineer, cutting and patching of mechanical work to accommodate the installation of other work is not permitted.
- B. Cut and Patch: Cut and patch walls, floors, and similar items resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.
- C. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for piping and similar items shall be core drilled to exact size.

- D. Approval: If holes or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no change in Contract amount. Undertake no cutting or patching without first securing written approval from the Architect/Engineer. Patching shall create a surface which is structurally and aesthetically equal to the surface surrounding the area patched and shall be performed by the trade whose work is involved, at no change in the Contract amount.
- E. Protection: Openings through exterior walls or roofs shall be provided with suitable covers while they are left open to protect the property or materials involved. Any openings through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.
- F. Restoration: All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes. Restoration work shall be performed by the trades who originally installed the work being restored and shall be performed at no cost to the Owner or Architect/Engineer.
- G. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, and similar items shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.
- H. Plaster: All electrical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.
- I. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

3.7 ACCESS DOORS:

- A. General: This Contractor shall provide wall or ceiling access doors for installation in finished surfaces for unrestricted access to all concealed items of mechanical equipment.
- B. Types: Doors shall be factory-finished as noted below and turned over to the General Contractor for installation, refer to finish painting requirements specified herein below. Doors shall be as manufactured by Inryco/Milcor or an approved equal in the following styles:
 - 1. Drywall Construction Inryco/Milcor Style DW with gray prime finish.
 - 2. Finished Acoustical Ceiling Tile insert. Inryco/Milcor Style AT with door designed for tile insert.
 - 3. Finished Plaster Ceiling or Walls finish Inryco/Milcor Style WB-PL with door designed for plastering.
 - 4. Masonry Walls Inryco/Milcor Style M with gray prime finish.
 - 5. Fire Rated Construction Inryco/Milcor Fire Rated Access Door with gray prime finish.
 - 6. Fire Rated Ceiling or Ceiling Assembly Inryco/Milcor Style ATR with door designed for tile insert.
- C. Selection: Access doors shall be furnished with a continuous piano hinge with screwdriver-operated flush locks and shall be a minimum of 12" x 12". Larger sizes shall be furnished where required for proper access.
- D. Approval: Access doors shall not be installed until location and style have been approved by the Architect.

3.8 FIRESTOPPING FOR PIPING AND DUCTWORK:

- A. General: Provide a UL Systems Classified, intumescent material capable of expanding up to eight to ten times when exposed to temperatures beginning at 250°F for sealing all holes or voids created to extend mechanical system piping, ductwork and other components through fire-rated floors and walls

and other fire rated construction to prevent the spread of smoke, fire, toxic gas and water. The fire barrier system shall meet the fire test requirements and hose stream test requirements of ASTM E119-73.

- B. Fire barrier products shall be used to create through-penetration fire stop systems as required, with a minimum fire rating equal to the rating of the construction being penetrated. All fire stop systems shall be listed in the Underwriter's Laboratories Building Materials Directory, Through Penetration Firestop Systems (XHEZ).
- C. The products manufactured by 3M/Electrical Products Division or an approved equal are acceptable subject to Shop Drawing submittal approval.
- D. Install fire stop materials according to the following UL Systems Classifications and manufacturer's recommendations:

OPENING TYPE	UL SYSTEM CLASSIFICATION NUMBER
Metal Pipe Through Round Openings	No. 49, No. 95, and No. 147
Insulated Metal Pipe Through Round Openings	No. 91, No. 147, and No. 64C
Metal Pipe Through Large Openings	No. 93
Blank Openings	No. 92, No. 102, and No. 61
All Other Firestop Systems	Per manufacturer's recommendations

- E. Provide fire rated insulation blankets around ductwork and piping where shown on Drawings. Blankets shall be one inch (1"), 8 pound density thermo ceramic material, Thermo Ceramics Kas-Wool Fire Master Series thermal blankets or and approved equal. Blankets shall be wrapped to provide continuous coverage and be secured with stainless steel bands in accordance with the manufacturer's UL-listed installation instructions.

3.9 FIRE-RATED PARTITIONS:

- A. Coordinate locations of piping in fire-rated partitions so not to effect the fire rating of the partition. Notify the Architect/Engineer in writing where additional construction is required to maintain the partition fire rating.

3.10 FLAME SPREAD PROPERTIES OF MATERIALS:

- A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255 (1984), "Method of Test of Surface Burning Characteristics of Building Materials". The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, and similar items specified for each system, and shall not exceed a smoke-developed rating of 50.

3.11 PENETRATIONS, FLASHING, AND SEALS:

- A. Pipe sleeves, pitch pockets, and flashings compatible with the roofing and waterproofing installation shall be provided for all roof and wall penetrations and roof-mounted equipment and supports. Coordinate flashing details with the Architectural details and the roofing/waterproofing Contractors.
- B. Segmented Annular Seals: Seal the openings around piping which penetrate the exterior construction using segmented annular seals to prevent the entry of water and other foreign material. Segmented annular seals shall be Thunderline Corporation Type LS Series link seals or an approved equal. Seals shall be Style C insulating type for standard service at temperatures up to 250°F. Seals shall be Style T high temperature service at temperatures up to 450°F. Sleeves for use with annular seals shall be Thunderline Corporation Type WS or an approved equal.

3.12 CLEANING AND PAINTING OF MECHANICAL WORK:

- A. Prime, protective and touch-up painting is included in the Work of this Division. Finish painting in equipment spaces, concealed locations, and other locations not exposed to the view of building occupants is included in the work of this Division. Finished painting in areas exposed to the view of building occupants is specified under Division 9.

- B. All equipment furnished by the mechanical subcontractor shall be delivered to the job with suitable factory protective finish.
- C. Mechanical equipment with suitable factory-applied finishes shall not be repainted; except for aesthetic reasons where located in finished areas as directed by the Architect and in a color selected by the Architect. Where factory-applied finishes are damaged in transit, storage or installation, or before final acceptance, they shall be restored to factory-fresh condition by competent refinishers using the spray process.
- D. All equipment not finished at the factory shall be given a prime coat and then finish painted with two coats of enamel in a color as directed by the Architect/Engineer. No nameplates on equipment shall be painted, and suitable protection shall be afforded such plates to prevent their being rendered illegible during the painting operations.
- E. All uninsulated black steel piping, hangers, supports, and similar items shall be given two coats of primer. Where exposed to outdoor weather or exposed to view in equipment rooms, uninsulated black steel piping shall be primed and finished with two coats of enamel in colors as directed by the Architect/Engineer.
- F. Concealed fire protection and plumbing piping shall not be painted. Uninsulated plumbing and fire protection piping, where exposed to view in equipment rooms, shall be primed and finished with two coats of enamel in colors as directed by the Architect/Engineer.
- G. All uninsulated black steel pipe direct buried shall be given two coats of primer and then coated with 3M Scotchwrap Pipe Insulation #50 applied in strict accordance with manufacturer's published recommendations (machine wrapping of pipe is acceptable) prior to burial in the ground.
- H. All insulated piping and equipment in the Central Plant[, tunnels] and other mechanical/electrical rooms where exposed to view shall be primed and finish painted with two coats of enamel in colors as directed by the Architect/Engineer or Owner's Representative; and where concealed in furrings, chases, or suspended ceilings, need not be painted.
- I. All grilles and registers will be furnished with a factory-applied finish. Should the plans indicate that certain grilles and registers be furnished with a factory-applied prime coat for field painting, the cores shall be removed for painting under Division 9. The frames, after installation, shall be given two coats of enamel. The cores shall be spray painted with two coats of enamel, and shall be reinstalled in the frames only after both cores and frames are thoroughly dry. In such cases the color of the enamel finish shall be as directed by the Architect/Engineer.
- J. All equipment in the Central Plant, whether insulated or not, shall be field painted with two coats of suitable enamel in a color as directed by the Architect/Engineer.
- K. The surfaces to be finish-painted shall be prepared as follows:
 - 1. Galvanized and black steel surfaces shall be fully cleaned and painted with one coat of galvanized metal primer.
 - 2. Aluminum surfaces shall first be fully cleaned painted with one coat of zinc chromate primer.
 - 3. Cast iron pipe shall first be fully cleaned and painted with a "nonbleed" primer.
 - 4. Insulated surfaces shall be sized and primed using materials recommended by the insulation manufacturers.
- L. All ferrous metal surfaces without a protective finish and not galvanized in exposed and concealed areas including chases, under floor and above ceilings shall be painted with two coats of zinc chromate primer as the construction progresses to protect against deterioration.
- M. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible during the painting operation.
- N. Before painting, all surfaces to be painted shall be suitably prepared. This shall include removing all oil, rust, scale, dirt, and other foreign material. Surfaces shall be made smooth by grinding, filing,

brushing, or other approved method. In the painting operations, the primer for metal surfaces shall be of the zinc dust type unless specified otherwise, and where finish painting is specified, it shall be painted using materials and colors selected and approved by the Architect/Engineer. Refer to Division 9 for additional requirements.

3.13 MECHANICAL SYSTEM IDENTIFICATION:

A. Identification of Equipment:

1. All pieces of major mechanical, plumbing and fire protection equipment shall have a manufacturer's label identifying the manufacturer's address, equipment model and serial numbers, equipment size, and other pertinent data. Care shall be taken not to obliterate this nameplate in any way.
2. The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, controls, devices and similar items by marking them. All items of equipment, controls, devices and similar items shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same designation as shown on the Drawings, where applicable.
3. Equipment nameplates shall be three ply laminated plastic, a minimum of 3/32" thick, black-white-black for equipment on normal power, red-white-red for equipment on emergency power, and blue-white-blue for equipment on UPS power. Letters shall be similar to Roman Gothic of a size that is legible (1/2" minimum for description and 3/8" minimum for supplementary text) and appropriate to the application. Attachment of nameplates shall be by stainless steel screws. Rivets or adhesives are not acceptable.
 - a. Mechanical and Plumbing equipment to be identified includes: All pumps, fan coil units, control panels, fire dampers, fire/smoke dampers, motorized automatic dampers, and other major pieces of mechanical equipment.
 - b. Nameplates on powered equipment shall indicate the source feeding equipment and shall indicate variable speed, time delay operation, firefighter's override operation, etc., where applicable.

Example:

AHU 28
Fed from DPA-3
Room 1.102
Two Speed

- c. Individual controls and pilot lights on controllers and control panels shall have nameplates showing the device function.
- B. Valves:** Valves shall be marked with 1-1/2" diameter aluminum or engraved plastic tags securely attached to valve stems with "S" hooks.
1. Prepare and install, in a suitable glazed frame, typewritten valve charts giving the number, location and function of each line valve installed under this Contract. Each valve shall be numbered on these charts in accordance with the system of which it is a part of its location. For example, valves in different systems would be designated as follows:
 - a. HPS-1-3 High Pressure Steam - 1st Level - Valve No. 3.
 - b. CHS-2-4 Chilled Water Supply - 2nd Level - Valve No. 4.
 2. Provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above. These tags are to be affixed to only those valves the functions of which are not obvious. For example, it would not be expected that valves at a pressure reducing station in a machine room would be tagged.
 3. Valves at water heaters and steam PRV stations, valves associated with condensate, gas, water meters, and other valves as specified shall also be tagged with standardized color coded plastic

tags. These tags shall be 2-1/2" wide by 1-1/2" high with this color coding: red = normally closed; green = normally open; blue = open in winter, closed in summer; and yellow = closed in winter, open in summer. Tags should be engraved on both sides.

- C. Piping: Piping at major equipment, in all equipment rooms where exposed, where concealed in accessible locations and where concealed behind access doors or panels shall be color coded as to type of use, service and direction of flow in accordance with the latest edition of ANSI A13.1. Markers shall be located at each valve, at entries through walls and on 20'centers on straight runs of pipe. Piping concealed in accessible locations shall be marked on 50'centers on straight runs of pipe and at all changes in direction. Labels shall have color coded backgrounds with 1/2" to 2" high lettering, depending on pipe size.
1. Markers shall be located on the two lower quarters of the pipe where view is unobstructed.
 2. Use Seton Setmark Type SNA or Brady snap-on type identification for all piping systems, 3/4" through 6". For piping systems larger than 6", use Seton or Brady strap on markers.
 3. Pipe Markers shall conform to ANSI A 13.1-1981 "Scheme for the Identification of Piping Systems". Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.
 4. Pipe markers, zone identification and arrow markers shall be provided on, but not limited to, piping of the following systems:
 - a. Chilled water supply.
 - b. Chilled water return.
 - c. Emergency Chilled water supply.
 - d. Emergency Chilled water return.
 - e. Sanitary sewer/vent.
 - f. Roof/storm drain.
 - g. Fire protection.
- D. Underground Pipe Identification: Bury a continuous, preprinted, bright colored plastic ribbon cable marker, Brady No. 91600 Series or an approved equal with each underground pipe (or group of pipes). Locate each directly over piping, 6" to 8" below finished grade. Ribbons shall be detectable from above grade using a pipe locator.
- E. Manufacturers: Acceptable manufacturers are Seton Nameplate Corporation, W.H. Brady Company or Westline Company.
- F. Piping Drawings: Provide a schematic diagram of each piping system and mechanical room, showing each valve with its tag designation and location. Laminate diagrams and install under framed polycarbonate at locations as directed by the Owner.
- G. Records: Nameplate and valve designation data shall be recorded on record drawings and on itemized listing by equipment types and valve number sequence. Itemized listings shall include designation, device description and device location.
- 3.14 **WARNING SIGNS AND OPERATIONAL TAGS:**
- A. Warning Signs: Provide warning signs where there is hazardous exposure associated with access to or operation of mechanical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with recognized industry standards for color and design.
 - B. Operational Tags: Where needed for proper and adequate information on operation and maintenance of mechanical systems, provide tags of plasticized card stock, either preprinted or hand printed. Tags shall convey the message, example: "DO NOT OPEN THIS SWITCH WHEN BURNER IS OPERATING".

3.15 EQUIPMENT CONNECTIONS:

- A. Alignment: All piping connecting to pumps and other equipment shall be installed without strain at the piping connection. The Contractor may be required as directed to remove the bolts in these flanged connections or disconnect piping to demonstrate that piping has been so connected.
- B. Connections Different From Those Shown: Where equipment requiring different arrangement or connections from those shown is approved, it shall be the responsibility of the Contractor to install the equipment to operate properly and in harmony with the intent of the Drawings and Specification. When directed by the Architect/Engineer, the Contractor shall submit drawings showing the proposed installation.
- C. Equipment Guards: Provide easily removable expanded metal guards for all belts, couplings, exposed fan inlets and outlets and other moving parts of machinery. Provide access holes to motor and fan shafts on all belt drive and variable speed equipment.
- D. Supports: The Contractor shall support plumb, rigid and true to line all work and equipment furnished under his division. The Contractor shall study thoroughly all Architectural, Structural, Mechanical and Electrical drawings, shop drawings and catalog data to determine how equipment is to be supported, mounted or suspended, and shall provide all bolts, inserts, pipe stands, brackets and accessories for proper support

3.16 EQUIPMENT HOUSEKEEPING PADS AND ANCHOR BOLTS:

- A. Concrete pads for equipment (housekeeping pads) will be furnished under this Division. Pads shall be provided in locations where floor mounted equipment is to be installed.
- B. Pads shall be nominal 3-1/2" high and shall extend a minimum of 3" beyond all equipment and supports while generally conforming to the shape of the equipment. Provide pad heights to match existing pads where located in the same room.
- C. Pads shall be minimum 2500 psi (28 day) concrete reinforced with No. 6 - 6" x 6" welded wire mesh. Pad tops and sides shall be hard troweled smooth with a 3/4" bull nose on all external corners. Refer to Division 3 for additional requirements.
- D. Furnish galvanized anchor bolts with layout templates for installation in equipment pads. Bolts shall be of the size and quantity recommended by the manufacturer and where vibration isolators are used, they shall be anchor bolted to the equipment pad.

3.17 MISCELLANEOUS CURBS AND SUPPORTS:

- A. General: Where required, curbs and supports shall be of box section design, heavy gauge galvanized steel construction, continuous mitered and welded corner seams, integral base plate, factory installed wood nailer, and shall be insulated with 1-1/2" thick, rigid fiberglass board insulation. Curbs and supports shall be mounted and flashed according to manufacturer's recommendations. Curbs and supports shall be as manufactured by the Pate Company of the style as outlined below or approved equal.
- B. Utility Fan Curbs: Shall be Style PC-1A, 12" high.
- C. Duct Curbs: Where ducts are required to penetrate the roof without passing through an equipment curb, Pate Style PC-1A, 12" high curbs shall be used.
- D. Piping Curbs: Where piping penetrates the roof without passing through an equipment curb, Pate Style PCA-1, 12" high curbs shall be used.
- E. Equipment and Piping Supports: Roof mounted equipment and piping routed across the roof shall be supported using Pate Style ES-1A equipment supports with provisions for securing equipment and piping as required. Equipment curbs shall be 12" high. Piping curb height shall be as required to maintain piping slope.

3.18 DEVICE MOUNTING HEIGHTS:

- A. Refer to architectural drawings to determine whether devices occur in wainscot or cabinet spaces and coordinate mounting heights as required by architectural form. For example, mounting heights of devices occurring in a tile or brick wall should be adjusted so that the device will occur entirely within a single course. However, all devices in a given space shall be mounted at the same height.
- B. In general, unless noted otherwise on Architectural or Mechanical Drawings, mounting heights to device center line shall be as follows:
 - 1. Wall mounted thermostats/temperature sensors 48"
 - 2. Wall mounted air devices As noted on Drawings or as directed by the Architect/Engineer

3.19 DEMOLITION AND WORK WITHIN EXISTING BUILDINGS:

- A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in-service maintenance of all mechanical, plumbing and fire protection services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.
- B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.
- C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, air conditioning ductwork and equipment, and similar items to provide this access and shall reinstall same upon completion of work in the areas affected.
- D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed and reinstalled, this Contractor shall remove and reinstall, in locations approved by the Architect, all devices required for the operation of the various systems installed in the existing construction.
- E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner 2 weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.
- F. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the Drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Survey the project with the Owners representative before demolition begins and determine all materials which the Owner specifically chooses to have salvaged. Pre-establish with the Owner locations where salvaged materials are to be stored. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.
- G. All items which are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.
- H. When items scheduled for relocation are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's

responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner.

- I. Service lines and piping to items to be removed, salvaged, or relocated shall be removed to points indicated on the Drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities which must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as hereinbefore specified.
- J. During the construction and remodeling, portions of the project shall remain in service. Construction equipment, materials, tools, extension cords, and similar items shall be arranged so as to present minimum hazard or interruption to the occupants of the building.
- K. Certain work during the demolition and alteration phase of construction may require overtime or nighttime shifts or temporary evacuation of the occupants. Coordinate and schedule all proposed down time with the Owner's Representative at least 72 hours in advance.
- L. Make every effort to minimize damage to the existing building and the Owner's property. Repair, patch, or replace as required any damaged which might occur as a result of work at the site. Care shall be taken to minimize interference with the Owner's activities during construction. Cooperate with the Owner and other trades in scheduling and performance of the work.
- M. Include in the contract price all rerouting of existing ductwork, piping, air devices, fixtures, and similar items and the reconnecting of existing fixtures and devices as necessitated by field conditions to allow the installation of the new systems. Furnish all temporary ductwork and piping, and similar items as required to maintain service for the existing areas with a minimum of interruption.
- N. All existing air devices materials, equipment and appurtenances not included in the remodel or alteration areas are to remain in place and shall remain in service.
- O. Mechanical equipment and building systems equipment, and similar items which are to remain but which are served by piping that is disturbed by the remodeling work, shall be reconnected in such a manner as to leave it in proper operating condition.
- P. Existing plumbing fixtures, registers, grilles, and diffusers shown to be removed and indicated to be reused, shall be cleaned, repaired and provided with such new accessories as may be needed for the proper installation in their new locations.
- Q. Within the remodeled or alteration areas where existing ceilings are being removed and new ceilings are installed, all existing air devices, other ceiling mounted devices and their appurtenances shall be removed and reinstalled into the new ceiling, unless otherwise shown or specified.
- R. Within the remodeled or alteration areas where existing walls are being removed, all existing fixtures, thermostats, other materials and equipment and their appurtenances shall be removed, where required by the remodel work either shown or specified.
- S. Any salvageable equipment as determined by the Owner, shall be delivered to the Owner, and placed in storage at the location of his choice. All other debris shall be removed from the site immediately.
- T. Equipment, piping or other potential hazards to the working occupants of the building shall not be left overnight outside of the designated working or construction areas.
- U. All existing air handling equipment which is shown as being reused shall have coils cleaned and shall be equipped with new filters by this Contractor.
- V. No portion of the fire protection systems shall be turned off, modified or changed in any way without the express knowledge and written permission of the Owners representative.

- W. Refer to Architectural "Demolition" and "Alteration" plans for actual location of walls, ceilings, and similar items being removed and/or remodeled.
- X. Drawings do not fully indicate conditions nor existing obstructions or utilities. Visit the site and examine work to be removed and become familiar with conditions affecting work.
- Y. Asbestos removal, if any is not part of this Contract.

END OF SECTION

SECTION 15200
SYSTEM INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15002, "Mechanical General Provisions", govern this Section.
- B. Refer to Section 15840, "Ductwork", for duct lining requirements and Section 15867, "Air Distribution Devices", for additional insulation requirements.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide piping, ductwork, and equipment system insulation as specified.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
 - 1. Armstrong World Industries.
 - 2. Certain-teed Corporation.
 - 3. Schuller.
 - 4. Owens/Corning Fiberglass.
 - 5. Pittsburgh Corning.

1.4 SUBMITTALS:

- A. Shop Drawings submittals shall include, but not be limited to, the following:
 - 1. Cut sheets on all insulation products to be used.
 - 2. Cut sheets on all mastics and other products to be used with insulation products.
 - 3. Cut sheets on PVC and aluminum jacketing materials.
 - 4. Manufacturer's printed installation instructions for all of the above products.
 - 5. Additional information as required in Section 15002.

1.5 DELIVERY, STORAGE AND HANDLING:

- A. Store insulation products in their factory-furnished coverings, and in a clean, dry indoor space which provides protection against the weather.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Quality: The type of insulation and its installation in accordance with this Section of the Specifications for each service and the application technique shall be as recommended by the manufacturer.
- B. Fire Rating: All insulation shall have a composite (insulation, jacket or facing and adhesive used to adhere facing or jacket to insulation) fire and smoke hazard, as tested by ASTM E84, NFPA 255, and UL 723, not to exceed:

1. Flame Spread 25.
 2. Smoke Developed 50.
- C. Accessories: Accessories such as adhesives, mastics, tapes, and cements shall have the same component ratings as listed.
- D. Labels: Label products and their shipping cartons indicating that flame spread and smoke developed ratings do not exceed the above requirements.

2.2 INSULATION THICKNESS:

- A. Minimum: Insulation thickness shall not be less than the following:

Piping Surface

Domestic hot water piping 1/2"

Ductwork Surface

Conditioned air and return air ductwork, external wrap (where not noted on drawings to be lined)
2"

2.3 PIPING:

- A. Fiberglass Pipe Insulation: Provide Schuller Micro-Lok AP/AP-T, Owens/Corning ASJ/SSL, Certain-Teed Snap-on ASJ/SSJ or an approved equal pre-formed glass fiber pipe insulation with a white all service jacket/vapor barrier. Glass fiber pipe insulation shall have a K factor of 0.23 at 75° F mean, a jacket tensile strength of 40 pounds per inch of width, a Mullen Burst of 70 psi, a Beach Puncture of 50 ounce inch per inch and a permeability of 0.02 perm. Longitudinal laps on chilled water pipe insulation shall have a factory-applied pressure sensitive tape closure system. Three inch (3") wide factory-supplied pressure sensitive closure strips shall be provided for butt joints.
- B. Fitting Insulation: Provide pre-molded rigid insulation for valves, fittings, flanges, strainers, and unions. Insulation shall be as specified for pipe insulation, except without the all-service jacket, where applicable.
- C. Manufactured Fitting Covers: Provide matching 25/50 rated PVC covers for fiberglass insulation on valves, fittings, flanges, strainers, and unions. Covers shall be sealed at cover lap joints and at lap joints to adjacent pipe insulation with an approved vapor barrier mastic. All circumferential joints shall be taped with Manville Z-tape or an approved equal. Covers shall be designed to allow strainer removal or flange removal without destruction of the insulation or cover.
- D. Field Fitting Covers: Provide Foster 30-35 Tite-Fit coating or an approved equal set with Foster Mast-A-Fab or equal reinforcing mesh. Color shall be white unless noted otherwise.
- E. Metal Jacketing: Provide 0.016" thick aluminum jacketing where required or specified. 3/4" x 0.015" stainless steel bands and straps shall be provided for banding insulation jacketing.
- F. Elastomeric Insulation: Provide Armstrong Type II "Armaflex" or approved equal closed cell elastomeric insulation. Insulation shall have a K factor of not more than 0.28 Btu/inch per degree F-per hour at 75° F mean temperature and a water vapor permeability of 0.15 perm-inch or less. Insulation shall have a flame spread rating of 25 and a smoke developed rating of 50. Provide manufacturers recommended adhesive (Armstrong 520 or Manville No. 57).
- G. Miscellaneous: Provide all miscellaneous accessories, components and materials required for installation of a complete insulation system.

2.4 DUCTWORK:

- A. External Ductwork Insulation: Provide Schuller "Microlite" R-Series or an approved equal 2" thick flexible fiberglass duct wrap with fiberglass reinforced kraft-scrim-foil vapor barrier jacket. Ductwrap shall have a density of 0.75 pounds per cubic foot, K factor of 0.31 at 75° F and a permeability of 0.04 perm. Insulation shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less.
- B. Acoustical Duct Lining: Lining provided with ductwork, refer to Section 15840.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Install insulation products in accordance with the manufacturer's written instructions, the Midwest Insulation Contractors Association (MICA) Commercial and Industrial Insulation Standards, and recognized industry practices to ensure that the insulation serves the intended purpose. Surfaces to be insulated shall be thoroughly cleaned with all testing successfully completed prior to insulation.

3.2 PIPING APPLICATION:

- A. General: Apply insulation to clean, dry pipes after all pressure tests have been completed. Firmly butt all joints of insulation and seal all joints per manufacturers recommendations. Install insulation in strict accordance with these specifications and the manufacturer's printed instructions.
- B. Flanges, Strainers and Unions: Insulate flanges, strainers, and unions with pre-molded or shop-fabricated rigid insulation of same material and thickness as specified for adjacent piping. Cover fiberglass and foamglas insulation with pre-molded PVC covers, held in place with Zeston "Z-tape" or an approved equal. Covers and finish for foam glass and calcium silicate insulation shall be as specified for the adjacent pipe insulation. Ensure that insulation and covers for flanges, unions, and access plates shall be removable without damage to insulation or jackets.
- C. Valves and Fittings: Insulate and cover valves, tees, elbows, test parts, and other fittings the same as flanges and unions.
- D. Domestic Hot Water Piping: Install pre formed fiberglass insulation to provide a continuous external vapor barrier on all pipe insulation. Seal insulation lap joints using Insul-Coustic No. 215 or equal vapor barrier adhesive on insulation butts and the manufacturer's standard pressure sensitive self-sealing lap joint system. Seal butt joints using Insul-Coustic No. 215 or equal vapor barrier adhesive on insulation butts and the manufacturer's standard pressure-sensitive closure strip system. Butt strips shall be a minimum of 3" wide.
- E. Hangers and Supports: Blocking (for piping with a vapor barrier) or saddles (for piping without a vapor barrier) shall be provided at all hanger and support locations. Install insulation inside all pipe saddles. Extend vapor barrier across all pipe blocking. Refer to Section 15100, "Basic Materials and Methods", for additional requirements.
- F. Pipe Anchors: Insulate pipe anchors as specified for piping. Provide an isolating seal at anchors on piping with a vapor barrier as specified under Paragraph 3.03/D.
- G. Pipe Accessories: Valve operators, pressure/temperatures plugs, meters and gauge fittings and all other items which extend through required insulation shall be suitably insulated with removable caps to allow use without disturbing the insulation.
- H. Vapor Barrier: Maintain integrity of vapor barrier on chilled water and all other cold pipe insulation and protect barrier to prevent puncture and other damage. Insulation shall be replaced on cold piping systems operated with damaged or defective vapor barriers.
- I. Penetrations: Extend piping insulation without interruption through walls, floors, and similar penetrations, except where otherwise indicated. Where insulation is interrupted on chilled water piping, an isolating seal shall be provided between the insulation vapor barrier and the pipe and

penetration seal as specified under Paragraph 3.03/D. Where insulation is interrupted on steam and condensate piping, the penetration seal shall be insulated as specified for the penetrating piping, such that no high temperature surfaces are exposed.

- J. Ventilation: Provide adequate ventilation during initial start-up of piping systems to remove smoke and odor given off when the organic binders in the insulation are initially heated.

3.3 DUCTWORK APPLICATION:

- A. Exterior Ductwrap Insulation On Supply and Return Ductwork: After ductwork testing has been completed, insulate ductwork where specified in Section 15840. On ducts over 18" wide, apply weld clips to bottom of duct, spaced 18" on center each way, maximum. Seal all longitudinal and transverse seams and all punctures caused by weld clips or stick clips with 2" wide SMACNA-labeled duct tape and mastic.
- B. Acoustical Duct Lining For Supply, Return and General Exhaust Ductwork: Refer to Section 15840 for additional information.
- C. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles, cements adhesives, coatings, sealers, protective finishes, and similar compounds as recommended by the insulation manufacturer for the applications indicated.
- D. Surfaces: Install insulation materials with smooth, even surfaces.
- E. Butt Joints: Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- F. Vapor Barrier: Maintain integrity of vapor barrier on ductwrap insulation and protect barrier to prevent puncture and other damage.
- G. Penetrations: Extend ductwrap insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.
- H. Corner Angles: Install corner angles on external corners of insulation on ductwrap in exposed finished spaces before covering with jacketing.

3.4 INSPECTION:

- A. General: Visually inspect the completed insulation installation and repair or replace any improperly sealed joints.
- B. Wet Insulation: Where there is evidence of vapor barrier failure or "wet" insulation after installation, the damaged insulation shall be removed, the pipe or duct surface shall be cleaned and dried and new insulation shall be installed.

3.5 IDENTIFICATION:

- A. Refer to Section 15100 for applicable painting and labeling requirements.

END OF SECTION

SECTION 15275

OWNER AND CONTRACTOR-FURNISHED EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15002, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: The extent of mechanical and plumbing provisions and connections for equipment is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications.
- B. Types: The types of mechanical and plumbing provisions and connections specified in this Section include, but are not limited to, the following connections:
 - 1. Owner-furnished equipment.
 - 2. Contractor-furnished equipment.
 - 3. Other equipment requiring mechanical and plumbing connections.
 - 4. Relocated existing equipment.]

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. General: Refer to other Sections of this Division for materials and components applicable to equipment provisions and connections.

PART 3 - EXECUTION

3.1 PROVISIONS:

- A. General: Furnish and install all mechanical and plumbing provisions for Owner and Contractor-furnished equipment, relocated existing equipment, and other equipment as shown on the Drawing and as required to suit the actual equipment furnished. Provisions shall include actual utility connections provisions as well as space conditioning and any other required provisions.
- B. Coordination: Prior to installation of provisions, coordinate all provisions shown on the Drawings with actual provisions required on approved shop drawing submittals and cut sheets for the actual equipment which will be furnished and installed. Locations for utility rough-ins shall be modified as required to suit actual equipment furnished at no cost to the Owner or Engineer. Where utility requirements and environmental provisions shown on equipment shop drawings and cut sheets are equal to or less than those shown on the drawings then modifications to the mechanical and plumbing provisions shall be made at no cost as a matter of project coordination. Where utility requirements and environmental provisions shown on equipment shop drawings and cut sheets are in excess of those shown on the drawings, notify the Engineer in writing of the requirements.

3.2 CONNECTIONS:

- A. General: Furnish and install final utility connections to all Owner and Contractor-furnished equipment, relocated existing equipment, and other equipment. Connections shall be made as shown on the Drawings with coordination to locate and size actual connection requirements. All valves, unions, flexible connections, air gaps, traps, tailpieces, gas cocks, faucets, trim, and other devices required to

make connections shall be provided to assure the final installation meets the recommendations shown on the Drawings, equipment shop drawings, cut sheets and equipment manufacturer's written installation Drawings. Trim which is not furnished to this Contractor and which is required for a complete installation, shall be provided by this Contractor.

- B. Coordination: Utility connections shall be coordinated with equipment so as not to hinder any required service access points and to provide all required service access clearance. Connections shall be concealed to the maximum extent possible and all exposed piping which is not specified to be insulated shall be chrome-plated with chrome escutcheons.

3.3 COORDINATION:

- A. General: It shall be the responsibility of this Division to coordinate with the Owner, General Contractor and other Divisions to determine which equipment connections and provisions are provided by this Division and which are provided by others and to ensure that provisions are provided in a complete and timely manner.

3.4 INSTALLATION OF CONNECTIONS:

- A. General: Install provisions and connections in a neat and workman like manner. Where connections are exposed in finished areas, make every effort to minimize the visual impact of connections by properly coordinating connection locations and requirements prior to rough-in.
- B. Access: Locate provisions and connections so as not to hinder access to equipment for use or maintenance.

3.5 IDENTIFICATION:

- A. Refer to Section 15100 for applicable painting, nameplates, and labeling requirements.

END OF SECTION

SECTION 15510

WET-PIPE FIRE SPRINKLER SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15002, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. This Section of the Specification includes providing all labor and materials for modifications to the existing wet-pipe fire sprinkler system in areas of the building being modified under the project scope and to relocate existing fire protrusion piping as required for installation of the new project work. Design and installation of the sprinkler system shall be in accordance with NFPA 13 and all new sprinkler heads shall be fast-response type.
- B. The Work shall be installed in accordance with the Drawings and Specifications. All devices and equipment shall be listed by Underwriters' Laboratories, Inc. or Factory Mutual-approved, individually and as a system, as applicable.
- C. Sprinkler heads shall be spaced, located, and positioned as shown on the Architectural reflected ceiling plans, where shown, as specified herein and as required to suit the building partition layout according to NFPA 13. Piping sizes and configurations shall be on the basis of hydraulic calculations. Where head layouts shown on the Drawings or requirements specified herein are more stringent than NFPA requirements, the more stringent requirements shall apply. Special consideration of locations or conditions shall conform to NFPA 13.

1.3 QUALITY ASSURANCE:

- A. Contractor: The fire protection system shall be designed and installed by a fire protection contractor who is licensed by the State of Texas to perform fire protection work of the type specified for this project. The fire protection contractor shall have a minimum of 5 years of experience in the installation of fire protection work of the type specified for this project.
- B. Applicable Publications: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.
 - 1. National Fire Protection Association (NFPA):
 - a. NFPA 13 Standard for the Installation of Sprinkler Systems, latest edition.
 - b. NFPA 70 National Electrical Code, latest edition.
 - 2. Underwriters' Laboratories, Inc.:
 - a. Fire Protection Equipment Directory, latest edition.
 - 3. Factory Mutual Engineering Corporation (FM):
 - a. Approval Guide, latest edition.
 - 4. Materials shall be installed in accordance with NFPA 13. All valves, fittings, hose, sprinkler heads, and equipment shall be UL or FM-labeled. All necessary points of city connections shall be matched to city equipment.
 - 5. Acceptable Manufacturers: The model numbers listed in the Specifications establish a level of quality and material. The following manufacturers are acceptable subject to compliance with the requirements of these Specifications.

- a. Sprinkler Equipment:
 - 1) Viking Corporation.
 - 2) Grinnell Fire Protection Systems Co., Inc.
 - 3) Automatic Sprinkler Corporation.
 - 4) Central Sprinkler Corporation.
 - 5) Reliable Automatic Sprinkler Co.
 - 6) Firematic Sprinkler Devices, Inc.

1.4 SUBMITTALS:

- A. Shop drawing submittals shall include, but not be limited to:
 - 1. Cut sheets marked to clearly indicate all fire protection system materials, accessories and manufacturers to be used, including, but not limited to pipe and fittings, pipe hangers and supports, sprinkler heads, specialties and other required materials. This shall include cut sheets on all grooved piping system components [and all manufacturers] which will be used on the project.
 - 2. Samples of sprinkler heads to be furnished.
 - 3. Final fire protection system shop drawings showing all piping sizes and elevations, sprinkler head types and hydraulic calculations. Piping shall be sized and elevation of mains shall be indicated. Drawings shall be approved by state and local authorities prior to being submitted. Drawings shall be in accordance with NFPA 13 shall be submitted to the Engineer for approval prior to fabrication of piping. Pipe schedules or hydraulic calculations shall be a part of this submittal. A fire pump characteristic curve for the building fire pump shall be a part of this submittal.
 - 4. The submittal shall include a statement from the sprinkler contractor certifying that the design meets the requirements of NFPA 13.
 - 5. Additional items as specified in Section 15002 and Section 15500.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver sprinkler system components in factory-fabricated water resistant packaging.
- B. Handle sprinkler system components carefully to avoid damage to components, enclosures, and finish.
- C. Store sprinkler system components in a clean, dry space and protect from weather.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION:

- A. The existing sprinkler system being modified is a wet-pipe fixed water type fire protection sprinkler system with a pressurized water supply to fusible sprinkler heads for control of fire.
- B. The sprinkler system modifications shall be designed to meet the requirements of NFPA 13.
- C. All sprinkler heads in general shall be in a straight line, parallel to the lines of the building and shall be located in the approximate center of ceiling tiles.
- D. Sprinkler heads in rooms with electrical equipment shall be located as far as code requirements allow from electrical equipment.

2.2 PIPE AND FITTINGS:

- A. Pipe: Provide pipe and tube of type, joint, grade, size, and weight (wall thickness, schedule or class) indicated for each service. Comply with applicable governing regulations and industry standards.
 - 1. Steel Pipe: ASTM A53 or ASTM A106 black or hot-dipped galvanized as specified. [Piping shall be domestically manufactured by one of the manufacturers listed in the latest edition of the American Petroleum Institute (API) approved manufacturers listing.]
- B. Fittings: Provide factory-fabricated fittings of type, materials, grade, class, and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve, and equipment connections. Where not otherwise indicated, comply with governing regulations, industry standards, and where applicable, with pipe manufacturer's instructions for selections.
 - 1. Malleable Iron Threaded Fittings: ANSI B16.3, Class 150 or Class 300, black or galvanized as specified.
 - 2. Malleable Iron Threaded Unions: ANSI B16.39, select for proper piping fabrication and service requirements including style, end connections, and metal-to-metal seats (iron, bronze, or brass), plain or galvanized as specified.
 - 3. Threaded Pipe Plugs: ANSI B16.14.
 - 4. Steel Flanges/Fittings: ANSI B16.5, including bolting, gasketing, and butt weld end connections.
 - 5. Forged Steel Socket-welding and Threaded Fittings: ANSI B16.11, rated to match schedule of connected pipe.
 - 6. Wrought Steel Butt-welding Fittings: ANSI B16.9, except ANSI B16.28 for short radius elbows and returns; rated to match connected pipe.
 - 7. Grooved End Fittings: ASTM A47 or ASTM A536 joined with Victaulic Style 005, 07, 75, or 77 couplings and Grade "E" gaskets.
 - 8. Flanged Fittings: Comply with ANSI B16.15 for bolt-hole dimensioning, materials, and flange-thickness.
 - 9. Flange Bolts: Bolts shall be carbon steel ASTM A307 Grade A hexagon head bolts and hexagonal nuts. Where one or both flanges are cast iron, furnish Grade B bolts. Cap screws utilized with flanged butterfly valves shall be ASTM A307 Grade B with hexagon heads.
 - 10. Flange Bolt Thread Lubricant: Lubricant shall be an antiseize compound designed for temperatures up to 1000°F and shall be Crane Anti-Seize Thread Compound or approved equal.
- C. Miscellaneous Piping Materials/Products:
 - 1. Welding Materials: Comply with ASME Boiler and Pressure Vessels Code, Section II, Part C, for welding materials.
 - 2. Brazing Materials: American Welding Society, AWS A5.B, Classification BCup-5.
 - 3. Gaskets for Flanged Joints: 1/16" thick for all pipe size 10" and smaller and 1/8" thick for all pipe size 12" and larger. Ring-type shall be used between raised face flanges and full face-type between flat face flanges with punched bolt holes and pipe opening. Gaskets shall be Garlock Style 3400 compressed nonasbestos or equal.
 - 4. Insulating (Dielectric) Unions: Provide dielectric unions at all pipe connections between ferrous and nonferrous piping. Unions shall be "Clearflow" waterway made by Victaulic, "Delvin" as made by Pipeline Seal and Insulator Company or "EPCO" as made by Epco Sales, Inc. and shall have nylon insulation.

2.3 PIPE HANGERS AND SUPPORTS:

- A. Pipe Hangers and Supports: Support fire protection pipe with UL-listed and approved hangers and support devices. Provide any special hangers or supports that may be required. The design, selection, spacing, and application of horizontal and vertical pipe hangers, supports, restraints, anchors, and guides shall be in accordance with the NFPA 13. All pipe hangers, rods, supports, inserts and other components shall be galvanized.

2.4 SLEEVES AND ESCUTCHEONS:

- A. Pipe passing through walls, floors, and partitions shall be provided with standard weight steel pipe sleeves. Sleeves through walls in finished spaces shall be flush. Where located in the floor construction, the sleeves shall project not less than 2" above the floor line. Refer to Section 15100 for fire stopping and additional sleeve requirements.
- B. Provide escutcheons for pipes passing through walls, partitions, or ceilings. Escutcheons shall be provided where pendant sprinkler heads penetrate ceilings or sidewall heads penetrate walls. Pipe escutcheons shall be chrome-plated steel. Sprinkler escutcheons shall be white-painted or chrome-plated steel as specified. Refer to Section 15100 for additional requirements.

2.5 SPRINKLER HEADS/SPECIALTIES:

- A. Unless otherwise specified, sprinkler heads shall have 165 deg F fast response rating. Heads located within the air streams of heat emitting equipment and located at the top of elevator shafts shall be selected for proper temperature rating. Corrosion-resistant sprinkler heads shall be installed where they are exposed to weather, moisture, or corrosive vapors. Heads installed where they might receive mechanical injury or are less than 7' above the floor level shall be protected with approved guards in accordance with NFPA 13. Sprinkler guards shall be provided for sprinklers in electrical closets. Sprinklers in areas with suspended ceilings shall be pendant type, with pipe and fittings located above the suspended ceiling.
- B. Sprinkler heads in finished public areas and non-public shall be Reliable Model G semi-recessed chrome-plated fast response heads with a white escutcheon plates or an approved equal. Sprinkler head shall be UL-listed and FM-approved with the provided escutcheon plate.
- C. Sprinkler heads in the unfinished/non-ceiling areas shall be Reliable Model G or approved equal brass, fast response upright pendant or pendant heads as required.

PART 3 - EXECUTION

3.1 INSTALLATION OF FIRE PROTECTION PIPING SYSTEMS:

- A. General: All piping system materials, components and installation shall be in accordance with NFPA 13 and the requirements of the Texas State Board of Insurance and Industrial Risk Insurers (IRI). State Board of Insurance and IRI approval will not be required.]
 1. Sprinkler piping shall be Schedule 40 black steel pipe (6" or smaller). Thinwall, chlorinated polyvinyl chloride (CPVC) and copper piping shall not be used.
 2. Fittings 2-1/2" and smaller for Schedule 40 pipe shall be Class 150 malleable iron threaded fittings.
 3. Fittings for piping 3" and larger shall be standard welded fittings or shall be a UL-listed grooved piping connection system with "rolled-grooves" or "cut-grooves". Couplings for standpipes shall be Victaulic Style 07 Zero-Flex couplings with Grade "E" gaskets (no substitute) to prevent vertical up and down movement of the standpipe in accordance with NFPA 13 and NFPA 14. Couplings for piping connections to pumps and their associated valves, to wall mounted Siamese connections, to roof manifolds shall be Victaulic Style 07 Zero-Flex couplings with Grade "E" gaskets (no substitute) or Gruvlok Fig. 7000 couplings with Grade "E" gaskets and adequate supports for proper mounting and operation of connected devices. Couplings for

underground piping shall be Victaulic Style 77 or Gruvlok Fig. 7001 with Grade "E" gaskets. All other couplings shall be Victaulic Style 75 or Gruvlok Fig 7000 with Grade "E" gaskets. Taps to mains shall be made using Victaulic Style 72 or Style 920 or Gruvlok Fig. 7045/ 7046 outlet couplings or fittings. Mechanical "T" couplings with U-bolts shall not be permitted. Flange connections shall be made using Victaulic Style 741 or Gruvlok Fig. 7012 flanges with Grade "E" gaskets. Fittings for elbows, tees, reducers, and similar items shall be Victaulic or Gruvlok full flow fitting. All grooved piping couplings and fittings shall be the products of a single manufacturer and shall be UL listed for fire protection use as used on the project, including pressure and temperature ratings, pipe type and groove type. The use of boltless couplings, reducing couplings, mechanical "T" fittings with U-bolts and bolt on sprinkler head taps is prohibited. All grooved piping connection materials shall be used with the manufacturer' recommended groove rolling or cutting tool. All proposed grooved piping connection materials shall be suitable for fire protection use at the temperatures and pressures at the point of application. Painted couplings may be utilized in lieu of galvanized couplings.

B. Piping Installation:

1. Piping shall be concealed, except in mechanical equipment rooms, stairwells, or where otherwise indicated on the Drawings. Install exposed piping parallel to or at right angles to the column lines of the building wherever possible.
2. Grade piping to eliminate traps and pockets and for drainage per NFPA 13 and NFPA 14. Where air pockets or water traps cannot be avoided, provide hose bibbs for drainage.
3. Fire protection piping shall not be routed over electrical equipment. It shall be the responsibility of the Fire Protection Contractor to coordinate electrical equipment locations with the Electrical Contractor and design the fire protection piping system such that no piping is routed over electrical equipment.
4. All changes in direction, branches, offsets etc., shall be made with standard pipe fittings. Holes in the main for branches shall be made with a hole cutting machine and a standard "Weld-O-Let" or "Thread-O-Let" fitting used. Burning holes in the fire protection System Piping will cause that section of the piping to be cut out and replaced at the Contractor's expense.
5. All pipe shall be reamed to full pipe diameter before joining. Screwed joints shall be made with standard pipe thread and an approved compound applied to the male thread only. Welded joints shall be made in accordance with the procedure outlined in the A.S.A. piping code. Valves and specialties shall be screwed or flanged joints.
6. Install unions or flanges at equipment connections and as indicated on the Drawings.
7. Cold-springing piping will not be permitted. Install piping with adequate support to prevent strain on the equipment and to allow for piping system expansion and contraction.
8. Welded joints on pipe runs shall be made with continuous welds and with pipe ends beveled before fabrication. Piping shall be carefully aligned prior to welding and no metal shall project within the pipe.
9. Piping shall be sized as required by applicable codes and as indicated on the Drawings.
10. Field-grooving of pipe for Victaulic fittings shall use Victaulic groove depth control tool and a hole-cutting tool shall be used instead of burning a hole in the piping. Victaulic reducing couplings and outlet couplings shall not be installed. Victaulic gaskets shall be UL-approved for the service and working pressure of the systems.
11. Provide all test and drain lines as required by NFPA 13. Pressure gauges, signs, and other such standard appurtenances shall be furnished as required for a complete installation in accordance with NFPA 13. A nameplate data sign shall be provided at the zone controlling valve to identify the system as a hydraulically designed system indicating the location and basis for design in accordance with NFPA 13.

12. All sprinkler piping shall be so installed that it can be thoroughly drained, and where practicable shall be arranged to drain at the zone drain valve. The zone drain valve shall be capable of a full discharge test without allowing water to flow onto the floor. All drips and drains shall conform to NFPA No. 13.
13. Field changes in the piping layout or pipe sizes shall not be made without the prior approval of the Engineer.
14. All welding "cut-out" discs shall be retrieved and turned over to the Owner's Representative.

C. Pipe Hangers and Supports:

1. Pipe supports, sway braces, hangers, and clamps shall conform to and be placed in accordance with NFPA 13 and listed by Underwriters' Laboratories, Inc., or approved by Factory Mutual.
2. All pipe shall be supported from the building structure in a neat and workmanlike manner and wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze type hangers. Vertical risers shall be supported at each floor line with steel pipe clamps. The use of wire or perforated metal to support pipes will not be permitted. Hanging pipes from other pipes will not be permitted. Spacing of pipe supports shall not exceed 10' on all piping.
3. All standpipe and sprinkler piping shall be adequately supported to avoid excess strain on fittings and joints. As a minimum, all vertical risers shall be supported at the bottom level, the top level and at each alternate level in between.
4. Where pendant sprinklers are used, care shall be taken to resist upward movement of flowing sprinklers by means of rigid hangers or other restraints on the ends of branch lines or arm-overs exceeding 5' in length.

- D. Access Doors and Panels: Provide access doors or panels as required to provide full valve access. Refer to Section 15100 for additional requirements.

3.2 **PROTECTION DURING CONSTRUCTION:**

- A. Provide necessary fire protection during construction in accordance with NFPA and local codes.

3.3 **TESTS AND INSPECTIONS:**

- A. Inspections, examinations and tests required by the authorities or agencies specified shall be arranged and paid for by the Fire Protection Subcontractor, as necessary, to obtain complete and final acceptance of the system as installed. The certificates of inspection shall be in quadruplicate, and shall be delivered to the Engineer for review and distribution.
- B. Sprinkler systems shall be hydrostatically tested by the Contractor upon completion of the installation as required by NFPA 13 in the presence of UTHealth EH&S. When hydrostatic and alarm tests have been completed and all necessary corrections made, a material and test certification shall be provided in accordance with NFPA 13. Final inspection shall include full flow testing through the inspector's test connection. Actuation of the flow switch shall occur within one minute of opening of the inspector's test valve. The final tests may be witnessed by UTHealth EH&S.
- C. Arrange and pay for all tests and inspections required by UTHealth EH&S.

3.4 **IDENTIFICATION:**

- A. Refer to Section 15100 for applicable painting, nameplates and labeling requirements. All drain valves, test valves and other system valves shall be clearly labeled as to use and the fact that they are fire protection system valves.

END OF SECTION

SECTION 15836

HVAC TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15002, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: HVAC terminal units shall include, but not be limited to:
 - 1. Double duct terminal units.

1.3 QUALITY ASSURANCE:

- A. Basis of Design: The following manufacturer models have been tested and found to comply with both the performance and design specifications that follow. These tests and inspections were performed to verify the availability of equipment that is in compliance with these Specifications when properly selected.
 - 1. Nailor 3230 Series with attenuator for double duct terminal units
- B. Manufacturers: Terminal units from Titus or Metalaire may be acceptable where documented independent test results and equipment submittals are reviewed by the Engineer to verify specification compliance.
- C. Certification: Provide manufacturer's and independent test lab certification of test results, signed by an authorized officer of the company.
- D. Preparation: HVAC terminal units to be clean and free of all foreign matter prior to shipping. Units and associated equipment such as controls, shall be packaged in a manner to prevent dust and other foreign matter from entering the unit, controls, and similar items during shipment. All external controls, operators, and sensors shall be covered by rigid metal shields during shipment and storage.

1.4 SUBMITTALS:

- A. Shop drawing submittals shall include, but not be limited to, the following:
 - 1. Cut sheets on each terminal unit, clearly marked to show sizes, configuration, construction, unique features, controls, clearances, accessories, performance data, sound data, operating sequence and other pertinent information.
 - 2. Air valve curves or charts which clearly show air valve performance.
 - 3. Performance characteristics for each terminal unit.
 - 4. Wiring and control diagrams and air flow sensor calibration curves for each terminal unit type.
 - 5. Copies of factory-certified sound, leakage and performance test results from actual tests of units of the same model and construction to those which will be provided for the project.
 - 6. Written report of the test results including noise criteria (NC) in sound power as tested in a reverberant room with terminal unit operating at the scheduled airflow. When reporting NC levels, no credits or reduction shall in any way be considered for room, plenum, ceiling, and similar item effects.

7. Certified dimensioned drawings showing the locations of all openings, support points, connections, sizes for same, overall dimensions of all boxes and any other pertinent information that may affect the installation of the boxes.
8. Submit the following certified performance data for each size and type of terminal unit to be used on the project:
 - a. Maximum and minimum cfm ratings at 0.35" discharge static pressure.
 - b. Pressure drop through each primary air damper at 25%, 50% and 100% of design cfm.
 - c. Pressure drop through terminal unit and heating coil at full plenum air mode for fan powered terminal units and full heating and full cooling modes as applicable for single and double duct terminal units.
 - d. Radiated and discharge sound power data for each size terminal unit at 0.5", 1.0", and 1.5" primary duct static pressure, 0%, 25%, 50%, 75% and 100% primary cold air and design discharge cfm (constant fan powered terminal units only) and static pressure.
 - e. Temperature mixing data for each size fan powered or dual duct terminal unit at maximum and minimum discharge cfm for the unit size with 25%, 50% and 75% primary air.
9. Product warranties and guarantees.
10. Additional information as required in Section 15002.

1.5 **PRODUCT DELIVERY, STORAGE AND HANDLING:**

- A. Deliver HVAC terminal units in factory-fabricated water resistant packaging.
- B. Handle HVAC terminal units carefully to avoid damage to components, enclosures, and finish.
- C. Store HVAC terminal units in a clean, dry space and protect from weather.

PART 2 - PRODUCTS

2.1 **MATERIALS:**

- A. General: Provide HVAC terminal units of standard materials and components designed and constructed as recommended by the manufacturer and as required for a complete installation in compliance with these Specifications. Units with electrical equipment shall be constructed in accordance with NEMA and NEC and shall include disconnects or fused disconnects where specified required by the NEC.

2.2 **DOUBLE DUCT TERMINAL UNITS:**

- A. General: Provide variable volume, pressure independent double duct terminal units consisting of a sheet metal housing with control dampers, damper operators, mixer-attenuator and flow controls. Double duct terminal units shall be compatible with the temperature controls as specified in Section 15900, "Building Controls". Terminal unit capacities and sizes shall be as scheduled and shown on the Drawings. Terminal units shall comply with UT OFPC requirements for terminal units.
- B. Housing: Shall be constructed of 22 gauge minimum galvanized sheet metal with mechanical seals and gaskets to minimize housing leakage. Housing shall be insulated with one inch (1"), dual density coated fiberglass insulation meeting the requirements of NFPA 90A and UL 181 and protected with galvanized sheet metal liner. Housing shall be provided with a round or oval inlet for use with flexible duct (1800 fpm maximum velocity) and a rectangular outlet for slip and drive connection to sheet metal ductwork (1600 fpm maximum velocity).

- C. Mixer-attenuator: Each unit shall include a mixer-attenuator section as an integral part of the unit to minimize downstream stratification. The mixer shall provide less than 1°F downstream variation with 10°F difference between the two inlets. Certified independent test lab data shall be submitted for approval subject to witness testing by the Engineer or Owner's Representative.
- D. Control Dampers: Shall be of a low leakage, opposed blade or single blade design with galvanized steel blades and self-lubricating bearings. Dampers shall be selected to limit pressure drop to 0.25" wc pressure loss when operating at a velocity of 2000 fpm. Dampers shall be arranged to allow units to operate at constant or variable volume air flow.
- E. Damper Operators: Shall be electric type normally open damper operators rigidly mounted to the terminal unit and connected to the dampers with direct drive or an adjustable linkage. Operators shall be sized to properly operate the unit dampers. Damper shall be factory-mounted and wired. Operators shall be selected to coordinate with control dampers and the DDC controls and control sequence specified. All exposed operational/linkage components shall be protected with removable metal covers.
- F. Leakage: Overall leakage for the control damper and pressurized portions of the housing shall be less than 3% of nominal cfm at 6" SP, as rated by ARI 880 (latest Edition).
- G. Controls: Pressure independent volume controls shall be factory-installed, including multipoint air flow sensors for cold deck inlet and hot deck inlet flow measurement, a DDC terminal unit controller and related accessories and components required to operate the unit as a dual duct variable volume unit. Controls shall provide adjustable minimum and maximum cfm limits, adjustable throttling range and a constant throttling range option. Adjustments for control settings and gauge tees for flow measurement and balancing shall be easily accessible. DDC controllers and damper operators shall be furnished by the BAS Contractor for factory-installation, wiring and testing by the terminal unit manufacturer. Controllers shall be located for easy access from the ceiling below the unit. Temperature control functions and sequences shall be as specified in Section 15950, "HVAC Sequence of Operation", and as shown on the Drawings. The terminal unit manufacturer shall provide an appropriately sized 120 volt control power transformer to serve the terminal unit controller. An air flow sensor calibration curve label shall be attached to each terminal unit in a location visible from the unit controller.
- H. Unit Performance: The following performance tests shall be performed by an independent testing lab to verify compliance prior to equipment submittal. Acceptability of the testing facilities shall be subject to review by the Engineer. Cold air shall be supplied at 55°F and warm air shall be supplied at 80°F. Test results and criteria which shall be considered acceptable are as follows:
 - 1. Radiated sound power levels shall not exceed [NC 30] [NC 35] for any value unit discharge cfm, 2.0" inlet static pressure and 0.35" outlet static pressure with any percentage of cold air.

<u>Band</u>	<u>Hertz</u>	<u>NC 30 Criteria</u>
1	63	57dB
2	125	48 dB
3	250	41dB
4	500	35 dB
5	1000	31 dB
6	2000	29 dB
7	4000	28 dB
8	8000	27 dB

Test to be conducted in a mock-up condition approved by the Engineer.

2. Discharge noise level in sound pressure measured 5' from the terminal unit in a duct with 1/2" acoustical lining shall be a maximum of NC 25. The 5' duct shall include one elbow with turning vanes.
3. Temperature variation at the mixer-attenuator discharge shall not vary more than 3°F across the opening with 50% cold air at 55°F and 50% warm air at 80°F.
4. CFM fluctuation at any given flow setting over static pressure range shall be a maximum of +10%.
5. Dampers and unit casing shall prevent leakage in excess of 3% of maximum rated terminal unit capacity when operating against 3" of static pressure (SP).

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Except as otherwise indicated, install HVAC terminal units including components and controls required for operation, in accordance with manufacturer's instructions.
- B. Location: Locate each unit accurately in the position indicated in relation to other work. Position unit with sufficient clearance for normal service and maintenance, including clearance for cabinet removal.
- C. Supports: Minimum support requirements for terminal units shall be as follows. Terminal units weighing less than 150 pounds shall be supported by four 16 gauge, one inch (1") wide sheet metal straps with ends turned under bottom of unit at corners and secured by two maximum 3/4" long by 1/4" diameter sheet metal screw per strap. The other strap end shall be attached to the structure by 1/4" diameter threaded bolt into the concrete insert or into drilled-hole threaded concrete expansion anchor. Boxes over 150 pounds in weight shall be supported the same as described above except 1/4" diameter sheet metal screws shall be located with one screw on the side of the unit and one screw on the bottom of the unit. Seal all screw penetrations into the terminal unit air stream.
- D. Leveling: Level terminal units to the tolerances recommended by the manufacturer.
- E. Flow Graphs: Graphs shall be provided to coordinate pressure at flow measuring taps with unit primary cfm.
- F. Unit Connections: Duct connections shall be the more stringent of the connections detailed on the Drawings and the terminal unit manufacturers recommendations.

3.2 TESTING:

- A. General: Installed terminal units shall be leakage tested with the connected ductwork.

3.3 IDENTIFICATION:

- A. Refer to Section 15100 for applicable painting, nameplates and labeling requirements.

END OF SECTION

SECTION 15840

DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15002, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide metal ductwork systems as shown on the Drawings and as specified herein.
 - B. System Types: The types of ductwork systems specified in this Section include, but are not necessarily limited to the following:
 - 1. Air conditioning supply and return air systems.
 - C. VAV Supply Air Ductwork Upstream of Terminal Units: Ductwork shall be sheet metal ductwork designed for velocities up to 2500 fpm and pressures up to +3" wg. Ductwork shall be externally insulated.
 - D. Supply Air Ductwork Downstream of Terminal Units: Ductwork shall be sheet metal ductwork designed for velocities up to 2500 fpm and pressures up to +2" wg. Ductwork shall be externally insulated.
 - E. Constant Volume Supply Air Ductwork: Ductwork shall be sheet metal ductwork designed for velocities up to 2500 fpm and pressures up to +2" wg. Ductwork shall be externally insulated.
 - F. Return Air Ductwork Upstream of Return Air Fans: Ductwork shall be sheet metal ductwork designed for velocities up to 2500 fpm and pressures up to -1" wg. Ductwork used for return air boots and elbows and other return air ductwork where shown on the Drawings shall be lined with one inch (1") ductliner.
 - G. Return Air Ductwork Downstream of Return Air Fans: Ductwork shall be sheet metal ductwork designed for velocities up to 2500 fpm and pressures up to +3" wg. Ductwork used for return air boots and elbows and other return air ductwork where shown on the Drawings shall be lined with one inch (1") ductliner.
 - H. Flexible Ductwork: Ductwork connections to HVAC terminal units and air devices shall be made with flexible ductwork connection where shown on the Drawings. Additional connections may be made using flexible ductwork at the Contractors option, where approved in writing, in advance, by the Engineer.
 - I. Ductwrap Insulation: Refer to Section 15200, "System Insulation", for external ductwrap insulation.
 - J. Ductwork Accessories: Refer to Section 15845, "Ductwork Accessories", for accessories and specialties related to ductwork systems and installation.
 - K. Basic Materials and Methods: Refer to Section 15100, "Basic Materials and Methods", for basic materials and methods related to mechanical construction.
- ##### 1.3 QUALITY ASSURANCE:
- A. SMACNA Standards: Comply with Sheet Metal and Air Conditioning Contractors National Association (SMACNA), HVAC Duct Construction Standards, Metal and Flexible, 1985 Edition recommendations for fabrication, construction, details, and installation procedures, except as otherwise indicated on the Drawings or in these Specifications.

- B. ASHRAE Standards: Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards and recommendations, except as otherwise indicated on the Drawings or in these Specifications.

1.4 SUBMITTALS:

- A. Shop Drawing submittals shall include, but not be limited to, the following:
 - 1. Ductwork submittals shall include ductwork fabrication drawings and submittal data on ductwork specialties and construction details.
 - 2. Ductwork fabrication drawings shall be drawings to scale on 1/8" or 1/4" scale building floor plans and shall indicate duct sizes, duct material, duct insulation type, locations of transverse joints, fittings, ductwork bottom elevation, offsets, ductwork specialties, flexible connections, flexible ductwork, fire and fire/smoke dampers and all other information required for coordination with other trades and fabrication of ductwork. All fire and fire/smoke partitions shall be clearly designated on the ductwork shop drawings. Ductwork fabrication drawings shall be coordinated with other trades and building construction prior to submittal for approval.
 - 3. Duct specialties and construction details including, but not limited to information on duct construction and materials, transverse and longitudinal joints, cross-breaking or transverse beading, dampers, flexible connectors, fittings, transitions, elbows, control, fire and fire/smoke damper connections, branch taps, turning vanes, access doors and other required duct specialties and construction details.
 - 4. Cut sheets on flexible ductwork and related taps and accessories.
 - 5. Cut sheets on breeching and flue piping materials and accessories, including a complete flue design layout.
 - 6. Duct system leakage test procedures and reporting forms.
 - 7. Additional information as required in Section 15002.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver ductwork materials to the site in suitable packaging to prevent damage and exposure to weather.
- B. Store ductwork in dry areas, where it is not exposed to damage. Crib stored ductwork off of floors to prevent water damage.
- C. Handle ductwork to prevent damage.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS:

- A. Sheet Metal: Ductwork shall be constructed using prime G90 galvanized lock-forming quality or coil steel in widths up to 60", conforming to ASTM A924/A924M-74, A653 and A653M, and using gauges selected by application, based upon applicable SMACNA Standards.
- B. Labeling: Ductwork materials shall be stenciled on maximum 10' centers with the manufacturer's name and material gauge. Stenciling shall be visible after duct is fabricated and installed.
- C. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discolorations, and other imperfections, including those which would impair painting.

2.2 MISCELLANEOUS DUCTWORK MATERIALS:

- A. General: Provide miscellaneous materials and products of the types and sizes indicated and where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
- B. Duct Sealant: Provide non-hardening, non-migrating mastic or liquid elastic sealant (type applicable for the fabrication/installation detail) as compounded and recommended by the manufacturer specifically for sealing joints and seams in ductwork. Sealers shall be as follows:
 - 1. Sealer shall have a high solids content.
 - 2. Sealer shall have a high adhesive and cohesive strength and shall bond to both degreased and non-degreased metals.
 - 3. Sealer shall conform to NFPA 90-A requirements and be UL-labeled for ductwork applications.
 - 4. Sealer and related installation materials and methods shall be:
 - a. Hardcast Type 601 Iron Grip Duct Sealant.
 - b. United McGill Corporation United Duct Sealer.
 - c. Foster Type 30-02 High Velocity Duct Seal.
 - d. Transcontinental Equipment Ltd. Multipurpose Water Based Duct Sealer.
- C. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim, and angles for support of ductwork.
- D. Exposed Stainless Steel: Provide matching stainless steel supports for exposed stainless steel ductwork.

2.3 DUCTLINER:

- A. Acoustical Ductliner: Provide Schuller Permacote Linacoustic Standard/HP or Owens-Corning Aeroflex 1" thick fiberglass ductliner with an NCR of **0.70** or greater per ASTM C1071, a thermal conductivity of 0.31 BTU in/(hr ft² °F) and friction correction factor no greater than 1.02 at 500 fpm. All ductliner shall be guaranteed against delamination up to 3000 fpm velocities. Ductliner shall have a surface coating formulated with an immobilized, EPA-registered, anti-microbial agent so it will not support the growth of fungus or bacteria.
- B. Ductliner Adhesive: Provide non-flammable adhesives 3M #37, St. Clair R41B, Foster 85-11 or Foster 85-20, which comply with NFPA 90A and ASC-A-7001 by The Adhesive and Sealant Council, Inc. (see SMACNA standards).
- C. Ductliner Fasteners: Comply with SMACNA requirements.

2.4 FLEXIBLE DUCT:

- A. General: Insulated flexible duct shall be a factory fabricated assembly consisting of an inner liner, fiberglass insulation and a vapor barrier outer jacket.
- B. Inner Liner: The inner liner shall consist of a galvanized steel helix mechanically securing an inner liner composed of a tri-laminate of aluminum foil, fiberglass and aluminized polyester for applications upstream of HVAC terminal units and shall consist of a galvanized steel helix mechanically securing an inner liner composed of a SPUNBOND nylon fabric for applications downstream of HVAC terminal units.
- C. Insulation: Duct liner shall be wrapped with a nominal one inch (1") thick fiberglass insulation blanket with a maximum thermal conductance C Factor of 0.23 Btu/hr/sf/°F.
- D. Outer Jacket: Insulation shall be covered with a reinforced metalized aluminum vapor barrier jacket with a maximum permeability of 0.05 Perm per ASTM E96, Procedure A.

- E. Pressure Ratings: Flexible duct for applications upstream of HVAC terminal units shall be rated for a minimum of 12" positive and 5" negative internal working pressure. Flexible duct for air device applications shall be rated for 6" positive and 4" negative internal working pressure. Flexible duct shall be suitable for operation at temperatures up to 120°F.
- F. Sound Attenuation: Flexible duct for air device applications shall be designed to provide sound attenuation and a 9' length of 8" duct shall have typical insertion losses (IL), in dB, as follows:

Octave Band	2	3	4	5	6	7
Straight Duct at 2500 fpm flow	9	27	27	32	33	37
90° Bend Duct at 2500 fpm flow	18	31	34	37	34	38
- G. Codes/Standards: Flexible duct shall be listed as Class 1 Air Duct per UL 181 and shall comply with NFPA 90A and 90B.
- H. Fire Ratings: Flexible duct shall have a flame spread rating of less than 25 and a smoke developed rating of less than 50.
- I. Clamps: Terminal unit flexible duct inner liner shall be secured using Flexmaster LS Series or approved equal 1/2" wide positive locking stainless steel straps. Air device flexible duct outer jackets shall be secured using Panduit Corporation, Ideal or an approved equal 0.35" wide self-locking nylon straps.
- J. Terminal Unit Flexible Duct Taps: All take-offs for HVAC terminal units shall be conical bellmouth taps equal to a Flexmaster CB conical bellmouth fitting, or side take offs without dampers equal to a Flexmaster 45° STO fittings. Fittings shall be minimum 26 ga. Galvanized sheetmetal.
- K. Air Device Flexible Duct Taps: All round take-offs for air devices shall be made with a damper spin-collar, equal to a Flexmaster FLD dampered spin fitting. Where the duct height does not allow the use of a spin-in fitting, use 45° STOD side take offs with dampers, equal to Flexmaster 45° STOD STOD Fittings. Dampers shall be provided with full length 3/8" square shafts secured to the damper blade with a minimum of 2 U-bolts, nylon bearings, insulation build out, heavy duty locking hand quadrants and integral flexible duct retention beads. Fittings and damper blades shall be minimum 26 ga. galvanized sheetmetal for sizes up to 10" and minimum 24 ga. galvanized sheetmetal for sizes up 12" and larger.
- L. Manufacturers: Flexible duct for applications upstream of HVAC terminal units shall be Flexmaster Type 3M or an approved equal. Flexible duct for air device applications shall be Flexmaster Type 6M Acoustical or an approved equal.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS:

- A. Standards: Round and rectangular sheet metal ductwork shall be constructed in accordance with SMACNA "HVAC Duct Constructions Standards", 1985 Edition, ASHRAE Guide and Data Book, "Handbook of Fundamentals", latest edition, specifically Chapter 25 and NFPA Standard 90-A, "Standard for the Installation of Air Conditioning and Ventilating Systems". Duct sizes shown are clear inside dimensions. Where ductliner is specified, increase each dimension to accommodate liner.
- B. Route all duct tight to underside of structure, unless otherwise noted or required for coordination. All ductwork shall be top level with bottom and side transitions only. The Mechanical Contractor shall be held responsible for coordinating with all other trades prior to the construction or installation of ductwork. Some ductwork may require the use of S-drive joints, flat seams or offsets to allow installation of other ducts or equipment. Use 45 degree radius elbows (center line radius 1.5 times duct height) to rise up and drop down when crossing ductwork or other material. The Mechanical Contractor shall be responsible for coordination of all such work with the General Contractor and other Subcontractors as required. Minimum bottom of duct elevation above finished floor shall be as noted on the Drawings, where applicable.

- C. Adhere to the Drawings for routing and location of ductwork as closely as possible. Ductwork shop drawings shall be made after job site measurements are made and shall be coordinated with all other trade. Ductwork construction details and materials shall be submitted and approved prior to fabrication of any ductwork.
- D. All ductwork shown on the Drawings, specified or required for the heating, ventilating and air conditioning systems shall be constructed and erected in a first class workmanlike manner. The work shall be guaranteed for a period of one year from and after the date of acceptance of the job against noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation. After the system is in operation, should these defects occur, they shall be corrected as directed by the Engineer.
- E. The interior surface of all ductwork shall be smooth with no parts projecting into the air stream unless specified to do so. All seams and joints shall be external. The inside of all ductwork shall be thoroughly cleaned and all fans operated to remove any debris prior to connection of air devices.
- F. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched), and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for any length of time.
- G. Where ducts, exposed to view (including equipment rooms), pass through walls, floors or ceilings, furnish and install sheet metal collars around the duct.
- H. When the Mechanical Contractor submits revised duct sizes for review by the Engineer or requests to substitute rectangular, round or flat oval duct sizes for rectangular, round or flat oval spiral duct, substitute sizes shall be based on equivalent hydraulic diameter as calculated by ASHRAE formulae for equivalent friction loss and airflow.
- I. Sheet metal plenums shall be constructed and reinforced in accordance with SMACNA standards. Where plenums are connected to louvers, the plenum bottom shall be sloped to drain to the louver.
- J. Ductwork which is exposed to weather shall have soldered joints and seams and shall be painted with a suitable epoxy coating.

3.2 **COORDINATION:**

- A. Prior to submitting ductwork shop drawings, the Division 15 Contractor shall fully coordinate the routing and height of all ductwork with all other trades and with ceiling heights, lighting fixtures and building construction. Where ductwork is concealed, bottom of duct shall be a minimum of 8" above the ceiling unless otherwise noted. Where ductwork is exposed, bottom of horizontal duct shall be a minimum of 6'-6" above finished floor. Where ductwork is exposed in occupied areas it shall be tight to the structure and the bottom of the duct shall be minimum 6'-6" above finished floor.

3.3 **GENERAL DUCTWORK FABRICATION:**

- A. Duct Gauge and Reinforcing:
 - 1. Rectangular Ductwork: Minimum metal gauges and reinforcement shall be in accordance with SMACNA HVAC Duct Construction Standards (SDCS) Tables 1-3 through 1-13. Minimum aluminum gauges and reinforcement shall be in accordance with SDCS Tables 1-14 through 1-16. Reinforcing shall be installed per SDCS Fig. 1-9 through 1-12.
 - 2. Round Ductwork: Minimum metal gauges for longitudinal and spiral seam round ductwork shall be in accordance with SDCS Table 3-2. Minimum aluminum gauges for longitudinal and spiral seam round ductwork shall be in accordance with SDCS Table 3-3. Longitudinal seam ductwork larger than 12" diameter shall not be permitted unless welded seams are used.
 - 3. Cross-breaking: Cross-break or transverse bead all flat surfaces which are more than 12" wide. Transverse beading shall be on 12" centers and shall be a minimum of 1/8" deep at the center of the bead and 3/8" wide at the base of the bead.

4. Minimum Gauges: The metal gauges listed in the SDCS for round and rectangular ductwork are the minimum recommended. It shall be the Contractor's responsibility to select a metal gauge heavy enough to withstand the physical abuse of installation.
- B. Duct Joints And Seams:
1. General: Make all joints airtight. The distance between transverse joints on any size duct shall not exceed 5'.
 2. Rectangular Ductwork: Transverse joints and longitudinal seams in ductwork shall be constructed in accordance with SDCS Fig. 1-4 and 1-5. Drive slips may be used on rectangular ductwork on short sides only, up to 18" maximum. Gauge of drive slips shall be at least as heavy as ductwork on which they are installed. Bend drive slips over at least 3/4" at corners. Corner closures shall be in accordance with SDCS Fig. 1-13 through 1-18. All longitudinal seams shall be "Pittsburgh Lock" or button punch snap lock at corner seams and grooved seam or seam welded in sides between corners, in accordance with SDCS Fig. 1-5. At the Contractor's option, transverse joints may be transverse duct flange joints or Ductmate EP12/11 prefabricated galvanized "Ductmate" sections. The proposed gasket material, flange, corner piece and Ductmate details shall be submitted for approval.
 3. Round Ductwork: Transverse joints for round ductwork shall be beaded sleeve type constructed in accordance with SDCS Fig. 3-2, properly secured and sealed. Draw bands shall not be used on round ductwork. Longitudinal and spiral seams shall be constructed in accordance with SDCS Fig. 3-1.
 4. Ductwork Sealing: Seal all longitudinal and transverse ductwork joints and seams using SMACNA ductwork sealant and 3" wide open weave tape to provide positive seal. Sufficient sealant shall be used to completely imbed the cloth.
- C. Connections and Take-offs:
1. Rectangular Ductwork: Parallel flow branches shall be constructed using radius elbow take-offs in accordance with SDCS Fig. 2-7. Branch duct connections shall be 45 degree entry expanded taps constructed in accordance with SDCS Fig. 2-8. Duct-mounted coil connections shall be constructed in accordance with SDCS Fig. 2-11.
 2. Round Ductwork: Connections and takeoffs shall be made using 90 degree conical taps, 45 degree lateral taps or wye fittings constructed in accordance with SDCS Fig. 3-4 and 3-5. Use of 90 degree tees shall not be allowed.
 3. Spin-in Fittings: Spin-in fittings may be used for duct taps to air supply and exhaust devices and shall include quadrant dampers even though a volume damper may be specified for the air device. Spin-in fittings shall be sealed at the duct tap with a gasket and compression fit or sealed with duct sealant. The location of spin-in fittings in the ducts shall be determined after terminal units are hung and the location of the light fixtures is known so as to minimize flexible duct lengths and sharp bends. Spin-ins shall be installed with their damper axis parallel to airflow.
 4. Flexible Joints In Ductwork: Provide flexible connections where ductwork connects to air-handling units, fans, and similar powered equipment items and where required for expansion and contraction of the ductwork or the building structure. A minimum of one inch (1") slack shall be provided in all flexible connection to insure vibration isolation. Flexible joints are not required where equipment is connected with flexible duct. Flexible connections shall be rigidly connected to metal work on each side and shall be airtight. Bond flanges of flexible duct connectors to ducts and housings to provide airtight connections. Seal seams and penetrations to prevent air leakage.
- D. Elbows and Tees:
1. Rectangular Ductwork: Provide radius or square elbows in ductwork, where shown on the Drawings. Where radius elbows are shown, radius elbows must be provided. Where square

elbows are shown, square or radius elbows may be provided, at the Contractor's option. Elbows shall be constructed in accordance with SDCS Fig. 2-2. Turning vanes are required in all square elbows of 46 degrees or greater angle. Turning vanes are not required in radius elbows. Turning vanes shall be single vane type without a trailing edge and shall be constructed and installed in accordance with SDCS Fig. 2-3 and 2-4.

2. Round Ductwork: Provide radius elbows of the stamped or segmented type constructed in accordance with SDCS Fig. 3-3. Segmented elbows shall have a minimum of three segments for 45 degree elbows and five segments for 90 degree elbows.

E. Offsets and Transitions: Where duct width increases, maximum angle of slope shall be 20 degrees (one inch (1") in 2.7"). Where duct width decreases, maximum angle of slope shall be 30 degrees (one inch (1") in 1.7"). Offsets and transitions shall be constructed in accordance with SDCS Fig. 2-9 (type 2 and 3 only) and 2-10 (exclude C and E).

F. Air Device Connections: Make connections to air devices and fabricate air device plenums as detailed on the Drawings and in accordance with SDCS Fig. 2-16 through 2-18.

3.4 DUCTLINER:

A. General: The liner shall be applied to the inside of the duct with heavy density side to the air stream and shall be secured in the duct with adhesive, completely coating the clean sheet metal. All joints in the insulation shall be "battered" and firmly butted tightly to the adjoining liner using fireproof adhesive. Where a cut is made for duct taps, etc., the raw edge shall be accurately and evenly cut and shall be thoroughly coated with fireproof adhesive. On ducts over 24" in width or depth, the liner shall be further secured with mechanical fasteners. The fasteners shall be A.J. Gerrard Company pronged straps, or approved equal, secured to the ducts by fireproof adhesive. The clips shall be 18" maximum spacing and shall be pointed up with fireproof adhesive. Liner shall be accurately cut and ends thoroughly coated with fireproof adhesive so that when the duct section is installed, the liner shall make a firmly butted and tightly sealed joint. [Where ducts are lined exterior insulation will not be needed unless otherwise noted, except that the two insulations shall lap not less than 24".] Ductliner for velocities over 2500 fpm shall be as specified except a perforated metal liner shall be used over ductliner for securement, in lieu of fasteners. Ductliner installation and fasteners shall comply with SDCS Fig. 2-22 through 2-25.

3.5 DUCTWORK INSTALLATION:

A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve airtight and noiseless systems, capable of performing each indicated service. Install each run with a minimum of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers, and anchors of the type which will hold ducts true-to-shape and prevent buckling.

B. Inserts: Install concrete inserts for support of ductwork in coordination with formwork, as required to avoid delays in the work.

C. Completion: Complete fabrication of work at the project as necessary to match shop-fabricated work and accommodate installation requirements.

D. Run Location: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, grams, details, and notations or, if not otherwise indicated, run ductwork in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of the building. Limit clearance to 0.5" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork to assure 1.0" clearance of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate the layout with suspended ceiling and lighting layouts and similar finished work.

- E. Coordination: Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of the ductwork system.
- F. Hangers and Supports:
 - 1. General: All ductwork supports shall be per Section IV of the SMACNA "HVAC Duct Construction Standards - First Edition" with all supports directly anchored to the building structure. Supports shall be on maximum 8'-0" centers with additional supports as required to prevent sagging.
 - 2. Attachment to Structure: Provide hanger attachment to the building structure as specified in Section 15100, "Basic Materials and Methods", and in accordance with SDCS Fig. 4-1 through 4-3.
 - 3. Hangers: Hangers shall be strap or rod sized in accordance with SDCS Table 4-1 and 4-2. Strap hanger attachment to rectangular duct shall consist of a turning strap under the duct a minimum of one inch (1") and securing the strap with one screw into the bottom of the duct and one screw to the side of the duct. Rectangular duct supported on trapeze hangers shall be attached to the trapeze. Round duct attachments shall be constructed in accordance with SDCS Fig. 4-4.
 - 4. Horizontal Ducts: Ducts larger than 50" in their greatest dimension shall be supported by means of hanger rods bolted to angle iron or half round trapeze hangers. Duct shall have at least one pair of supports 8'-0" on centers according to the following:

Angle Length	Angle	Rod Diameter
4'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
8'-0"	2" x 2" x 1/8"	5/16"
10'-0"	3" x 3" x 1/8"	3/8"
 - 5. Vertical Ducts: Ducts shall be supported where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60". Above 60", the angles must be increased in strength and sized on an individual basis considering space requirements.

- G. Flexible Ductwork:
 - 1. General: Flexible ductwork shall be provided as shown on Drawings. Flexible ducts shall be installed in a fully extended condition free of sags and kinks, using only the minimum length required to make the connection, subject to the maximum lengths hereinbelow. Bends in any length of flexible duct shall not exceed 45 degrees for HVAC terminal unit connections or 90 degrees for air device connections and shall not exceed that recommended by the flexible ductwork manufacturer. Unless otherwise shown on the Drawings, the length of any one run of flexible ductwork shall not exceed 1'-6" for HVAC terminal unit connections or 8'-0" for air device connections. Where longer runs are required, provide externally insulated rigid duct extensions.
 - 2. Supports: Where flexible duct extension exceeds 36", horizontally, a support shall be provided. Duct shall be suspended on 36" centers with a minimum 3/4" wide flat banding material and a minimum 6" wide sheet metal protective saddle. Refer to SDCS Fig. 3-9 and 3-10 and Page 3-17 for additional requirements.
 - 3. Terminal Unit Flexible Duct Connections: All flexible duct connections upstream of HVAC terminal units shall be made by turning back the insulation and securing the inner liner with duct sealer and 1/2" wide positive locking stainless steel straps. The insulation shall then be placed over the joint and sealed on the exterior with self-locking nylon straps and an approved metalized duct tape. Refer to SDCS Page 3-13 and 3-15 for additional requirements.

4. Air Device Flexible Duct Connections: All air device flexible duct connections shall be made by turning back the insulation and securing the inner liner with 1/2" wide positive locking stainless steel straps or self-locking nylon straps and sealing with an approved metalized duct tape. The insulation shall then be placed over the joint and sealed on the exterior with an approved metalized duct tape. Spin-ins for air device taps shall be installed with their damper axis parallel to air flow. Refer to SDCS Page 3-13 and 3-15 for additional requirements.

H. Duct Mounted Devices:

1. Install duct mounted sensors and control devices furnished under Section 15900, "Building Controls". Provide access doors at each duct mounted control device. Coordinate location of devices and installation requirements with the Section 15900 Subcontractor.
2. Install duct type smoke detectors furnished under Division 16. Provide access doors at each sampling tube assembly. Coordinate location of detectors and installation requirements with Division 16.

3.6 **CLEANING AND PROTECTION:**

- A. General: Clean ductwork internally, section-by-section of dust and debris as it is installed. Clean external surfaces of foreign substances which might cause corrosive deterioration of the metal or, where ductwork is to be painted, might interfere with painting or cause paint damage.
- B. Repairs: Strip protective paper from stainless ductwork surfaces and repair finish or replace ductwork portion wherever it has been damaged.
- C. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at the time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent the entrance of dust and debris until such time that connections are to be completed.

3.7 **TESTING:**

- A. General: Provide duct integrity and leakage testing for all supply ductwork installed on the project. Testing shall be in accordance with the SMACNA HVAC Air Duct Leakage Test Manual, First Edition, 1985 (DLTM) and shall include, but not be limited to:
 1. Test Complete Systems: Duct systems shall be tested as complete systems (e.g. from air handling equipment to terminal units/air devices, from terminal units to air devices or from air devices to exhaust (return fans). Duct systems shall not be tested in partial sections, unless approved in writing by the Engineer.
 2. Preparation for Testing: Duct system installation must be complete, including, but not limited to, fittings, spin-ins, taps, access doors, hangers, test ports/holes, dampers and other system components. Temporary caps shall be installed at the system inlet (supply air system), system outlet (exhaust/return air systems) and at all terminal unit/air device taps.
 3. Leakage Calculations: Prior to testing a duct system, the permissible leakage rate in cfm shall be calculated based on the square feet of duct surface and the duct system leakage classification.
 4. Test Configuration: The configuration for testing shall be similar to DLTM Fig. 3-1, using a variable volume blower as a test air source, an orifice plate meter with an inclined manometer to measure leakage cfm and a manometer to measure duct static pressure.
 5. Acceptable Results: Duct systems shall be tested, resealed and retested until acceptable results are obtained, eg. the measured leakage rate is equal to or less than the calculated permissible leakage rate.
 6. Documentation: Duct system leakage testing results shall be recorded on forms which include the following information as a minimum:
 - a. Duct System Tested.

- b. System Leakage Classification.
 - c. Duct System Square Footage.
 - d. Permissible Leakage Rate in CFM.
 - e. Duct Test Pressure.
 - f. Orifice Size.
 - g. Measured Pressure Differential.
 - h. Measured Leakage Rate in CFM.
 - i. Measured Duct Pressure.
 - j. Test Performed By.
 - k. Date/Time of Test.
 - l. Temperature and Weather Conditions of Test.
 - m. Engineer or Owners Representative Signoff.
7. Duct leakage test reporting forms shall be submitted to the Engineer for approval.
- B. Leakage Classifications:
- 1. VAV Supply Ductwork Upstream of Terminal Units and Return Ductwork Downstream of Return Air Fans: Ductwork shall be tested to leakage Class 6 at +3" wg.
 - 2. Supply Ductwork Downstream of Terminal Units and Return Ductwork Upstream of Return Air Fans: Ductwork shall be tested at leakage Class 12 at +2" wg.
 - 3. Constant Volume Supply Air Ductwork: Ductwork shall be tested at leakage Class 12 at +2" wg.

END OF SECTION

SECTION 15845
DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15002, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide ductwork accessories as shown on the Drawings, specified and required.
- B. Types: The types of ductwork accessories required for the project include, but are not limited to:
 - 1. Flexible connections.
 - 2. Direction and volume control dampers.
 - 3. Fire dampers.
 - 4. Turning vanes.
 - 5. Duct access doors and inspection plates.
 - 6. Test openings.
 - 7. Screens.
 - 8. Miscellaneous ductwork materials.

1.3 QUALITY ASSURANCE:

- A. SMACNA Compliance: Comply with applicable portions of Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) "HVAC Duct Construction Standards", 1985 Edition.
- B. ASHRAE Standards: Comply with American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
- C. Certification: Fire, fire/smoke and smoke dampers shall be UL-listed, FM-approved and comply with applicable building code requirements.
- D. Manufacturers: Provide products complying with the specifications and produced by one of the following:
 - 1. American Foundry.
 - 2. Duro-Dyne.
 - 3. Elgin Sheet Metal Products.
 - 4. Nailor Industries.
 - 5. Prefco.
 - 6. Ruskin.
 - 7. Tuttle and Bailey.
 - 8. United Sheet Metal.
 - 9. Vent-Fabrics, Inc.

- 10. Ventlok.
- 11. Young Regulator Co.

1.4 SUBMITTALS:

- A. Shop drawings submittals shall include, but not be limited to, the following:
 - 1. Cut sheets of ductwork accessories, clearly indicating materials, construction dimensions, ratings, approvals, and other pertinent information.
 - 2. Manufacturers' UL-approved installation instructions for fire, fire/smoke, and smoke dampers.
 - 3. Additional information as required in Section 15002.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver ductwork accessories in factory-fabricated water-resistant wrapping.
- B. Handle ductwork accessories carefully to avoid damage to material component, enclosure and finish.
- C. Store ductwork accessories in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 DUCTWORK ACCESSORIES, MATERIALS, AND FABRICATION:

- A. General: Provide ductwork accessories which comply with Sections 15840, "Ductwork", and 15845, "Ductwork Accessories", for applicable product requirements of ductwork materials and as required for a complete ductwork system installation.

2.2 FLEXIBLE CONNECTIONS:

- A. General: Flexible connections shall be minimum 3" wide and be UL-labeled, 30 ounces glass fabric-lined with insulation and coated on both sides with neoprene, complete with attachment accessories, "Vent-Glass" by Vent-Fabrics, Inc., Elgen "Zipper-lock" HZ-LN-14, Duro-Dyne Excelon "Metal-Fab", flexible connections shall be fabricated in accordance with Fig. No. 2-19 of the SMACNA HVAC Duct Construction Standards, 1985 Edition, or approved equal.

2.3 DIRECTION AND VOLUME CONTROL DAMPERS:

- A. General: Provide all direction and balancing (volume control) shown or noted on Drawings. All damper control devices shall be installed so as to be fully concealed in finished rooms and spaces.
- B. Control Dampers:
 - 1. Splitter Dampers: Splitter dampers shall be fabricated of steel not lighter than 16 gauge. The leading edge of the damper shall be hemmed. Each splitter shall be a minimum of 12" long or 1-1/2 times the width of the smaller of the two branches it controls, whichever is greater. Dampers shall be carefully fitted, and shall be controlled by locking quadrants equal to Ventlok No. 555 on exposed uninsulated ductwork, Ventlok No. 644 on exposed externally insulated ductwork and Ventlok No. 677 (2-5/8" diameter) chromium plated cover plate for concealed ductwork not above lay-in accessible ceilings, or approved equals.. Furnish and install end bearings for the damper rods on the end opposite the quadrant when Ventlok No. 555 or No. 644 regulators are used, and on both ends when Ventlok No. 677 regulators are used. On concealed ductwork above lay-in accessible ceilings use Ventlok No. 555 or No. 644 locking quadrant for splitter dampers. Dampers larger than 3 square feet in area shall be controlled by means of rods hinged near the leading edge of the damper with provisions for firmly anchoring the rod and bearings supporting the axle.
 - 2. Balancing Dampers: Balancing dampers shall be provided in all zones of multi-zone air handling units, in all air device taps and where shown on the drawings. Refer to Section 15840

"Ductwork" for air device flexible duct taps. Balancing dampers shall consist of single blade dampers in rigid round duct and rectangular duct up to 10" high and 12" wide, and opposed blade dampers in ducts 11" high and larger. Single blade dampers shall be in accordance with Fig. 2-14 of the SMACNA HVAC Duct Construction Standards (SDCS), 1985 Edition, and opposed blade dampers shall be in accordance with SDCS Fig. No. 2-15. Single blade dampers for rectangular duct shall be Ruskin MD35 22 ga. single blade galvanized steel dampers or an approved equal. Single blade dampers for round duct shall be Ruskin MDRS35 20 ga. single blade galvanized steel dampers. Single blade dampers shall be provided with full length 3/8" square shafts secured to the damper blade with a minimum of 2 U-bolts, nylon bearings, insulation build out and heavy duty locking hand quadrants. Opposed blade dampers for rectangular duct shall be Ruskin MD35/OB 16 ga. Galvanized steel opposed blade dampers or an approved equal. Opposed blade dampers shall be provided with full length 1/2" square shafts, concealed linkage, nylon bearings, insulation build out and heavy duty locking hand quadrants. Air pressure drop through each balancing damper not to exceed 0.05" wg at design airflow. All balancing dampers shall have 100% free area with damper open.

3. Damper Regulators: Damper regulators for concealed accessible applications shall be Young Valcalox 400 series lever handle damper quadrants or an approved equal. Where regulators are installed on externally insulated ductwork, provide stand-off platforms at least 1/4" higher than the insulation thickness. Where damper regulators are required in non-accessible locations, provide access doors or Young or equal extension rods, couplings, 90 degree gear drives, etc. as required and Young 301 or approved equal flush mounted remote regulator as directed by the Architect.
 4. Extractors: Provide extractors of the size and type indicated, with hex-key operated adjustable blades, with gang operated galvanized steel blades on one inch centers.
 5. Backdraft Dampers: Provide all aluminum gravity type backdraft dampers with an extruded frame and roll formed blades with silicon impregnated felt seals. Blade height shall not exceed 4", blade width shall not exceed 48" and blade linkage shall be provided to gang operate dampers by section.
- C. Operators: Damper operators for concealed inaccessible ductwork shall be Young Regulator Company, Catalog No. 700 or No. 315, as shown. Non-insulated accessible ductwork shall be Young Regulator Company, Catalog No. 433. Accessible insulated ductwork shall be Young Regulator Company, Catalog No. 443. Approved equal units by Duro-Dyne or Vent Fabrics, Inc. will be acceptable.

2.4 FIRE DAMPERS:

- A. General: Provide fire dampers at duct penetrations of rated floors, fire walls, elsewhere as shown in the Drawings and where required by the International Building Code. Fire dampers shall be UL-labeled and shall meet all of the requirements of NFPA 90A and UL Standard 555.
1. Provide 1 hour rated dampers where penetrations are in required 1 hour fire rated assemblies.
 2. Provide 1-1/2 hour rated dampers where penetrations are in required 2 hour fire rated assemblies.
 3. Provide 3 hour rated dampers where penetrations are in required 4 hour fire rated assemblies. 4 hour occupancy separating walls are excepted and shall not be penetrated by ductwork..
 4. Dampers shall be activated by a UL-approved fusible link which shall automatically close the damper upon operation. Fusible links shall operate at approximately 50°F above the maximum temperature in the duct system in normal operation, but not less than 165°F. All dampers associated with Life Safety Systems shall have minimum 212°F fusible links. Hinged dampers shall have stainless or cadmium-plated spring steel catches. All dampers shall be dynamic rated and shall have spring closure to ensure positive shutoff at velocities up to 5000 fpm and pressures up to 10" wg.

5. Dampers shall be UL-rated per UL Standard 555 and shall be Ruskin Type DIBD Series, Style A, B or C, or an approved equal.
6. Dampers shall be sized so that the free area space is not less than 95% of the connected duct free area space for low velocity, low pressure ductwork and 100% of the connected duct free area space for high velocity, high pressure ductwork. Dampers shall be installed so as to provide a positive barrier to the passage of air when in the closed position. Dampers shall be installed with angle iron frames and slip joint connections per manufacturer's installation requirements and SMACNA Standards such that they are self-supporting in the case of duct destruction due to heat. The installing contractor shall be responsible for coordinating locations which require special sleeves.
7. Provide access doors as specified under ductwork for all internally actuated dampers. Where duct access doors are installed in non-accessible locations, provide ceiling or wall access doors. Label duct access doors "FIRE DAMPER ACCESS" with 1/2" high black stencil letters.

2.5 TURNING VANES:

- A. General: Provide turning vanes in the size and type indicated with the following additional construction features:
 1. Blades: 2" galvanized steel for up to and including 18" ducts.
 2. Blades: 4-1/2" galvanized steel for ducts over 18".
 3. Construction: Single wall blade, constructed in accordance with Fig. No. 2-3 and Fig. No. 2-4 of the SMACNA HVAC Duct Construction Standards, 1985 Edition.
 4. Types: Fixed blades for 90 degree elbows, adjustable for transition elbows and fixed for 45 degree elbows where shown.

2.6 DUCT ACCESS DOORS AND INSPECTION PLATES:

- A. Access Doors: Provide Ruskin Type ADH2, Flexmaster Inspector Series Tab Doors or approved equal dual wall, insulated, hinged access doors in ductwork as required for access to fire, smoke and fire/smoke dampers, duct smoke detectors, sampling tubes, humidifiers and other duct mounted devices. Minimum door size shall be **14" x 14"** unless a smaller size is required due to duct dimensions. Square access doors shall be constructed in accordance with Fig. No. 2-12 and 2-13 of the SMACNA HVAC Duct Construction Standards, 1985 Edition.
- B. Inspection Plates: Provide inspection plates where shown on the Drawings. If not detailed, provide a minimum opening of 4" x 4" with a 6" x 6" cover plate. The cover plate shall be one gauge heavier than the ductwork, gasketed and secured with a minimum of eight sheet metal screws.

2.7 TEST OPENINGS:

- A. General: Ventlok No. 699 instrument test holes in locations as required to measure pressure drops across each item in the system, e.g., O.A. louvers, filters, fans, coils, intermediate points in duct runs, etc. Test holes in stainless steel duct systems shall be 316 stainless steel or an approved corrosion resistant design.

2.8 SCREENS:

- A. General: Provide screens on all duct, fan, etc., openings furnished by this Contractor which lead to, or are, outdoors. Screens shall be No. 16 gauge, 1/2" galvanized steel mesh in removable galvanized steel frame. Provide safety screens meeting OSHA requirements for protection of maintenance personnel on all fan inlets and fan outlets to which no ductwork is connected.

2.9 MISCELLANEOUS DUCTWORK MATERIALS:

- A. General: Provide miscellaneous materials for ductwork accessories, including hinges, refrigerator latches, sash locks, bolts and wing nuts, gaskets and pitot tubes as recommended by the ductwork accessories manufacturer for the application indicated.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Flexible Connections: Install flexible connections where ducts connect to fans, including roof exhausters. There shall be a minimum of 1/2" slack in the connections, and a minimum of 2-1/2" distance between the edges of the ducts except that there shall also be a minimum of one inch (1") of slack for each inch of static pressure on the fan system.
- B. Dampers: Install balancing, splitter and backdraft dampers where shown on the Drawings and wherever necessary for complete control of the airflow, including all supply, return and exhaust branches, "division" in main supply, return and general exhaust ducts, each individual air supply outlet and fresh air ducts. Where access to dampers through a fixed suspended ceiling is necessary, this Contractor shall be responsible for the proper location of the access doors. Install balancing dampers in each zone of multi-zone units.
- C. Fire Dampers: Install fire dampers as detailed on the Drawings and in strict accordance with the damper manufacturers UL-approved installation instructions.
- D. Flashing: Install flashing where ducts pass through roofs or exterior walls, suitable flashing shall be provided to prevent rain or air currents from entering the building. The flashing shall be of not less than No. 24 gauge 316 stainless steel.
- E. Turning Vanes: Install turning vanes per SMACNA standards. Turning vanes in ducts carrying air under pressure of 1-1/2" water gauge or more shall be anchored to the cheeks of the elbow in such a way that the cheeks will not breathe at the surfaces where the vanes touch the cheeks. In most cases, this will necessitate the installation of an angle iron support on the outside of the cheek parallel to the line of the turning vanes.
- F. Access Doors: Install access doors so that the doors open against the system air pressure wherever feasible and that their latches are operable from either side, except where the duct is too small to be entered. Provide access to each fire damper link to permit resetting. Comply with City Code Requirements and NFPA 96. Install hinged access doors in ductwork to provide access to all fire dampers, mixed air plenums, upstream of steam reheat coils, automatic dampers, etc. Where the ducts are insulated, the access doors shall be double skin doors with one inch of insulation in the door. Where access doors are located above a suspended ceiling, this Contractor shall be responsible for the proper location of the ceiling access doors, if the ceiling system does not provide proper access.
- G. Inspection Plates: Install plates at each multi-zone zone damper and where otherwise indicated on the Plans.
- H. Test Openings: Install test openings for pitot transverse of all supply, return, and exhaust duct connections to fan powered equipment, at each duct mounted balancing damper and at other locations required for proper measurement of airflow in all duct systems.

3.2 TESTING:

- A. General: Check installed ductwork accessories for required operation and leakproof performance during the system's operational test. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.
- B. Damper Testing: Test all fire, fire/smoke and smoke dampers for proper operation after the damper installation is complete. Dampers which exhibit any binding or other forms of impaired operation shall be replaced and retested. Refer to Section 15020 for additional requirements.

- C. Damper Certification: The Contractor shall include in the Operating and Maintenance Manuals, a letter certifying that all fire, fire/smoke and smoke dampers have been tested and are fully operational. Refer to Section 15020 for additional requirements.

END OF SECTION

SECTION 15867

AIR DISTRIBUTION DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15002, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide air distribution devices and accessories as specified, scheduled, and shown on the Drawings.
- B. Types: The types of air distribution devices required for the project include, but are not limited to:
 - 1. Ceiling diffusers.
 - 2. Registers and grilles.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Devices manufactured by Metal-Aire, Titus, Krueger, Anemostat/Waterloo, Aeronca, Carnes, or Barber-Coleman will be acceptable if the devices furnished comply with these Specifications, the conditions scheduled and are similar in appearance and performance to the units scheduled.
- B. NFPA Compliance: Comply with National Fire Protection Association (NFPA) Standard NFPA 90, as applicable to air diffuser construction and installation.
- C. Design Compliance: When directed by the Engineer, test air outlets to verify compliance with these Specifications. Perform all revisions required to comply with terminal velocity, noise level or maximum temperature variation requirements at no cost to the Owner or Engineer.
- D. Air Distribution Equipment: Maximum space temperature variation shall not exceed 2°F through the conditioned area from 2' above the floor, to 7' above the floor. The air outlets shall be selected by the manufacturer to suit the volume, throw and noise level scheduled as shown on the Drawings and maintain maximum terminal velocities of 50 fpm, unless otherwise indicated.

1.4 SUBMITTALS:

- A. Shop Drawing submittals shall include, but not be limited to, the following:
 - 1. Submit cutsheets on air devices clearly indicating all features, accessories, mounting provisions, throw, pressure drop, noise criteria, and other pertinent performance data clearly indicated.
 - 2. Submit dimensioned drawings for all custom and special dimension linear slot diffusers and air devices.
 - 3. Submit test data and results as specified herein. Test results shall be certified by an authorized officer of the company.
 - 4. Additional information as required in Section 15002.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver air distribution devices in factory-fabricated water-resistant wrapping.
- B. Handle air distribution devices carefully to avoid damage to material component, enclosure, and finish.

- C. Store air distribution devices in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 AIR DISTRIBUTION DEVICE GENERAL REQUIREMENTS:

- A. General: Provide air distribution devices of the size, shape, and type, constructed of materials and components and with finishes as scheduled and shown on the Drawings. Grilles, registers and ceiling outlets shall be provided with sponge rubber or soft felt gaskets. If a manufacturer other than the one scheduled is used, the sizes shown on the Drawings shall be checked for performance, noise level, face velocity, throw, pressure drop, etc., before the submittal is made. Selections shall meet the manufacturer's own published data for the above performance criteria. The throw shall be such that the velocity at the end of the throw in the five foot occupancy zone will be not more than 50 fpm nor less than 25 fpm. Noise levels shall not exceed those published in the ASHRAE Guide for the type of space being served (NC level).
- B. Compatibility: Air distribution devices shall be fully compatible with the surfaces in which they are installed and shall be provided with all required mounting accessories for installation in the actual construction at the installation location.
- C. Finishes: All ceiling and wall mounted air devices shall be painted white or off white unless specified otherwise and all air devices shall be the same color. Where the factory finish on all devices is not the same as determined by the Architect/Engineer, then the Division 15 Contractor shall be responsible for coordinating field painting of air devices by the Division 9 Contractor. The Division 15 Contractor shall be responsible for all costs associated with painting of white or off white air devices. Special color painting of air devices shall be the responsibility of the Division 9 Contractor. The Architect/Engineer's decision on white color compatibility is final.
- D. Ceiling Diffusers: Provide diffusers with corrosion resistant treated surfaces and finished in off-white baked enamel unless otherwise specified, scheduled, or shown on the Drawings. Provide opposed volume control dampers with supply air diffusers where scheduled. Where applicable, provide adapters with diffusers to permit connection to round supply duct. The interior of all perforated plate diffusers shall be painted flat black. Perforated plate supply air diffusers shall have pattern control blades installed in the diffuser neck. Pattern controllers attached to the perforated plate are **not** acceptable. Provide concealed fastening on all ceiling diffusers.
- E. Registers and Grilles: Provide registers which contain a key-operated multilouvered opposed blade damper operable from the face side, unless scheduled otherwise. Supply air registers shall be of the double deflection type, unless scheduled. Return air grilles and registers shall have fixed face blades and match the face of the supply air registers, unless scheduled otherwise. Provide concealed fastening for all registers and grilles.

2.2 AIR DISTRIBUTION DEVICES:

- A. Louver Face Supply Grilles: Grilles shall be all aluminum construction with 3/4" airfoil double deflection blades, mitered frames and an opposed blade balancing damper where scheduled or shown on the Drawings. Grilles shall be suitable for duct mounting. The entire grille shall have a factory applied white or off-white baked enamel finish. Grilles shall have mounting hardware as required for the project installation.
- B. Perforated Plate Supply Air Diffusers: Diffusers shall be aluminum/steel construction with an aluminum face and aluminum or steel pans. Frames shall have mitered corners and be suitable for lay-in installation. Perforated faces shall have a concealed hinge mechanism such that the plate remains attached to the frame when opened. Exposed external parts shall have a factory applied white or off-white baked enamel finish. Visible internal parts shall be factory painted flat black. All steel components shall be fully phosphatized prior to painting and there shall be no unpainted steel parts. Diffusers shall incorporate internal pattern control louvers. The use of pattern control devices attached to the perforated plate is not acceptable. Air devices shall be 4-way diffusion pattern unless

noted otherwise on the drawings. Device neck size shall be as shown on the drawings. Air device frame shall be suitable for use with the ceiling in which the device is installed.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Install air distribution devices in accordance with manufacturer's written instructions and recognized industry practices to ensure that products serve intended functions.
- B. Coordination: Coordinate with other trades, including ductwork, and ductwork accessories, as necessary to interface air distribution devices properly with other work.
- C. Locations: Locations of air distribution devices shown on Drawings are approximate and shall be coordinated with other trades to make symmetrical patterns and shall be governed by the established pattern of the lighting fixtures. Where air distribution devices are installed in acoustical tile and other ceilings they shall be either centered on tile or ceiling joints as directed by Architect at job site. Coordinate location of all ceiling air devices with Architectural reflected ceiling plans.
- D. Mounting Provisions: Coordinate mounting provisions and accessories required for proper installation of air devices in finish and construction at the point of installation. Refer to details on the Mechanical and Architectural Drawings for special installation details and provide all mounting accessories shown or required for the complete and proper installation of each air device.
- E. Accessories: Where scheduled, the grilles, registers and ceiling outlets shall be provided with deflecting devices and manual balancing damper. These devices shall be the standard product of the manufacturer, subject to review by the Architect, and equal to brand scheduled.

3.2 FIELD QUALITY CONTROL:

- A. Test: Test installed devices to demonstrate satisfactory compliance with specified and indicated requirements.
- B. Adjustment: Adjust air distribution devices to provide air distribution patterns shown on the drawings or required.
- C. Air Balancing: Balance the airflow through each air device to the volumes shown on the Drawings. Refer to Section 15020 for additional balancing requirements.

END OF SECTION

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SECTION 15900

BUILDING CONTROLS AND AUTOMATION (BAS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15002, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: This Section require the furnishing and installing of an expansion of the existing JCI MetaSys Building Control and Automation System (BAS) to control new mechanical equipment being provided under the project scope, complete including all items specified herein, indicated on the Drawings or reasonably inferred as necessary for safe and proper operation, monitoring and control; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, programming supervision, supplies, equipment, transportation, storage, utilities and all required permits and licenses. All work performed under this Section shall be in accordance with the Drawings and Specifications and subject to the terms and conditions of the Contract. For purposes of these Specifications, "provide" and "furnish and install" shall be synonymous. Owner's Representative (OR) shall refer to the individual designated by the owner to receive and distribute correspondence with the contractor.
- B. Drawings: Refer to the Mechanical, Plumbing and Electrical Drawings for graphic representations, schedules, and notations showing building control and automation work.
- C. Work Included: This Work includes the furnishing of all labor, materials, equipment, fixtures, apparatus, and appurtenances required for complete installation of operating Building Control and Automation System expansion as specified, in place and ready for service. Provide labor, materials, tools, machinery, equipment, appliances, and services necessary to complete the specified building control and automation work of this Division. Coordinate Work with other trades to prevent conflicts without impeding job progress. The Work includes, but is not limited to, the following systems, equipment and services:
 - 1. An expansion of the existing Johnson Controls, Inc. (JCI) Metasys Building Control and Automation System (BAS), furnished and installed by the JCI Houston office, as specified and required to provide controls and monitoring for new Building and M/E/P systems being installed under the project as specified and shown on the drawings.
 - 2. All the necessary controls, wiring and installation shall be provided under this Division. System to be installed shall be as specified in this Division providing a complete system of electronic and computer devices to perform the sequences and programs outline herein, including, but not limited to:
 - a. Electric and electronic control and operation for items shown on the Drawings, to provide the specified Sequence of Controls, and as specified hereinafter including sensors, relays and motors. Electric damper operators and control valves furnished to the appropriate trade as specified under the Work of other Sections.
 - b. Control panels as specified hereinafter and as shown on the Drawings.
 - c. The existing PC based central computer and associated peripherals and software shall be reused with additional components and programming as required.
 - 3. Other miscellaneous control system and components as shown on the Drawings and/or specified herein.

4. Testing, balancing, and adjusting of building automation and control systems as specified.
 5. Additional items as shown on the Drawings or specified.
- D. Work of Other Sections: Requirements given within this Section apply to the Work of all Sections of this Division. The actual performance of the Work stays within the Section in which it occurs; but subject to the requirements of this Section to the extent applicable.
1. Owner's Representative (OR) shall refer to the individual designated by the owner to receive and distribute correspondence with the contractor. Finish painting of mechanical systems in areas exposed to the view of building occupants is specified in other Divisions. All prime and protective painting for all areas and finished painting of mechanical systems in areas not exposed to the view of building occupants shall be provided under this Division.
 2. Installation of electrical control power which is not specified as an integral part of equipment specified under this Division is specified under Division 16 and where shown on the Electrical Drawings. Necessary conduit, wiring, boxes, and fittings are specified under Division 16.
 3. Finish painting of BAS systems in areas exposed to the view of building occupants is specified in other Divisions. All prime, finished and protective painting and finished painting of BAS systems in areas not exposed to the view of building occupants shall be provided under this Division.
 4. Access doors in finished surfaces are provided under this Division and installed by the Contractor installing the finished surface. Locations are as shown on the Drawings and as required for proper equipment access.
 5. Owner and General Contractor-furnished equipment is furnished and installed under other Divisions. Proper BAS provisions, including rough-in and final equipment connections, are included in the Work of this Division.
 6. The following work shall be provided by the Division 15 Contractor under other sections of this Specification:
 - a. Install immersion wells, pressure taps and any associated shut-off cocks.
 - b. Install flow switches.
 - c. Install automatic control valves.
 - d. Install level switches.
 - e. Furnish and install venturi flanges.
 - f. Install venturis and flow sensors.
 - g. Furnish automatic valve flanges and flange gaskets, increasers, reducers, nuts and bolts as required.
 - h. Furnish flare nuts for unitary valves.
 - i. Furnish union fittings where required in unitary equipment for service of automatic valves, including necessary transitions.
 - j. Install automatic control dampers.
 - k. Provide necessary transitions and blank-off plates required to install dampers that are different than duct size.
 - l. Assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper motors.
 - m. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation and affix and seal permanently in place only after stratification problem has been eliminated.

- n. Provide access doors or other approved means of access through ducts for service to control equipment.
- o. Include necessary duct transitions to provide velocities as recommended by airflow station manufacturers.
- 7. The Division 16 Contractor shall:
 - a. Provide control power to all BAS control panel locations as shown on the Electrical Drawings and the power supply to the temperature control air compressors. All BAS control wiring and other required control power shall be included in the work of Division 15.
 - b. Fire alarm interface relays and addressable input devices shall be provided by Division 16. Control wiring to these relays shall be by Division 15.
- 8. Refer to Section 15950 "Sequence of Operation" for BCAS sequences of operation and device naming requirements.
- E. Drawings: Refer to the Mechanical and Plumbing Drawings for graphic representations, schedules, and notations showing mechanical and plumbing work.
- F. Specifications: Refer to this Division for the primary technical specifications of mechanical and plumbing work.
- G. Workmanship: All mechanical and plumbing work shall be constructed and finished in every respect in a workmanlike and substantial manner. Furnish and install all work as may be necessary to complete systems in accordance with the best trade practice and to the satisfaction of the OR and Engineer. The entire installation shall be ready in every respect for satisfactory and efficient operation when completed. The OR and Engineer will interpret the meaning of the drawings and specifications and will reject all work and materials which, in their judgment, is not in full accordance therewith.
- H. Certification: Submit a single certification stating that all portions of the work are in accordance with contract requirements. Warranty all work against faulty and improper material and workmanship for a period of one year from date of final acceptance by the OR, except that where guarantees or warranties for longer terms are specified by contract, such longer term shall apply. At no additional cost to Owner, within 24 hours after notification, correct any deficiencies which occur during the warranty period, to the satisfaction of the Owner.
- I. Safe Work Place: The Contractor covenants and agrees that he and his Subcontractors and his and their agents and employees will provide and maintain a safe place to work and will comply with all laws and regulations of any governmental authorities having jurisdiction thereof, and the contractor agrees to indemnify, defend and hold harmless, the Engineer and Owner from and against any liability, loss, damage or expense, including attorneys' fees, arising from a failure or alleged failure on the part of the contractor, his subcontractors and his and their agents and employees to provide and maintain a safe place to work or to comply with laws and regulations of governmental authorities having jurisdiction thereof.
- J. Indemnification: The Contractor and each Subcontractor covenants and agrees to indemnify, defend and hold harmless the Engineer and Owner against any liability, loss, damage or expenses, including attorneys' fees, arising from a failure or alleged failure on the part of the contractor, his subcontractor or his or their agents and employees properly to discharge the obligations assumed by him or them in the performance of the work, including any act or omission allegedly resulting in death or personal injury or property damage on improper construction, construction techniques, or the use of improper or inappropriate material or tools.
- K. System Down Time: This building is a 24 hour research/classroom/office facility and any shutdown of the supply and exhaust systems or interruption of utility service will be strictly enforced and number of shutdowns must be minimized. Any required shutdowns must be scheduled during weekday evening hours of a duration no longer than 10 consecutive hours, during weekends from 6 PM Friday till 5 AM Monday morning, or as agreed in writing with the OR. Only one power system may be shut down at a time unless required by work on a common item of service and specifically scheduled with the OR.

Shutdown of power systems is extremely critical and must be coordinated with the OR before any scheduled shutdown. A detailed schedule of activities and system shutdowns is critical and must be submitted to and coordinated with the OR within two weeks of the award of contract. Primary system shutdowns shall be scheduled a minimum of two weeks in advance and reconfirmed 72 hours prior to shutdown. The agreed schedule shall be posted in the penthouse and the scheduled shutdown date shall be posted on each piece of equipment and in the affected laboratories. Refer to phasing notes on drawings for additional requirements.

1. Noise and vibrations within the work space must be minimized since it is likely that research will continue in all surrounding spaces. Work that requires loud noise or noticeable vibration must be scheduled with the RCM.
 2. Dust and dirt are extremely detrimental to research in adjacent spaces. All duct removal process shall minimize the spread of dirt and dust from the materials removed.
 3. A schedule will be submitted by the contractor and subsequently reviewed by the building users to determine acceptance or alternative scheduling. All cleaning, treating and coating work shall be undertaken by this contractor using means and methods that minimize odors during working hours
- L. Project Completion: All bid submissions, coordination schedules and project staffing shall be based on the critical project completion time.

1.3 MANUFACTURERS

- A. Products and installation by Johnson Controls, Inc is acceptable contingent upon compliance with the Specifications:
- B. All of the following Quality Assurance requirements shall be met.
1. All BAS work shall be furnished and installed by the temperature control system Contractor. The work shall be performed by skilled mechanics under the direction of experienced engineers, all of whom shall be properly trained and qualified for this work.
 2. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems, and not custom designed for this project. All systems and components shall have been thoroughly tested and proven in actual use.
 3. Single source responsibility of supplier shall be the complete installation and proper operation of the BAS and control system, and shall include debugging and proper calibration of each component in the entire system.
 4. Supplier shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory, and all necessary test and diagnostic equipment.
 5. All electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.
 6. BAS shall comply with UL 864 UDTZ and UUKL and UL 1076 as applicable to the project.
- C. Electrical Standards: Provide electrical products which have been tested, listed and labeled by Underwriters' Laboratories, Inc. (UL) and which comply with National Electrical Manufacturers' Association (NEMA) standards.
- D. Accuracy Standards:
1. Sensing elements and associated controllers or readout devices shall be field-adjusted to provide the minimum operating throttling range possible without control loop hunting. Variation from control point setting through the full control range shall be no more than 1/2 the throttling range.
 2. Accuracy standards for individual sensors, transducers, devices, and systems shall be as specified for the individual components and systems.

- E. Equipment and materials shall be catalogued products of manufacturers regularly engaged in production and installation of HVAC control products. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.
- F. Complete installation and proper operation of the DDC control system shall include debugging and calibration of the entire control system shall be the single source responsibility of the BAS supplier.
- G. Maintenance service contract by supplier using an established program shall be available to the Owner following the warranty period.
- H. The specification covers minimum requirements and is not intended to preclude provisions of equipment or methods that exceed the requirements.
- I. The supplier shall have established office within 100 mile radius of the job site staffed with factory trained engineers fully capable of providing instruction, routine maintenance, and emergency maintenance service on all system components.
- J. Prepare test procedure and perform, calibration, performance testing, and adjusting of entire system. Submit written report documenting procedures and results. Demonstrate satisfactory operation of points randomly selected by the Engineer. If more than 10% of the selected points fail to perform as expected, repeat entire testing procedure.
- K. Provide skilled technicians, properly trained and qualified for the work, and directed by experienced engineers.
- L. Electrical work and safety requirements shall comply with NFPA 70 and all applicable local and State codes.
- M. Environmental Conditions of Operation:
 - 1. DDC controller and I/O equipment shall be designed to operate in ambient temperatures from 32°F to 122°F and relative humidity from 10% to 95% non-condensing.
 - 2. Sensors and Operating Devices: The environment which they are sensing or controlling but not less severe than for controller and I/O devices.
- N. Ratings: All equipment shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered at the installed location.

1.4 SYSTEM ACCEPTANCE:

- A. The BAS manufacturer shall issue a report upon project completion stating that the system is complete, has been adjusted, has had all hardware and software functions verified, and is operating in accordance with the specifications. Any deviations from specified setting or operations necessitated during system adjustment shall be specifically noted. A demonstration of complete system operation shall be made to the Engineer and Owner's Representative.
- B. Upon receipt of a detailed punch list from the Engineer or Owner's Representative an installation inspection report shall be prepared by the BAS contractor showing, by system, each outstanding item on the punch list. After all items appearing on the installation inspection report are completed, a second written request for system approval shall be made to the Owner's Representative. As each or all items are approved, an appropriate notation shall be entered at the time of joint inspection on the system report, with counter signature of the Owner's Representative and date. A copy of this report shall be made to the Owner's Representative.
- C. Where it is required for the BAS contractor to modify, alter, add or remove hardware or software programs of the building automation system or related accessories for the purpose of eliminating punch list items, off-line operation and testing to implement them shall be done as required by the BAS contractor until such time acceptance performance of the building automation system has been established.

- D. Problems which occur within approved hardware or software, shall be corrected in an appropriate fashion under guarantee. Any such occurrence shall not void previous approval; however, the BAS contractor shall be responsible to attend to and remedy such items within a reasonable amount of time. Appropriate logs, schedules, and reports shall be maintained to reflect these items and their redress.

1.5 OWNER INSTRUCTION:

- A. General: This Contractor and appropriate factory-trained representatives shall instruct the Owner's representative in the proper operation and maintenance of all systems and equipment and shall explain all warranties.
- B. Outline: Prior to instruction of Owner Personnel, prepare a typed outline, listing the subjects that will be included in this instruction, and submit the outline for review by the Engineer.
- C. Certification: At the conclusion of the instruction period obtain the signature of each person being instructed on each copy of the approved outline to signify that he has a proper understanding of the operation and maintenance of the systems and resubmit the signed outlines.
- D. Other Requirements: Refer to other Division 15 Sections for additional operator training requirements.
- E. Operator Training: Provide training encompassing:
 - 1. Creating and modifying color graphics.
- F. Programmer Training: Provide training encompassing:
 - 1. Use of portable programmer's terminal.
- G. Operator and Supervisor training shall be in a classroom format at the project site and shall be scheduled at the Owners convenience. Class size shall be approximately eight per session.
- H. Programmer training shall be for two Owner personnel and shall be scheduled by the Owner with two week notice anytime during the warranty period.
- I. Other Requirements: Refer to other Division 17 Sections for additional Operator Training requirements.

1.6 CONTRACTOR WARRANTIES AND GUARANTEES:

- A. General: Contractor shall guarantee all material and equipment installed by him against defects in workmanship and material and provide service for a period of 24 months after final acceptance of the work by the Owner and he shall repair or replace any materials or equipment developing such defects within that time, promptly on due notice given him by the Owner and at Contractor's sole cost and expense.
- B. After completion of the installation, control manufacturer shall completely adjust all control equipment provided under this Contract; place the system in operation, subject to the Engineer and Owner's Representative approval, and instruct the operating personnel in the operation of the control system.
- C. Local service shall be available within 50 miles of the project.
- D. Service shall be accomplished and guarantee fulfilled by qualified employees of the BAS contractor. The contractor shall have a quality history of at least 5 years in the project area.
- E. Indirect temperature control service by independent contractors, distributors and franchised installers will not be acceptable.
- F. Warranty servicing shall include, but not be limited to, the following:
 - 1. Replacing defective parts and components are required.
 - 2. Servicing by factory-trained and locally employed service representative of system contractor.
 - 3. Maintaining of system programming.

- G. The BAS contractor shall have an in-place service facility within 50 miles of project site with technical staff, complete spare parts inventory, and all necessary test and diagnostic equipment to keep system operating.

1.7 **SUBMITTALS:**

- A. Shop drawing submittals shall include, but not be limited to, the following:
1. Control one-line diagrams for this specific project with accompanying description of the sequence control.
 2. Provide a flow diagram depicting the program control algorithms and how they are implemented on this project with specific input and output points shown.
 3. Scope and details of field tests that supplier shall perform to demonstrate that the system meets these specifications.
 4. One-line diagrams from sensor and control points to I/O boards and controllers, including all components, signal values and cables.
 5. Terminal cabinets, including terminal blocks.
 6. Communication links between distributed controllers and central controller complete with communications systems and one-line diagrams, including all components, elements and cables.
 7. Communication terminal cabinets including terminal blocks.
 8. Control panels.
 9. Test Reports: Description of test exercise events and results of measurements and observations.
 10. Provide complete manuals which include the following documentation:
 - a. General description and specifications for all components.
 - b. Principles and theory of operation.
 - c. Detailed schematics and assembly drawings and complete alignment and calibration procedures for all components.
 - d. Complete trouble-shooting procedures, diagrams and guidelines.
 - e. Operators Manual: Complete instruction with keyboard pictures and step-by-step procedures annotated to properly describe the system and its operation as installed. Provide index and tabbed sections for each operator function.
 - f. Complete description of all keyboard programming functions with sample written programs.
 - g. Two sets of manuals for each application package and each utility package.
 - h. Provide one copy of the final version of all software on CD-Rom.
 - i. Document all user-performed maintenance, including inspection, preventive maintenance, fault diagnosis and repair/replacement of defective components. Provide properly identified ordering number for each system components and source of supply. Provide a list of recommended spare parts needed to minimize downtime of the DDC control system.
 - j. Interconnection wiring diagrams and wire lists of the complete field installed system with ordering number for each component.
 - k. Test reports.
 11. Certified drawings showing overall dimensions of completed assemblies only with weights, mounting requirements and parts lists.
 12. Cut sheets on all equipment showing adjustment capabilities, performance criteria and accuracy limits for each specific application.
 13. Pressure ratings, leakage ratings, and dead end isolation pressure ratings for all valves.
 14. Sizing calculation for all control valves and dampers.

15. Floor plan drawings showing proposed locations of all wall mounted and return air path space temperature sensors.
16. Additional information as specified in Section 15002.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver materials and components in fabricated water-resistant wrapping.
- B. Handle materials and components carefully to avoid damage to material component, enclosure and finish.
- C. Store materials and components in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. General: Provide new components as required to provide the monitoring and controls shown on the drawings. In general new BAS components shall match the types and applications used in other buildings on the UTHSC-H campus.

2.2 MATERIALS AND EQUIPMENT:

- A. General: Provide electronic temperature control products in the size, capacities, and quality indicated by these Specifications and required, conforming to manufacturer's standard materials and components as published in their product information, designed and constructed as recommended by the manufacturer, and as required for the application indicated or required. These Specifications shall be considered minimum standards in all situations.

2.3 APPLICATION SPECIFIC CONTROLLERS - HVAC APPLICATIONS:

- A. HVAC Terminal Unit Controllers/Actuators: HVAC terminal unit controllers for Double Duct applications shall be JCI FEC VMA controllers ~~to~~ matching existing controllers in the building, no exception. Damper ~~per~~ operators for double duct terminal units shall be JCI FEC VMA actuators ~~to~~ matching existing actuators in the building, no exception.

2.4 ELECTRONIC ACTUATORS:

- A. General: Provide fully proportioning electronic actuators of either the push-pull or rotary type, as required. Actuator motor shall be of the low voltage synchronous type and shall be non-overloading at a continuous stall. Provide each motor with corrosion protection. Actuators for outside air and exhaust applications shall have nonferrous motor housings and stainless steel shaft and linkage. Actuator control signal shall be 0-10 VDC or 4-20 mA as required. Provide spring return for normally open/closed positioning.
- B. Selection: Size electronic actuators to operate their appropriate dampers and valves with sufficient reserve power to provide smooth modulating or two position action as specified.

2.5 TEMPERATURE SENSORS:

- A. Space Temperature Sensors: Wall mounted DDC space temperature sensors shall be JCI FEC type compatible with the specified FEC VMA controller and ~~to~~ matching existing sensors in the building, no exception.

2.6 POSITION/STATUS INDICATORS:

- A. End (Limit) Switches: Limit switches shall be of the sealed or enclosed type as required for the application. Contacts shall be snap-action SPDT rated for the application. Damper end switches shall be industrial quality, shaft-mounted, enclosed switches set to sense open or closed position of damper

blades. Switches shall be arranged to prevent "oven-center" operation and for mounting as required. Switch enclosures shall be waterproof with a conduit entry seal where subject to moisture or water.

- B. Key-operated Switches: Hand-off-automatic (H-O-A), off-automatic, and all similar use switches shall be key-operated with all switches keyed alike where switches are not located in access limited locations. All switches shall be rated for a minimum of 600 volt ac, 5-A, and shall be mounted in an enclosure as specified or shown.

2.7 OUTPUT DEVICES:

- A. Control Relays: Control relay contacts shall be rated for the application, with a minimum of two sets of SPDT contacts, enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage.
- B. Time Delay Relays: Time delay relay contacts shall be rated for the application with a minimum of two sets of SPDT contacts, enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Relays shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage. Delayed contact opening or closing shall be adjustable from one (1) to 60 seconds with a minimum accuracy of $\pm 2\%$ of setting.
- C. Latching Relays: Latching relay contacts shall be rated for the application with a minimum of two sets of SPDT contacts, enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage.
- D. Reed Relays: Reed relays shall be encapsulated in a container housed in a plastic, epoxy, or metal case. Contacts shall be rated for the application. Operating and release times shall be 1 millisecond or less. Relays shall be rated for a minimum life of 10 million operations and shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage.
- E. Contactors: Contactors shall be of the single coil, electrically operated, mechanically or electrically held type. Positive locking shall be obtained without the use of hooks, latches, or semi-permanent magnets. Contacts shall be double break silver-to-silver type protected by arcing contacts where necessary. Number of contacts and ratings 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 to limit transients to 150% of rated coil voltage.
- F. Solid State Relays: Input-output isolation shall be greater than 1000 megohms with a breakdown voltage of 1500 volt root mean square or greater at 60 Hz. Relays shall be rated for a minimum life of 10 million operations. The ambient temperature range shall be at least -20°F to +140°F. Input impedance shall not be less than 500 ohms. Relays shall be rated for the application in accordance with NEMA ICS 1. Operating and release times shall be one millisecond or less. Transients shall be limited to 150% of control voltage.

PART 3 - EXECUTION

3.1 EXECUTION:

- A. The BAS contractor shall enter all computer programs and data files into the related computers including all control programs, initial approved parameters and settings, English descriptors, and color graphics complete with dynamic dispersed data. In addition, the following, to be user implemented, shall have samples installed for training and validation.
 - 1. Bar chart (four different bars on one chart).
 - 2. Curve plot (five curves on one plot).
 - 3. Trend log.

4. Alarm message (action taking message).
 5. Run time maintenance message.
 6. Trouble action message.
- B. The BAS contractor shall maintain CD-ROM copies of all data file and application software for reload use in the event of a system crash or memory failure, including DDC panel programs. One copy shall be delivered to the Owner during training session, and one copy shall be archived in the BAS manufacturer's local software vault.
- C. The BAS contractor shall completely check out, calibrate and test all connected hardware and software to ensure that the system performs in accordance with the approved specifications and sequences of operation submitted.
1. Running each specified control sequence.
 2. Display and demonstrate such data entry template and show site specific customizing capability. Demonstrate parameter changes.
 3. Execute menu tree.
 4. Display graphics, demo update.
 5. Execute digital and analog commands in English and graphic mode.
 6. Demonstrate freeform address assignment and commands.
 7. Demonstrates all specified diagnostics.
 8. Demonstrate DDC loop precision and stability via trend logs of inputs and outputs (six loops minimum).
 9. Demonstrate BAS performance via trend logs and command printouts.
 10. Demonstrate scan, update, and alarm responsiveness.

3.2 **MANUALS:**

- A. Operators Manual shall be provided with graphic explanations of keyboard use for all operator functions specified under Operator Training, including graphic mode. Although operator functions are to be self-instructional, and menu-interactive from the keyboard terminal, this manual shall be of off-line study and refresher use.
- B. A Programmer's Manual shall be provided with graphic descriptions of all keyboard functions required for software modifications and development specified under Programmer Training. Although high level languages may be required to be usable on the system, full manuals and training are not required. The use and installation of high level type programs shall be included in this manual.
- C. A manual shall be provided including revised As-build Documents.
- D. A minimum of three operator manuals, two programmers, and two As-built manuals shall be provided to the Owner.

3.3 **PANEL LOCATIONS:**

- A. General: Direct Digital Control (DDC) Panels, status/monitoring panels and other control panels shall be located where shown on the Drawings or as close to the controlled equipment as is feasible.
- B. Location: Panels shall be located so as to provide adequate clearance for maintenance and shall not interfere with maintenance or code clearances for other equipment. Floor plan drawings showing the proposed locations of all control panels shall be submitted for approval.
- C. Mounting: Wall mounted panels shall be adequately supported from the wall which they are attached to. Floor mounted panels shall be mounted on housekeeping pads.

- D. Coordination: Panel locations shall be coordinated with the Division 16 Contractor so that there is adequate lighting and convenience outlets at the panel location for panel use and maintenance.

3.4 CONTROL POWER:

- A. General: Control power for the BAS is provided by Division 16 at each BAS panel location and at other locations where shown on the Electrical Drawings. Control power transformers are typically provided in motor starters on the project. All other required control power shall be provided by Division 16 at the expense of this Division.
- B. Coordination: Control power requirements and locations shall be coordinated with the Division 16 Contractor and be responsible for any additional costs incurred to provide the required control power. Input to the Division 16 Contractor shall include, but not be limited to:
 - 1. Locations requiring control power.
 - 2. Voltage, phase and ampacity.
 - 3. Power type, normal or emergency.
 - 4. Type of connection.

3.5 BAS WIRING:

- A. General: All wiring required for a complete and operational building control and automation system shall be provided by this Division.
- B. Wiring shall be jacketed cables installed with or without conduit as specified herein or single conductors installed in conduit. Control wiring shall have minimum 600 volt insulation for low voltage wiring and 600 volt insulation for line voltage wiring.
- C. All line voltage control wiring and all low voltage control wiring and the main data communications loop shall be installed in conduit.
- D. Minimum requirements for control wiring shall be as follows:
 - 1. Control wiring for digital functions shall be No. 18 AWG copper minimum, with 600 volt insulation. Multi-conductor wire shall have an outer jacket of polyvinyl chloride (PVC) or UL listed plenum rated jacket.
 - 2. Control wiring for analog functions shall be No. 18 AWG copper minimum, with 600 volt insulation, twisted and shielded, 2-, 3- or 4-wire to match analog function hardware. Multi-conductor wire shall have an outer jacket of PVC or UL listed plenum rated jacket.
 - 3. Sensor wiring shall be No. 18 AWG copper minimum, twisted and shielded, 2-, 3- or 4-wire to match analog function hardware. Multi-conductor wire shall have an outer jacket of PVC or UL listed plenum rated jacket.
 - 4. Class 2 low energy conductor sizes specified for digital and analog functions shall take precedence over any requirements for Class2 low energy remote control and signal circuit conductors specified elsewhere, unless a larger conductor size is required by the NEC.
- E. Line and low voltage control wiring shall not be installed in the same conduit and control wiring shall not be installed in the same conduit with power wiring.
- F. All conduit in exposed locations shall be run in a neat manner and shall be perpendicular and parallel to building lines. Coordinate conduit routing with field conditions so as not to interfere with code clearances, maintenance access and walkways.
- G. All conduit and control wiring in concealed locations shall be installed in an orderly manner, generally perpendicular and parallel to building lines.
- H. Permanently mark terminal blocks for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions. Line-protect all wiring that comes from external sources to the site from lightning and static electricity.

- I. Label or code each field wire at each end. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color-coded cable with cable diagrams may be used to accomplish cable identification.
- J. Signal Transmission System wiring shall be installed as follows:
 - 1. Splices in shielded and coaxial cables shall consist of terminations and the use of shielded cable couplers. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties.
 - 2. Fit all equipment contained in cabinets or panels with service loops, each loop being at least 12" long. Equipment for fiber optics system shall be rack-mounted, as applicable, in ventilated, self-supporting, code gauge steel enclosure. Cables shall be supported for minimum sag.
 - 3. Keep cable runs as short as possible. Allow extra length for connecting to the terminal board.
 - 4. Use vinyl tape, sleeves, or grommets to protect cables from vibration at points where they pass around sharp corners, through walls, panel cabinets, etc.
 - 5. Grounding shall be in accordance with NFPA 70. All ground wire shall be insulated conductors.
 - 6. Ground wire shall be run to service entrance ground.
 - 7. Conduit grounds shall be isolated from BAS panels by PVC couplings to prevent ground loops.
- K. Refer to applicable Division 16 Sections for additional requirements for conduit and wiring materials and installation. All conduit and wiring shall be installed in accordance with all requirements of applicable codes.

3.6 COMPONENT INSTALLATION:

- A. General: Install system and materials in accordance with manufacturer's instructions, roughing-in drawings and details on the Drawings. All components and appurtenances shall be installed in accordance with the manufacturer's instructions and as shown or specified. All necessary interconnections, services, and adjustments required to prepare the building for interface to the BAS shall be furnished. All electrical work shall be in accordance with Division 16. Instrumentation grounding as necessary to preclude ground loops and noise from adversely affecting equipment operations shall be installed. Final adjustment shall be performed by specially trained personnel in the direct employ of the manufacturer of the BAS.
- B. Electrical Wiring: Refer to the applicable Sections of Division 16 for electrical wiring and raceway installation requirements.
- C. Mechanical Work: Refer to the applicable Sections of Division 15 for the installation of wells, valve bodies, and dampers in mechanical systems.
- D. I/O Summary Tables shall be used in conjunction with the Drawings to identify the hardware required for each building control and automation system.
- E. All temperature control and automation materials shall be applied and installed per the manufacturers' recommendations.
- F. Remote bulbs shall be flange mounted in ductwork and casing and mounted with separable sockets in pipes and tanks. Where installed through insulation, flanges and sockets shall have extension necks to finish flush with the insulation surface.
- G. All sensing elements for supply air temperature in ductwork or casing shall be of averaging type with sensing length of number of elements to measure air temperature through the entire cross section of the duct or casing.

3.7 EQUIPMENT INSTALLATION:

A. Temperature Instruments:

1. Temperature Sensor/Transducers: When a temperature sensor/transducer is installed in pipes or is susceptible to corrosion and vibration, the sensor shall be installed in a thermowell. Temperature sensors/transducers used for space temperature sensing shall include a housing suitable for wall-mounting. Temperature sensors/transducers used for outside air sensing shall have an instrument shelter to minimize solar effects, and shall be mounted to minimize building effects. Assemblies shall be readily accessible and installed in a manner as to allow easy replacement without special tools. Mount duct sensors/transducers in locations to sense the correct temperature of the air only, within the vibration and velocity limits of the sensing element. Mount extended surface element, when used, securely within the duct and position to measure the average temperature. Thermally isolate elements from brackets and supports to respond to air temperature only. Securely seal duct penetrations.
2. Sensor Locations: Sensors shall be wall mounted in office areas, approximate locations are shown on the Drawings and shall typically be located 6" from the room light switch as the same vertical centerline height as the switches. Sensors shall be mounted in the space return air space for public areas, corridors and similar areas, unless shown otherwise on the drawings. Locate sensors to sense average return air temperature in the space monitored. Submit Drawings showing proposed locations of space and return air temperature sensors to the Engineer for review.

B. Output Devices:

1. Controllers, Relays and Contactors: Install controllers, relays and contactors in control cabinets or as required.

C. Position Sensors:

1. End (Limit) Switches: Limit switch type and mounting shall be properly suited for the application to provide reliable switch operation.
2. Potentiometers: Potentiometer type and mounting shall be properly suited for the application to provide reliable operation.
3. Instrument shelters shall be installed with the bottom 4' above the supporting surface using legs and secured rigidly to minimize vibrations from winds. Instrument shelters shall be oriented facing north.

3.8 FINAL ADJUSTMENT OF EQUIPMENT:

- A. General: After completion of the installation, adjust thermostats, control valves, motors, and similar equipment provided as work of this Section. Final adjustment shall be performed by specially trained personnel in the direct employ of the manufacturer of the primary temperature control system.

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SECTION 15950
SEQUENCE OF OPERATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The conditions of the contract and applicable requirements of Division 1, "General Requirements and Section 15002, "Building Control and Automation General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Sequence of operation is hereby defined to mean the manner in which and methods by which the building control and automation system functions. The requirements for each type of operation are specified in this Section.
- B. Work of Other Sections: The operating equipment, devices, and system components required for the building control and automation system are specified in other Division 15 Sections.
- C. Extent: The extent of the building control and automation system work is as shown on the Drawings and in schedule sand as required by the Control Sequence requirements specified in this Section.

1.3 SUBMITTALS:

- A. Shop drawing submittals shall include, but not be limited to, the following:
 - 1. Project sequence of operation including a written and diagrammatic representation of each control and operating sequence which is being provided.
 - 2. A complete points matrix showing all system inputs and outputs and control functionality.
 - 3. Additional information as specified in Section 15002.

PART 2 - SEQUENCE OF OPERATION

2.1 DOUBLE DUCT VAV TERMINAL UNITS:

- A. General: These units consist of new ~~and reused existing~~ double duct VAV terminal units with variable air volume cold deck and hot deck dampers, ~~total supply~~ hot and cold deck flow sensors and related DDC controls for pressure independent temperature control. Terminal unit naming shall correspond to the UHealth provided naming style guide for all BCAS component naming and identification
- B. System Graphic: A new BAS system graphic shall be provided for each new terminal unit and shall actively display all monitored and controlled system points. Graphics format and displayed information shall be shall be approved by the UHealth Project Manager and Controls representative prior to implementation.
- C. BAS Control: BAS control shall be from a dedicated stand-alone terminal unit DDC controller.
- D. Space Temperature Sensor: An analog space temperature sensor located in the served space shall provide an analog input to the terminal unit DDC controller.
- E. Occupied/Unoccupied Mode Temperature Set Points: Terminal Unit controls shall incorporate separate temperature set points for occupied mode and unoccupied mode and a time schedule for programming space occupied and unoccupied mode time periods on a daily basis, including separate space occupied and unoccupied mode time periods when campus is in session and out of session.

Space temperature set points and schedules shall be as directed by the UTHealth Project Manager and Controls representative.

- F. Unit Controls: Final control sequence shall be confirmed with UTHealth prior to implementation. The terminal unit DDC controller shall be activated whenever the air handling unit serving the terminal unit is running. An analog temperature sensor sensing the space temperature and airflow sensors sensing the cold air damper and hot air damper airflow volumes shall provide inputs to the terminal unit DDC controller which shall modulate the cold deck and hot deck dampers to provide VAV/Constant volume operation, subject to terminal unit maximum and minimum airflows as noted below, to maintain the space temperature set point (operator programmable). Upon terminal unit shutdown, corresponding to shutdown of the air handling unit serving the terminal unit, the unit cold and hot deck dampers shall close.

2.2 **BAS GRAPHICS:**

- A. General: Existing building BAS graphics shall be updated and new BAS graphics shall be developed and populated to provide a user interface acceptable to UTHealth for all control systems added or modified by the scope of this project. BCAS contractor to follow UTHealth provided naming style guide for all BCAS component naming and identification.

PART 3-EXECUTION

3.1 **INSTALLATION:**

- A. General: Installation shall be in accordance with applicable Division 15 specification sections.

END OF SECTION

SECTION 16002

ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and this Section govern the work of this Division.

1.2 DESCRIPTION OF WORK:

- A. This Division requires the furnishing and installing of all items specified herein, indicated on the Drawings or reasonably inferred as necessary for safe and proper operation; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, equipment, transportation, storage, utilities, and all required permits and licenses. All work performed under this Section shall be in accordance with the Drawings and Specifications and subject to the terms and conditions of the Contract. For purposes of these Specifications, "provide" and "furnish and install" shall be synonymous.
- B. Drawings: Refer to the Electrical Drawings for graphic representations, schedules, and notations showing electrical work.
- C. Specifications: Refer to this Division for the primary technical specifications of electrical work.
- D. Work Included: This Work includes the furnishing of all labor, materials, equipment, fixtures, apparatus, and appurtenances required for complete installation of operating electrical systems as specified, in place and ready for service. Refer to Section 16004, "Electrical Scope of Work", for additional requirements.
- E. Work of Other Sections: Requirements given within this Section apply to the Work of all Sections of this Division. The actual performance of the Work stays within the Section in which it occurs; but subject to the requirements of this Section to the extent applicable.
 - 1. All prime, finished, and protective painting for all areas, and finished painting of electrical systems in areas not exposed to the view of building occupants shall be provided under this Division.
 - 2. Installation of electrical control power which is not specified as an integral part of equipment specified under Division 15 is specified under this Division.
 - 3. Access doors in finished surfaces are provided under this Division and installed by the Contractor installing the finished surface. Locations are shown on the Drawings and as required for proper equipment access.
 - 4. Concrete housekeeping pads, curbs and supporting structures are specified under this Division. Dimensions and locations of pads and supports shall be the responsibility of this Division.
 - 5. Owner and General Contractor-furnished equipment is furnished and installed under other Divisions. Proper electrical provisions, including rough-in and final equipment connections, are included in the Work of this Division.
 - 6. Motors for all equipment shall be furnished and installed with the equipment.

7. Motors and motor starters that are an integral part of the equipment are furnished with the driven equipment; all other motor starters, electrical wiring and connections are included in the Work of this Division.
- F. Workmanship: All electrical work shall be constructed and finished in every respect in a workmanlike and substantial manner. Furnish and install all work as may be necessary to complete systems in accordance with the best trade practice and to the satisfaction of the OR and Engineer. The entire installation shall be ready in every respect for satisfactory and efficient operation when completed. The OR and Engineer will interpret the meaning of the drawings and specifications and will reject all work and materials which, in their judgment, is not in full accordance therewith.
- G. Certification: Submit a single certification stating that all portions of the work are in accordance with contract requirements. Warranty all work against faulty and improper material and workmanship for a period of one year from date of final acceptance by the OR, except that where guarantees or warranties for longer terms are specified by contract, such longer term shall apply. At no additional cost to Owner, within 24 hours after notification, correct any deficiencies which occur during the warranty period, to the satisfaction of the Owner.
- H. Safe Work Place: The Contractor covenants and agrees that he and his Subcontractors and his and their agents and employees will provide and maintain a safe place to work and will comply with all laws and regulations of any governmental authorities having jurisdiction thereof, and the contractor agrees to indemnify, defend and hold harmless, the Engineer and Owner from and against any liability, loss, damage or expense, including attorneys' fees, arising from a failure or alleged failure on the part of the contractor, his subcontractors and his and their agents and employees to provide and maintain a safe place to work or to comply with laws and regulations of governmental authorities having jurisdiction thereof.
- I. Indemnification: The Contractor and each Subcontractor covenants and agrees to indemnify, defend and hold harmless the Engineer and Owner against any liability, loss, damage or expenses, including reasonable attorneys' fees, arising from a failure or alleged failure on the part of the contractor, his subcontractor or his or their agents and employees properly to discharge the obligations assumed by him or them in the performance of the work, including any act or omission allegedly resulting in death or personal injury or property damage on improper construction, construction techniques, or the use of improper or inappropriate material or tools.

1.3 **CODES, PERMITS AND FEES:**

- A. General: Comply with the most recently revised versions of applicable laws, rules, regulations, and ordinances of federal, state, and local utilities and authorities. Where alterations to and deviations from the Contract Documents are required by said authority, report the requirements and secure approval before starting work. Obtain all applicable permits, licenses and inspections and pay all fees charged by above authorities.
- B. Codes and Standards: All work shall be done in full compliance with all applicable state and local codes, requirements and ordinances and applicable requirements of NFPA, UL and other applicable standards.
- C. Industry Standards: All equipment and materials shall be new and listed by the Underwriters' Laboratories, inc., Manufactured in full accordance with applicable ASME, NEMA, ANSI or IEEE standards.
- D. Approvals, Permits and Inspections: Secure and pay for all necessary approvals, permits, inspections, etc., and deliver the official records of the granting of permits to the Owner without additional cost to the Owner.
- E. Code Design Basis: The following codes and ordinances were used in the design of the project and shall be complied with during construction of the project.

1. Building Code - International Building Code 2009 Edition and NFPA 101 Life Safety Code 2009 Edition.
2. Fire Code - International Fire Code 2009 Edition.
3. Electrical Code - National Electrical Code 2014 Edition.
4. Mechanical Code - International Building Code 2009 Edition.
5. Plumbing Code - International Plumbing Code 2009 Edition.
6. Accessibility Code- Texas Accessibility Standards (TAS), 1994 and Americans with Disabilities Act of 1990.

- F. Precedence: Where Contract Document requirements are in excess of Code requirements and are permitted under the Code, the Contract Documents shall govern. None of the terms or provisions of the Drawings or specification shall be construed as waiving any of the rules, regulations or requirements of these authorities. In the event of conflict between the Contract Documents and the local enforcing authority, the latter shall rule. Any modifications resulting therefrom shall be made without additional cost to the Owner or Engineer. This Contractor shall report any such modifications to the Engineer and secure his approval before proceeding.

1.4 QUALITY ASSURANCE AND STANDARDS:

- A. Materials/Methods: Manufacturers, materials, and methods described in the various sections of the Specifications, and indicated on the Drawings are intended to establish a standard of quality only. It is not the intention of the Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturers standard product will meet the requirements of the project design, Specifications and space constraints. **The Engineer shall be the sole judge of quality and equivalence of equipment, materials and methods.**
- B. Alternative Products/Materials/Methods: Products by other reliable manufacturers, other materials, and other methods may be accepted provided they have equivalent capacity, construction, and performance. **Under no circumstances shall any substitution be made without the prior written approval of the Engineer.** Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Engineer that the specified product, material or method is the only one that shall be used without prior approval. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be provided, it is the intention of the Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without prior written approval.
- C. Alternative Equipment: Where substituted or alternative equipment is used on the project, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available, including all required Code and maintenance clearances, and to coordinate all equipment requirements and provisions with the Electrical Design and all other Contractors.
- D. Compatibility: Provide products which are compatible with other products of the electrical work, and with other work requiring interface with the electrical work, including electrical connections and control devices. For exposed electrical work, coordinate colors and finishes with other work. Determine in advance of purchase that equipment and materials proposed for installation will fit into the confines indicated, leaving adequate clearance as required by applicable codes and for adjustment, repair, and replacement.

- E. Standards: Refer to Division 1 for general administrative/procedural requirements related to compliance with applicable standards. This Work and all materials shall meet the standards set forth in the applicable portions of the following recognized standards:
1. AEIC Association of Edison Illuminating Companies.
 2. ANSI American National Standards Institute.
 3. ASHRAE American Society of Heating, Refrigerating & Air-Conditioning Engineers.
 4. ASME American Society of Mechanical Engineers.
 5. ASPE American Society of Plumbing Engineers.
 6. ASSE American Society of Sanitary Engineering.
 7. ASTM American Society for Testing and Materials.
 8. AWS American Welding Society.
 9. CBM Certified Ballast Manufacturers.
 10. CDA Copper Development Association.
 11. CE Corps of Engineers (U. S. Department of the Army).
 12. EIA Electronic Industry Association.
 13. ETL Electrical Testing Laboratory.
 14. FAA Federal Aviation Administration (US Department of Transportation).
 15. FCC Federal Communications Commission.
 16. FM Factory Mutual Engineering Corporation.
 17. FS Federal Specification (General Services Administration).
 18. ICEA Insulated Cable Engineering Association.
 19. IEEE Institute of Electrical and Electronics Engineers.
 20. IES Illuminating Engineering Society of North America.
 21. IRI Industrial Risk Insurers.
 22. LPI Lighting Protection Institute.
 23. MIL Military Standardization Documents (US Dept. of Defense).
 24. MSS Manufacturers Standardization Society of the Valve and Fittings Industry.
 25. NEC National Electrical Code (by NFPA).
 26. NECA National Electrical Contractor Association.
 27. NEMA National Electrical Manufacturers Association.
 28. NFPA National Fire Protection Association.
 29. OSHA Occupational Safety Health Administration (US Department of Labor).
 30. UL Underwriters' Laboratories, Inc.

1.5 SITE VISIT AND FAMILIARIZATION:

- A. General: Become familiar with the Drawings and Specifications, examine the premises, and understand the conditions under which the Contract shall be performed, prior to submitting a bid.
- B. Site: Be informed of the site conditions, verify locations of new and existing equipment, and determine exact requirements for connections.
- C. Coordination: Submission of a bid for this project infers that the Contractor has visited the site and has become familiar with the Drawings and site conditions and has included in his proposal, all work necessary to properly install the systems on the project.
- D. Pre-Bid Conference: Refer to Division 1.

1.6 DRAWINGS AND SPECIFICATIONS:

- A. General: The Drawings are schematic in nature and indicate approximate locations of the electrical systems, equipment, fixtures and devices, except where specific locations are noted and dimensioned on the Drawings. All items are shown approximately to scale. The intent is to show how these items shall be integrated into the building. Locate all items by on the job measurements and in accordance with the Contract Documents. Cooperate with other trades to ensure project completion as indicated.
- B. Location: Prior to locating electrical devices, light fixtures, and other items, obtain the Architect/Engineer's approval as to exact location. Locations shall not be determined by scaling Drawings. Mount lighting fixtures and electrical devices at the heights directed by the Architect/Engineer. Contractor shall be responsible for costs of redoing work of trades necessitated by failure to comply with this requirement.
 - 1. All electrical devices, lighting fixtures, and other devices shall be referenced to coordinated, established data points and shall be located to present symmetrical arrangements with these points and to facilitate the proper arrangements of acoustical tile panels and other similar panels with respect to the mechanical and electrical outlets and devices. Electrical devices, fixtures, and outlets shall be referenced to such features as wall and ceiling furrings, balanced border widths, masonry joints, etc. Outlets in acoustical tile shall occur symmetrically in tile joints or in the centers of whole tiles and the exact location of each outlet and the arrangements to be followed shall be acceptable to the Architect/Engineer. Outlets in wall tile or masonry construction shall occur symmetrically in the centers of whole tiles, bricks, or blocks and the exact location of each outlet and the arrangement to be followed shall be acceptable to the Architect/Engineer.
 - 2. The Drawings show diagrammatically the location of the various outlets and apparatus. Exact locations of these outlets and apparatus shall be determined by reference to the general Drawings and to all detail Drawings, equipment Drawings, rough-in Drawings, etc., by measurements at the building, and in cooperation with the other trades. The Owner and Architect/Engineer reserve the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner.
- C. Specifications: The specifications are intended to supplement the Drawings and it is not in the scope of the specifications to mention any part of the work which the Drawings are competent to fully explain. Conversely, any part of the work which the specification are competent to fully explain, may not be mentioned on the Drawings.
- D. Disagreement: Disagreement between the Drawings or specifications or within the Drawings or specifications shall be estimated using the better quality or greater quantity of material or installation, and a request for information shall be made in writing to the Engineer. All questions and requests for clarifications shall be submitted in writing to the Engineer.

1.7 DISCREPANCIES:

- A. Clarification: Clarification shall be obtained before submitting a proposal for the Work under this Division as to discrepancies or omissions from the Contract Documents or questions as to the intent thereof.
- B. Detailed Instructions: Should it appear that the work hereby intended to be done or any of the materials relative thereto, is not sufficiently detailed or explained in the Drawings or Specifications, then the Contractor shall apply to the Engineer for such further Drawings or explanations as may be necessary, allowing a reasonable time for the Engineer to respond. The Contractor shall conform to this additional information as a part of the Contract without additional cost to the Owner or Engineer.
- C. Interpretations: Should any doubt or question arise respecting the true meaning of Drawings or Specifications, reference shall be made to the Engineer, whose written decision shall be final and conclusive. No alleged statement by the Engineer will be accepted as an excuse for inferior work.
- D. Contractor Agreement: Consideration will not be granted for misunderstanding of the amount of work to be performed. Submission of a bid conveys full Contractor agreement of the items and conditions specified, shown, scheduled, or required by the nature of the project.
- E. Discrepancy Notification: Immediately notify engineer in writing when existing field conditions differ from the conditions shown on the contract documents.

1.8 SAFETY REGULATIONS:

- A. General: All electrical work shall be performed in compliance with all applicable and governing safety regulations. All safety lights, guards, signs, and other safety materials and provisions required for the performance of the mechanical work shall be provided by and operated by the Mechanical contractor.
- B. OSHA: It shall be the duty and responsibility of the Contractor and all of its subcontractors to be familiar and comply with all requirements of Public Law 91596, 29 U.S.C. Secs. 651 et seq., the Occupational Safety and Health Act of 1970, (OSHA) and all amendments thereto, and to enforce and comply with all of the provisions of this Act.
- C. Emergencies: In any emergency affecting the safety of persons or property, the Contractor shall act, at its direction, to prevent threatened damage, injury or loss.

1.9 UTILITIES:

- A. General: Utility information shown on the Drawings have been shown based upon data obtained from the site survey and the agencies having jurisdiction and are accurate to the best of the knowledge of the Engineer.
- B. Coordination: The Contractor shall be responsible for field verification of the actual location of site and/or building utilities and shall make modifications necessary for connection to or construction around those utilities at no additional cost to the Owner or Engineer.

1.10 CHANGE ORDERS:

- A. General: Refer to Uniform General Conditions and Division 1 for requirement concerning Change Orders.

1.11 ALTERNATES:

- A. General: Refer to Divisions 0 and 1 for information concerning Alternates.
- B. Alternate 1: Alternate price to provide Type A LED light fixtures and associated accessories in new offices and corridors in lieu of the Base Bid fluorescent Type A light fixtures.

- C. Alternate 2: Alternate price to provide new ceilings and Type A LED light fixtures and associated accessories and lighting controls in existing offices as shown on the drawings.
- D. Alternate 3: Alternate price to provide new ceilings, Type A LED light fixtures, LED exit signs and associated accessories in corridors as shown on the drawings.

1.12 PRECONSTRUCTION CONFERENCE:

- A. Conference: Upon the award of this Contract and prior to commencing any work, the Contractor and his designated major subcontractors, shall confer with the Architect, Engineer and Owner concerning the Work under this Contract. The conference shall be at a mutually agreeable place and time.

1.13 SITE OBSERVATION:

- A. General: Observation at the site to verify general compliance with Contract Documents shall be made periodically by the Engineer or his representative. Written observation comments shall be submitted to the General Contractor for review and a written response.
- B. Notification: Contractor shall contact Engineer at project milestones so that Engineer can schedule site visit after most of the mechanical and plumbing installation is complete, but before the installations are covered by ceilings, walls, etc.

1.14 REQUESTS FOR INFORMATION (RFI):

- A. General: All Contractor Requests for Information (RFI's) shall be submitted to the Engineer in writing, for response.
- B. Format: All RFI's shall be submitted on a form which has a space for the requested information and the Engineer's response.
- C. RFI Numbering: The method of numbering for RFI's shall be approved by the Architect and Engineer and shall be formatted as follows

RFI-xx.yyy

Where xx = An agreed to text string to identify project and yy.=.The RFI sequence number.

- D. RFI Log: The Contractor shall compile and maintain an RFI Status log which shall be transmitted to the Engineer on a weekly basis in either hardcopy or e-mailed electronic format.
- E. RFI Electronic Submission and Responses: RFI's shall be submitted in electronic form as a .Word or Excel file submitted as an attachment to an e-mail with the RFI name specifically included in the e-mail subject line. Supplemental information associated with an RFI shall be specifically addressed by file name in the RFI and shall be included in PDF file format as an attachment to the RFI e-mail. RFI file names shall match the RFI number. The Engineer's response to an RFI will be a PDF file renamed "E&C Response to RFI-xx.yy" and locked for printing only.
- F. Responses: The Engineer will endeavor to provide RFI response time in the Engineer's office of **five** working days after receipt of the RFI by the Engineer.

1.15 SUBMITTALS:

- A. General: Submittals required for this project shall include, but not be limited to:
 - 1. Shop Drawings and Product Brochure Submittals.
 - 2. Certifications and Test Reports.
 - 3. Operating and Maintenance Manuals.

4. Warranties (Guarantees).
- B. Refer to Division 1 for additional submittal requirements.
- C. Submittal Schedule: The Contractor shall provide a Schedule of Submittals to the Engineer within two weeks of bid award. This document shall list the submittal number and name for all required submittals for the project and shall include the proposed date on which each required initial submittal will be issued to the Engineer for review. The schedule shall allow adequate time to complete the submittal process at times appropriate to the construction schedule while allowing for delivery time to and from the Engineer and Engineer review time. The schedule shall also allow for submittal resubmissions and related delivery and Engineer review time, as may be required. The Engineer shall not be held responsible for delays or costs incurred due to excessive Shop Drawing review time where the initial submittal is received after the scheduled issue date or is not in compliance with submittal requirements contained herein.
- D. Submittal Log: The Contractor shall compile and maintain a Submittal Status log which shall be transmitted to the Engineer on a weekly basis in either hardcopy or e-mailed electronic format.
- E. Shop Drawings and Product Brochure Submittals: The Contractor shall submit one electronic (unprotected pdf format) copy or a sufficient number of complete bound hardcopy sets of Shop Drawings and complete data covering each item of equipment or material. The terms "Submittal" and "Shop Drawing" in this Specification are defined as either product literature, samples of equipment, or actual Shop Drawings. The first submittal of each item requiring a submittal must be received by the Engineer within 90 days of contract award. The Engineer shall not be responsible for any delays or costs incurred due to excessive Shop Drawing review time where the first submittal is received more than 90 days after contract award. The Architect and Engineer will each retain one copy of all hardcopy Shop Drawing submittals for their files. The Contractor is required to include a copy of all final electrical Shop Drawing submittals in Electrical O&M manuals.
- F. Shop Drawings and Product Brochure Submittal Requirements: The Contractor shall prepare complete submittals that include all pertinent information about the product. **A single Shop Drawing shall not contain information from more than one Specification section, but a single Specification section may be subdivided into separate submittals for items or equipment that are specified in that section.** Shop Drawings shall be separately bound by complete or partial Specification section. Where a single Shop Drawing contains information from more than one Specification section, it will be marked "REVISE AND RESUBMIT" and returned. Each Shop Drawing shall include the following items enclosed in a suitable binder, Shop Drawings that do not comply with the above requirements will be marked " REVISE AND RESUBMIT " and returned to the Contractor:
1. Cover Sheet: The cover sheet shall include the Project Name and the names and addresses of the Owner, Project, Architect, M/E/P Engineer, General Contractor and the Subcontractor making the submittal. The cover sheet shall also contain the Specification section number applicable to the item or items submitted, the item nomenclature and description and the submittal number. HVAC, plumbing and fire protection submittals shall be numbered sequentially by Specification section with a sequence suffix (e.g. 16450-1, 16450-2, 16500-1, etc.). Resubmittals shall be numbered with the original submittal number plus an R in the sequence suffix (e.g. the resubmittals of submittal 16500-1 would be 16500-1R1, 16500-1R2, ...).
 2. Index: The index page shall include a listing of all data included in the submittal.
 3. List of Variations: This page shall list all variations, including unfurnished or additional items or features between the submitted equipment and the specified equipment. If there are no variations, then this page shall state "No Variations". Where variations affect the work of other contractors, then the contractor shall certify on this page that these variations have been fully coordinated with the affected contractors and that all additional costs to the affected contractors associated with the variations shall be paid by the submitting contractor.

4. Specification Review. A copy of the appropriate specification section shall be included in the submittal with each specification paragraph marked in the right margin with a "C" for Submitted Product/Material/Installation Complies or an "N" for Submitted Product/Material/Installation Not In Compliance. All paragraphs marked with a "N" shall be specifically addressed in the Submittal List of Variations.
 5. Equipment Information: Submittal shall include equipment information including manufacturer's name and designation, size, performance and capacity data. All applicable listings, labels, approvals and standards shall be clearly indicated.
 6. Dimensional Data: Submittal shall include dimensional data and actual sketches as applicable to show that the submitted equipment will fit the space available with all required Code and maintenance clearances.
 7. Identification Information: Submittal shall include Identification/designation for each item of material or equipment matching that indicated in the Specifications or on the Drawings.
 8. Product Data: Submittal shall include sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Drawings and Specifications. Any options or special requirements shall be so indicated. All applicable information shall be clearly indicated with arrows or another approved method. Any non-applicable information shall be crossed out.
 9. Contractor Certification: Submittal shall include certification by the General Contractor and Subcontractor that the material submitted is in accordance with the Contract Documents, signed and dated.
 10. Manufacturer Certification: Where specified, submittals shall include reports or information requiring certification which shall be certified by an authorized officer of the manufacturer or testing agency.
 11. Certified Shop Drawings: Submittals shall include Certified Shop Drawings showing dimensions, loading details, anchor bolt locations and inserts required for each piece of equipment set on concrete in sufficient time to cause no delay in the Work.
 12. Equipment/Material Data: Equipment and material submittals shall show sufficient data including all performance curves, sound data, recommended installation details, and sufficient data to indicate complete compliance with the Contract Documents, including proper sizes, clearances, capacities, materials, and finishes.
 13. Additional Information: Submittal shall include additional information as required in other sections of this Division.
- G. Required Shop Drawing Submittals: Submit Shop Drawings, including, but not limited to the following items. Refer to individual specification sections for specific submittal requirements.
- | | |
|---|-------------------------|
| 1. Schedule of Submittals | Refer to Section 15002. |
| 2. Basic Materials and Methods | Refer to Section 16100. |
| 3. Electrical Raceways and Fittings | Refer to Section 16110. |
| 4. Electrical Boxes and Fittings | Refer to Section 16112. |
| 5. Electrical Gutters and Wireways | Refer to Section 16115. |
| 6. 300/600 Volt Cable, Wire, and Connectors | Refer to Section 16120. |
| 7. Wiring Devices | Refer to Section 16140. |
| 8. Panelboards and Enclosures | Refer to Section 16160. |
| 9. Safety and Disconnect Switches | Refer to Section 16170. |

10. 250/600 Volt Fuses Refer to Section 16181.
 11. Electrical Connections for Equipment Refer to Section 16190.
 12. Miscellaneous Electrical Controls and Control Wiring Refer to Section 16195.
 13. Electrical Grounding Refer to Section 16450.
 14. Lighting Fixtures and Lamps Refer to Section 16500.
 15. Low-Rise Addressable Device Fire Alarm System Refer to Section 16720.
 16. Voice/Data System Provisions Refer to Section 16741.
- H. Samples: Submit two samples, upon request, of electrical devices and materials for review by the Architect/Engineer. Samples will be returned upon written request of the Contractor.
- I. Shop Drawing Submittal Review: Shop Drawings will be reviewed for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action shown in review comments is subject to the requirements of the Contract Documents. The submitting Contractor is responsible for: dimensions which shall be confirmed at the job site; fabrication processes and techniques of construction; coordination of his work with that of all other trades; and the satisfactory performance of his work.
1. The Engineer will endeavor to provide a Shop Drawing review time in the Engineer's office of two weeks per review, exclusive of transmittal time, and this review time shall be considered by the Contractor when scheduling his work on the project.
 2. The Architect's review or approval and the Engineer's review of Shop Drawings shall not relieve the Contractor of the responsibility for errors, omissions or deviations that may be contained in the submittals. If the Contractor proceeds on the basis of undetected errors, omissions or deviations in reviewed Shop Drawings, it shall be at his sole responsibility and the review does not allow deviations from the requirements of the Contract Documents. Noting some errors, omissions, and deviations but overlooking other errors, omissions, and deviations does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawing or the Engineer's review thereof, the Contract Documents shall govern the Work and are neither waived or superseded by the Shop Drawing review.
 3. It shall be the responsibility of the submitting Contractor to check all equipment and materials for conformance with the Contract Documents and "REVIEWED WITH NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" submittal at the time such equipment and materials are delivered to the job site, and to notify the Engineer of any deviations.
 4. Inadequate or incomplete Shop Drawings will not be reviewed by the Architect or the Engineer and will be returned to the Contractor marked "REVISE AND RESUBMIT" for completion and resubmittal.
 5. Shop Drawings will be marked "REVIEWED WITH NO EXCEPTIONS TAKEN", "MAKE CORRECTIONS NOTED", "MAKE CORRECTIONS NOTED AND SUBMIT WRITTEN RESPONSE", "REVISE AND RESUBMIT" or "REJECTED" when reviewed by the Engineer. The definitions of these terms for review purposes is as follows:
 - a. **REVIEWED WITH NO EXCEPTIONS TAKEN** - The Shop Drawing was reviewed and no exceptions from the general conformance with the design concept and general compliance with the information given in the Contract Documents were noted.
 - b. **MAKE CORRECTIONS NOTED** - The Shop Drawing was reviewed and found to have minor deviations from the requirements of the Contract Documents, as noted. A Shop Drawing resubmittal is not required, however, the furnished material/systems shall comply with the corrections noted in the submittal review.

- c. **MAKE CORRECTIONS NOTED AND SUBMIT WRITTEN RESPONSE** - The Shop Drawing was reviewed and found to have either minor deviations from the requirements of the Contract Documents or information missing from the submittal, as noted. A complete Shop Drawing resubmittal is not required, however, a written response to all review comments shall be submitted in the format used for a resubmittal.
 - d. **REVISE AND RESUBMIT** - The Shop Drawing was reviewed and major deviations from general conformance with the design concept and general compliance with the information given in the Contract Documents were observed, as noted. The Shop Drawing shall be revised to eliminate the deviations noted and resubmitted.
 - e. **REJECTED** - The Shop Drawing was reviewed and is not in general conformance with the design concept or in compliance with the information given in the Contract Documents, as noted. A revised Shop Drawing submittal for the specified equipment or materials shall be resubmitted.
- 6. Division 1 and General Conditions requirements concerning Shop Drawing submittal review are not applicable to this Division.
 - 7. Materials and equipment which are purchased or installed without a "REVIEWED WITH NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" Shop Drawing review shall be at the risk of the Contractor and the cost for removal and replacement of such materials and equipment and related work which is judged unsatisfactory by the Architect/Engineer for any reason, shall be at the expense of the Contractor.
 - 8. Shop Drawings shall be complete and checked prior to submission to the Engineer for review. **Where more than two reviews are required for a given Shop Drawing to reach "REVIEWED WITH NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" status, the Subcontractor will be invoiced for extra services at a cost of \$150.00 per hour for review of the third and subsequent reviews.** If the Subcontractor fails to pay any legitimate extra services invoice in full within 30 days, then that invoice will be forwarded to the Architect/Owner requesting him to withhold payment of the amount invoiced from the next General Contractors request for payment as allowed for under the General Conditions of the Contract for Construction (AIA Document A-201). Incomplete submittals will be returned to the Contractor unchecked.
- J. Certifications and Test Reports: The Engineer may, at their option, witness any or all on and off-site acceptance and operational testing. Submit a detailed listing of certification and testing for each system indicating estimated dates for completion of system installation. This listing of certification and testing shall be submitted at least 30 days before any testing is conducted.
- 1. Test procedures and test result reporting forms shall be submitted for review no later than the date of the certification and testing listing submittal.
 - 2. Notify the Engineer in writing two weeks prior to all scheduled testing to allow time for Engineer to schedule witnessing of testing, where elected by the Engineer.
 - 3. Submit four copies of all certifications and test reports to the Engineer for review adequately in advance of completion of the Work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.
 - 4. Certifications and test reports to be submitted shall include, but not be limited to those items outlined in Section 16020, "Electrical Testing".
- K. Operating and Maintenance Manuals: Submit two copies of Operating and Maintenance Manuals to the Engineer for approval prior to the beginning of operator training. Provide four approved Operating and Maintenance Manuals for use in operator training. Manuals shall be bound in rigid cover, 3-ring binders with spine and cover labels and shall provide operating and maintenance information for every piece of equipment furnished under this Specification. All sections shall be typed and indexed into

sections and labeled for easy reference. Bulletins containing information about equipment which is not installed on the project shall be properly marked up or stripped and reassembled. All pertinent information required by the Owner for proper operation and maintenance of equipment supplied by Division 16 shall be clearly and legibly set forth in memoranda which shall, likewise, be bound with bulletins. As a minimum, the following information shall be provided as applicable:

1. Complete description of each system, item of equipment, and apparatus provided under this Division, including ratings, capacities, performances, data and curves, characteristics identifying name and number, locations, and wiring diagrams, including sources for all parts.
 2. Fully detailed parts lists, including all numbered parts and recommended spare parts, of each item of equipment and apparatus provided under this Division.
 3. Manufacturer's printed instructions describing operation, service, maintenance, and repair of each item of equipment and apparatus.
 4. Typewritten record of tests made of materials, equipment, and systems included under this Division. Such records shall state the dates the tests were conducted, name(s) of person(s) making and witnessing the tests, and citing any unusual conditions relevant to the tests.
 5. Identifying names, name tags designations and locations for all equipment.
 6. Fuse and motor heater information including location and use.
 7. Equipment and motor nameplate data.
 8. Copies of all approved Shop Drawing submittals.
 9. Fabrication drawings.
 10. Equipment and device bulletins and cutsheets clearly highlighted to show equipment installed on the project and including performance curves and data as applicable.
 11. Maintenance instructions clearly highlighted to show all required periodic maintenance and lubrication.
 12. Wiring diagrams.
 13. Operating instructions clearly highlighted to show proper operating procedures for all equipment.
 14. Exploded parts views and parts lists for all equipment and devices.
 15. Color coding charts for all painted equipment and conduit.
 16. Location and listing of all spare parts and special keys and tools furnished to the Owner.
- L. Tools: Provide and deliver to the Owner's authorized representative any special tools required for maintenance of systems, equipment, and apparatus installed under this Division prior to requesting final acceptance of the installation.

1.16 PROJECT RECORD DOCUMENTS:

- A. Site Prints: Maintain a set of clearly marked black line prints of the Contract Drawings at the job site which shall be used for recording the work details, final size, location, interrelation, and similar items of all work under this Division. This set of Drawings shall be corrected daily as the Work progresses and shall clearly indicate all changes to suit field conditions, changes made by "Field Order" or "Change Order", accurate dimensions of all buried or concealed work, precise locations of all concealed work, locations of all concealed boxes, controls and devices and any deviations from the work shown on the Construction Documents which are required for coordination. All dimensions shall be to at least two permanent structure points.

- B. Upon completion of the work, the Contractor shall transfer all marks from the site prints to a set of reproducible record "as-built" Drawings using red pencil. The reproducible record "as-built" Drawings shall have the Engineers Name and Seal removed or blacked out and shall be clearly marked and signed on each sheet as follows:

CERTIFIED RECORD DRAWINGS

DATE: _____

(NAME OF GENERAL CONTRACTOR)

BY: _____
(SIGNATURE)

(NAME OF SUBCONTRACTOR)

BY: _____
(SIGNATURE)

- C. Approval: Prior to final acceptance of the Work of this Division, the Contractor shall submit one reproducible and two black line prints of properly certified Record Drawings to the Engineer for review and shall make changes, corrections, or additions as the Engineer may require to the Record Drawings.

1.17 COORDINATION OF ELECTRICAL WORK:

- A. General: Refer to Division 1 for general coordination requirements applicable to the entire work. It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships which must be established within the electrical work, and in its interface with other work including utilities and mechanical work and that such establishment is the exclusive responsibility of the Contractor. The Drawings show diagrammatically the sizes and locations of the various conduit and raceway systems and equipment items and the sizes of the major interconnecting distribution, without showing exact details as to elevations, offsets, control lines, and installation details.
1. Arrange electrical work in a neat, well organized manner with services running parallel with primary lines of the building construction and with a minimum of 7' overhead clearance where possible.
 2. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to avoid obstructions and to provide proper grading of lines. Exact locations of outlets, apparatus and connections thereto shall be determined by reference to detail Drawings, equipment Drawings, rough-in Drawings, etc., by measurements at the building and in cooperation with other Contractors and in all cases shall be subject to the approval of the Engineer. Relocations necessitated by the conditions at the site or directed by the Engineer shall be made without any additional cost to the Owner or Engineer.
 3. All conduit and boxes except those in the various equipment rooms, in unfinished spaces or where specifically designated herein or on the Drawings shall be run concealed in furrings, plenums and chases. Wherever conditions exist which would cause any of these items to be exposed in finished spaces, the Contractor whose work is involved shall immediately call the situation to the attention of the Engineer and shall stop work in those areas until the Owner's Representative or General Contractor directs the resumption of the work. Submit for approval a Shop Drawing for any change in equipment placement, etc.
 4. Equipment has been chosen to fit within the available space with all required Code and maintenance clearances and shall be installed as shown. Every effort has been made to also accommodate equipment of other approved manufacturers, however since equipment and

access space requirements vary, the final responsibility for installation access and proper fit of substituted equipment rests with the Contractor.

5. System interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Where space requirements conflict, the following order of precedence shall, in general, be observed:
 - a. Building lines.
 - b. Structural members.
 - c. Soil and drain piping.
 - d. Sprinkler piping.
 - e. Vent piping.
 - f. Supply ductwork.
 - g. Exhaust ductwork.
 - h. Chilled water and heating hot water piping.
 - i. Domestic water piping.
 - j. Electrical conduit.
6. Locate electrical equipment properly to provide easy access. Arrange entire electrical work with adequate code access for operation and maintenance.
7. Advise other trades of openings required in their work for the subsequent move in of large units of electrical work (equipment).
8. Coordinate all items which will affect the installation of the work of this Division. This coordination shall include, but not be limited to: voltage, ampacity, capacity, electrical connections, space requirements, sequence of construction, building requirements and special conditions.
9. When submitting Shop Drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other Contractors and Subcontractors.

B. Sequencing Plan/Coordination Drawings:

1. This project involves modifications to the chilled water system and electrical distribution in an operating building which will require sequencing of the construction and multiple scheduled utility outages to construct.
2. A proposed project construction sequence for critical project work is included on the drawings for Contractor reference.
3. All work related to backfeeding existing loads shall be completed before existing feeder conductors and conduits and electrical equipment shown to be demolished are removed.
4. Contractor shall submit a proposed project construction sequencing plan and coordination drawings outlining the specific steps for project construction including the proposed date and duration of all required utility outages to the UTHSC-H Project Manager and A/E team for review prior to beginning any work at the site.
5. The proposed project construction sequencing plan and coordination drawings shall sequence and coordinate the work of the General Contractor and all Subcontractors and shall be organized to minimize the quantity and duration of utility outages.

6. The requirement for a "Sequencing Plan" and "Coordination Drawings" shall not be construed as releasing the General Contractor or Subcontractors from their responsibility to Plan and Coordinate the installation of the work or as authorization for the General Contractor or Subcontractors to make unauthorized changes to the Construction Documents or the project design concepts.

1.18 MATERIALS AND WORKMANSHIP:

- A. General: Materials and equipment shall be new, of best grade and quality, and standard products of reputable manufacturers regularly engaged in the production of such materials and equipment.
- B. Workmanship: Work shall be executed and materials installed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent workmen, presenting a neat appearance when completed.
- C. Manufacturer's Recommendations: With exceptions as specified or indicated on the Drawings or in the Specifications, apply, install, connect, erect, use, clean, and condition manufactured articles, materials, and equipment per manufacturer's current printed recommendations. Copies of such printed recommendations shall be kept at the job site and made available as required.

1.19 SPACE REQUIREMENTS:

- A. General: Determine in advance of purchase that the equipment and materials proposed for installation will fit into the confines indicated, leaving adequate code clearances for adjustments, repair, or replacement.
- B. Clearance: Allow adequate space for clearance in accordance with requirements of the Code and local inspection department.
- C. Scheduled Equipment: The design shown on the Drawings is based on the equipment scheduled.
- D. Responsibility: Since space requirements and equipment arrangement vary for each manufacturer, the responsibility for initial access and proper fit rests with the Contractor.
- E. Review: Final arrangements of equipment to be installed shall be subject to the Architect's review.

1.20 SAFETY REGULATIONS:

- A. All electrical work shall be performed in compliance with all applicable and governing safety regulations. All safety lights, guards, signs, and other safety materials and provisions required for the performance of the electrical work shall be provided by and operated by the Electrical contractor.

1.21 DELIVERY, STORAGE AND HANDLING OF MATERIALS:

- A. General: Protect all materials and equipment to be installed under this Division from physical and weather damage.
- B. Scope: Work under this Division shall include, but not limited to:
 1. Shipping from point of manufacture to job site.
 2. Unloading, moving, and storage on site with proper protection as required to properly protect equipment from rust, drip, humidity, dust, or physical damage.
 3. Hoisting and scaffolding of materials and equipment included in this Division.
 4. Ensuring safety of employees, materials, and equipment using such hoisting equipment and scaffolding.

- C. Installation Coordination: All large pieces of apparatus which are to be installed in the building and which are too large to permit access through doorways, stairways or shafts shall be brought to the job by the Contractor and shall be placed in the spaces before enclosing partitions and structure are completed. All apparatus shall be cribbed up from the floor by Contractor and shall be covered with tarpaulins or other protective covering where required for protection.

1.22 NOISE AND VIBRATION:

- A. General: Warrant the electrical systems, and their component parts to operate without objectionable noise or vibration. Noise from systems or equipment which results in noise within occupied spaces above the recommended NC curves (refer to ASHRAE Standard) shall be considered objectionable. Vibration shall not be apparent to the senses in occupied areas of the building. Objectionable noise, vibration, or transmission thereof to the building shall be corrected.

1.23 ADJUSTING, AND START-UP:

- A. Start-up Services: Where specified for any individual item of electrical equipment, provide a factory-authorized representative for testing, start-up of equipment, and instruction of Owner's operating personnel. Certify that these services have been performed by including a properly executed invoice for these services or a letter from the manufacturer.
- B. Lubrication: Provide means for lubricating all bearings and other machine parts. Extend a lubrication tube with suitable fitting to an accessible location and suitably identify it where lubrication fittings are concealed or inaccessible. Lubricate all parts requiring lubrication and keep them adequately lubricated until final acceptance by the Owner.
- C. Testing: Refer to Section 16020 for requirements.

1.24 SITE CLEAN-UP:

- A. Clean-up: Each Contractor shall clean away from the job site all debris, surplus material and similar items, resulting from his work or operations, leaving the job and equipment in a clean condition. Each Contractor shall thoroughly clean all pieces of equipment, ductwork, fixtures and similar items, leaving the installation in a first class, clean, operable condition.
- B. Clean Work Space: If the facility will remain occupied during the construction process, each Contractor shall clean up and maintain, at all times, areas visible to the public to prevent the appearance of a sloppy or careless work space. Employee trash shall be disposed of in a designated trash receptacle maintained by the contractor. All demolition or construction debris not designated for salvage by the Project Manager shall daily be collected and temporarily held in an area designated by, and in quantities allowed by, the owner or the general contractor, or the contractor shall be removed from the site by this contractor and disposed of properly off site.
- C. Salvageable Materials: Materials designated by the OR to be salvaged shall be stored in the building, at a location as directed by the OR and the contractor shall verify with the OR which materials are to be salvaged.
- D. Continuing Facilities Maintenance: In areas that contain equipment or systems that must be serviced, inspected, or maintained, no construction debris shall be allowed to block normal access paths or inhibit the required maintenance or service of those systems. This contractor shall immediately remove any debris that constitutes a hindrance to normal service.
- E. Directed Clean-Up: If the facility will remain occupied during the construction process, should, for any reason, the OR, the Architect or the Engineer notify the contractor of his failure to comply with a clean work space requirement, and the contractor ignores this requirement, the Owner shall retain the services of a clean-up crew to maintain a clean public work space and back charge the contractor for such contract costs.

- F. Daily Clean-Up: Each Contractor shall clean away from the job site all debris, surplus material, and similar items, resulting from his work or operations, on a daily basis leaving the job and equipment in a clean condition. Each Contractor shall thoroughly clean all pieces of equipment, fixtures, and similar items, leaving the installation in a first class, clean, operable condition.
- G. Equipment Operation: When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the OR's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first. Regardless of whether or not the equipment has or has not been operated the Contractor shall properly clean the equipment, install clean filter media, properly adjust and complete all deficiency list items before final acceptance by the Owner. The date of final acceptance and the start of the warranty may not be the same date.

1.25 **POLICIES AND PROCEDURES**

- A. Employees: Employees of the contractor that are assigned to this project shall be competent, experienced personnel who have received training for their related tasks and in the operation of any equipment that they are to operate.
- B. Identification: Employees shall be uniformed or wear clothing that clearly distinguishes them as employees of the contractor or subcontractors authorized to provide services at this facility. In addition, employees shall have picture identification badges of a type acceptable to the Owner.
- C. Supervision: Each work crew on the project shall include a full time site foreman or supervisor.
- D. Contact: The contractor shall provide a contact point, available by phone or pager, who will respond immediately to problems, questions or concerns reported by the OR.
- E. Training: Employees shall be trained in any required safety precautions related to the equipment and materials that they are using.

1.26 **FINAL REVIEW:**

- A. General: Upon completion of the Work, perform a final test of the entire system.
 - 1. The system shall be operating properly.
 - 2. After the final test, any changes or corrections noted as necessary for the Work to comply with these Specifications or the Drawings, shall be accomplished without delay in order to secure final acceptance of the Work.
 - 3. The date for the final test shall be sufficiently in advance of the Contract completion date to permit execution, before expiration of the Contract, of any adjustments or alterations which the final acceptance tests indicate as necessary for the proper functioning of all equipment. Any such modifications shall be completed within the time allotted for completion of the Contract. Retests shall be conducted as directed and shall be of such time duration as necessary to ensure proper functioning of adjusted and altered items. Retests shall not relieve the Contractor of completion date responsibility.
 - 4. Certificates, including certificates of occupancy from local authorities and documents required herein, shall be completely in order and presented to the Engineer at least one week prior to the review.
- B. Qualified Person: Individuals knowledgeable of the systems and persons approved by the Engineer, shall be present at this final inspection to demonstrate the system and prove the performance of the equipment.

1.27 OWNER INSTRUCTION:

- A. General: This Contractor and appropriate factory-trained representatives shall instruct the Owner's representative in the proper operation and maintenance of all systems and equipment and shall explain all warranties.
- B. Outline: Prior to instruction of Owner Personnel, prepare a typed outline, listing the subjects that will be included in this instruction, and submit the outline for review by the Engineer.
- C. Certification: At the conclusion of the instruction period obtain the signature of each person being instructed on each copy of the approved outline to signify that he has a proper understanding of the operation and maintenance of the systems and resubmit the signed outlines.
- D. Other Requirements: Refer to other Division 16 Sections for additional Operator Training requirements.

1.28 CONTRACTOR WARRANTIES AND GUARANTEES:

- A. General: Contractor shall guarantee all material and equipment installed by him against defects in workmanship and material for a period of 12 months after final acceptance of the work by the Owner and he shall repair or replace any materials or equipment developing such defects within that time, promptly on due notice given him by the Owner and at Contractor's sole cost and expense.
- B. Equipment: All equipment bearing a manufacturer's guarantee, such as electrical equipment, devices, components, and similar items, shall be construed to have an extended guarantee to the Owner by the manufacturer. Any such equipment that proves defective in materials or workmanship within the guarantee period is to be replaced by the Contractor in accordance with the manufacturer's guarantee.
- C. Start-up: The Electrical Contractor shall provide instructions and equipment starting service on new equipment for one complete year after date of final acceptance of the work by the Owner, at Contractor's sole cost and expense.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

SECTION 16004
ELECTRICAL SCOPE OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: Provide labor, materials, tools, machinery, equipment, appliances, fixtures, devices, and services necessary to complete the specified electrical work of this Division. Coordinate Work with other trades to prevent conflicts without impeding job progress.
- B. Utility Charges: Existing building utilities shall be used for construction power and utility costs shall be paid by the Owner.
- C. Work Included: The Work includes, but is not limited to, the following systems, equipment, and services:
 - 1. Lighting system modifications including, but not limited to:
 - a. Lighting fixtures.
 - b. Lamps.
 - c. Switches/Controls.
 - d. Branch circuit wiring.
 - e. Raceways.
 - f. All other components shown on the Drawings, specified or required for a fully operational system.
 - 2. Branch circuit distribution system modifications including, but not limited to:
 - a. Panelboard circuit breakers.
 - b. Branch circuit wiring.
 - c. Raceways.
 - d. Wiring devices.
 - e. Safety and disconnect switches.
 - f. Controls.
 - g. Connections to motors and equipment.
 - h. All other components shown on the Drawings, specified or required for a fully operational system.
 - 3. Grounding system modifications including, but not limited to:
 - a. Bonding and ground conductors.
 - b. Raceways.

- c. All other components shown on the Drawings, specified or required for a fully operational system.
4. Fire alarm system modifications.
5. Voice/data outlet provisions including, but not limited to:
 - a. Voice/Data outlet provisions.
 - b. All other components shown on the Drawings, specified or required for a fully operational system.
6. Electrical testing and certification as specified.
7. Access doors for access to concealed electrical equipment and devices.
8. Connections to equipment furnished by the General Contractor or other Divisions.
9. Connections for Owner-furnished equipment where shown on the Drawings or specified.
10. Additional items as shown on the Drawings or specified.
11. Structural Openings:
 - a. The Electrical Contractor shall provide the Structural Engineer with locations, dimensions, and weights of his equipment to be supported by the floor structural systems immediately following the awarding of the Contract. The final locations of his equipment shall be subject to the approval of the Structural Engineer. The Electrical Contractor shall provide accessories necessary to hang his equipment from structure at locations and in a manner approved by the Structural Engineer.
 - b. The Electrical Contractor shall be responsible for coordinating all required openings in existing construction with the General Contractor and Structural Engineer and shall be responsible for cutting or drilling required openings in a manner which is acceptable to the Owner. Cutting and drilling operations shall be performed at times which are acceptable to the Owner.
 - c. Except as otherwise indicated on the Drawings, all holes of area less than 50 square inches required through concrete floors, precast concrete, masonry, and similar items, shall be provided by the Electrical Contractor. All holes required through post-tensioned concrete floors and roof and all other holes that proper electrical installation require to be of a larger area than 50 square inches will be provided by the General Contractor at locations determined by this Contractor. Any cutting and patching for holes required for proper electrical installation where information on sizes and locations is not provided to the General Contractor in sufficient time shall be the responsibility of the Electrical Contractor. All cutting and patching shall be subject to the direction and approval of the Architect.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. Refer to specific Sections of the Specifications for equipment.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Installation shall be in accordance with the Specification section pertaining to the individual equipment.

END OF SECTION

SECTION 16020
ELECTRICAL TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: Provide testing of electrical work installed under Division 16, as specified herein and in other Division 16 sections. Feeders and equipment shall not be placed in service until they have been checked out and tested, as applicable.

1.3 QUALITY ASSURANCE:

- A. Personnel: Submit evidence to show that the personnel who will actually test the systems are qualified.
- B. The Engineer reserves the right to require that the originally approved personnel be replaced with other qualified personnel if, in his opinion, the original personnel are not qualified or are not properly conducting the system testing.

1.4 SUBMITTALS:

- A. Testing Procedures: Submit four copies of all proposed testing procedures to the Engineer for review at least 30 days prior to conducting any testing.
- B. Reporting Forms: Submit four copies of proposed forms to be used in recording testing data and results to the Engineer for review at least 30 days prior to conducting any testing on the project.
- C. Test Data and Results: Submit four copies of complete data and certified test results for each test performed, including, but not limited to:
 - 1. Test performed.
 - 2. Test procedure.
 - 3. System and area tested.
 - 4. Date(s) and time(s) of test.
 - 5. Weather conditions.
 - 6. Test criteria.
 - 7. Test results.
 - 8. Additional pertinent information.
- D. Operational Certification: Submit four certified copies of an operational certification which documents that all equipment and systems have been fully tested to verify proper operation in accordance with the design shown in the Construction Documents and manufacturer's recommendations.
- E. Certification: Certifications stating that submitted test data and results are true and correct shall be provided for all submittals under this Section. Certification shall be executed by an authorized officer if the Contractor is a corporation, by a partner if the Contractor is a partnership, by the Owner if the Contractor is a sole proprietorship or by the authorized representative if the Contractor is a joint venture.

- F. Calibration List: Submit four copies of a listing of testing devices to be used for the project to the Engineer for approval. Listing shall include documentation that devices are properly calibrated.
- G. Test Log: The Contractor shall maintain a test log at the site to document the results of all successful and unsuccessful testing and balancing as it is performed. This log shall be available for review by the Engineer and a copy of the log shall be submitted to the Engineer prior to the Substantial Completion inspection. A space shall be provided on the test log for signoff by the OR.

1.5 NOTICE:

- A. General: Notify the Engineer in writing two weeks prior all scheduled testing to allow time for Engineer to schedule witnessing of testing, where elected by the Engineer.

PART 2 - PRODUCTS

2.1 TESTING MATERIALS:

- A. General: Provide all materials and test equipment required for testing of specified electrical systems, including retesting until acceptable test results are obtained.
- B. Products: Tested products which fail to provide acceptable test results shall be repaired or replaced with suitable materials as required to obtain acceptable test results.

PART 3 - EXECUTION

3.1 TESTING:

- A. General: Tests shall be made during the course of construction as specified and as required by authorities having jurisdiction. Such tests shall be conducted by this Division as a part of the Work and shall include all personnel, material, and equipment required to perform tests until satisfactory results are obtained. Any defects detected during testing shall be satisfactorily repaired or the equipment involved shall be replaced and the tests re-executed.
- B. Tests: Testing shall include but not be limited to all items listed in other Sections of this Division and the following:
 - 1. 300/600 Volt Wire and Cable Testing: Refer to Section 16120, "300/600 Volt Cable, Wire and Connectors".
 - 2. Grounding System Testing: Refer to Section 16450, "Electrical Grounding".

END OF SECTION

SECTION 16100

BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide basic materials and methods for electrical construction as shown, scheduled, indicated, and specified.
- B. Types: The types of basic materials and methods required for the project include, but are not limited to:
 - 1. Manner of running conduits.
 - 2. Hangers and supports.
 - 3. Attachment.
 - 4. Sleeves.
 - 5. Openings, cutting, and patching.
 - 6. Access doors.
 - 7. Firestopping for conduit, wire, and cable.
 - 8. Fire-rated partitions.
 - 9. Flame spread properties of materials.
 - 10. Penetration flashing and seals.
 - 11. Escutcheon plates.
 - 12. Cleaning and painting of electrical work.
 - 13. Electrical system identification.
 - 14. Warning signs and operational tags.
 - 15. Equipment housekeeping pads and anchor bolts.
 - 16. Wiring device and equipment mounting heights.
 - 17. Demolition and work within existing buildings.

1.3 SUBMITTALS:

- A. Shop Drawing submittals shall include, but not be limited to, the following:
 - 1. The Contractor shall submit to the Engineer for review, a list of proposed manufacturers and product data on hangers, supports, and methods of attachment to the structure.
 - 2. Cut sheets on access doors, fire stopping materials, and electrical identification products.
 - 3. Cut sheets and samples of Electrical System Identification products.

4. Additional information as required in Section 16002.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver components in factory-fabricated water resistant packaging.
- B. Handle components carefully to avoid damage to components, enclosures, and finish.
- C. Store components in a clean, dry space and protect from weather.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. General: Refer to PART 3 - EXECUTION of this Section and other Division 16 sections for basic electrical products and materials.

PART 3 - EXECUTION

3.1 MANNER OF RUNNING CONDUITS:

- A. All conduits shall be concealed in pipe chases, walls, furred spaces, topping, or above the ceilings of the building unless otherwise indicated.
- B. Conduit may be run exposed in mechanical rooms, duct and piping chases, but only where necessary. All exposed conduit shall be run in the neatest, most inconspicuous manner, and parallel or perpendicular to the building lines.
- C. All conduit and surface raceways shall be adequately and properly supported from the building structure by means recommended by the manufacturer, or by the use of hanger rods or clamps as herein specified.
- D. Where limited space is available above the ceilings and below concrete beams or other deep projections, conduit shall be sleeved through the projection where it crosses rather than hung below them and in a manner to provide maximum above-floor clearance.
- E. No sleeves shall be installed through any concrete beam or other deep projection without written approval of the Architect/Engineer.
- F. Run conduit to avoid proximity to heat producing equipment, piping and flues, keeping a minimum of 8" clear.
- G. Whenever possible, install horizontal conduit runs above water piping.
- H. Install all conduit to allow for adequate maintenance and access clearances to all equipment and so as to not inhibit removal of ceiling tiles.
- I. The Contractor shall study all construction documents and carefully lay out all work in advance of fabrication and erection in order to meet the requirements of limited spaces. Where conflicts occur, the Contractor shall meet with all involved trades and the Construction Inspector and resolve the conflict prior to erection of any work in the area involved.
- J. Conduit and raceway connections, rough-in and stub-up locations for equipment shall be coordinated by the Contractor to provide locations indicated on approved manufacturers equipment shop drawings. Connection, rough-in and stub-up locations shown on the Drawings are diagrammatic for general reference only.

3.2 HANGERS AND SUPPORTS:

- A. All supports required for the proper installation of equipment, cable tray, wireway, and conduit shall be provided as hereinafter specified unless otherwise indicated on the Drawings.
- B. All conduits throughout the building shall be supported as specified in Section 16110, unless specifically noted differently on the Drawings or in the Specifications, but in every case shall be adequate to support the raceway being suspended. The supports shall be from the structure to line of grade, with proper provision for expansion, contraction, vibration elimination, and anchorage.
- C. Vertical conduits shall be supported from floor lines with riser clamps sized to fit the conduit and to adequately support their weight, with allowance for expansion and contraction. At the bases of conduit, where required for proper support, provide anchor base fittings or other approved supports.
- D. Conduit shall not be supported from ductwork, piping, or equipment.
- E. All electrical conduits and surface raceways exposed to view shall be run parallel to the adjacent building construction. All hangers shall be fastened to the building structure in a manner as hereinafter specified under "Attachment".
- F. Single conduits running horizontally shall be supported by Caddy, Minerallac, or approved equal adjustable conduit hangers from adequately sized rods (minimum 1/8") from the building structure. Refer to Section 16110 for additional requirements.
- G. Multiple conduits running horizontally shall be supported by trapeze channels suspended on rods or bolted to vertical building members. Channels shall be as manufactured by Unistrut, Superstrut, Powerstrut, Kindorf, Elcen, T&B or approved equal. Conduits shall be secured to the channel with galvanized or stainless steel clamps. Refer to Section 16110 for additional requirements.
- H. Vertical conduits, both concealed and exposed, shall be supported by clamping to vertical surfaces or by means of clamps resting on adjacent beams, or floor slabs, or both as required by the installation. Refer to Section 16110 for additional requirements.
- I. Conduits and raceways run against building surfaces shall be supported by means recommended by the manufacturer, or by means of single or two hole rigid conduit clamps. Two-hole clamps shall be provided where size of conduit and installation conditions warrant. Refer to Section 16110 for additional requirements.
- J. All auxiliary steel required for conduit, cable tray, and wireway supports, etc. shall be provided by the Electrical Trades unless specifically indicated to be provided by others. All support steel and fasteners shall be galvanized.
- K. Contractor shall review all Drawings, including Structural Drawings, for details regarding supports.
- L. 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.
- M. Perforated strap shall not be used as a hanger material.

3.3 ATTACHMENT:

- A. 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.
- B. All conduits not embedded in concrete or masonry shall be securely and independently supported so that no strain will be transmitted to outlet box and pull box supports, etc. Supports shall be rigid enough to prevent distortion of conduits during wire pulling.
- C. Inserts shall be of a type which will not interfere with reinforcing, as indicated on the Structural Drawings, and which will not displace excessive amounts of structural concrete. All methods of

attachment to the structure and the use of afterset inserts shall be approved in writing by the Structural Engineer.

- D. All conduit supports shall be designed and installed to avoid interference with other piping, hangers, ducts, conduit, supports, building structures, equipment, etc. All conduit, cable tray, and wireway 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.
- E. Hangers shall be attached to structure as follows:
 - 1. Poured-in-place Concrete:
 - a. Where conduits, equipment, etc., are supported under poured-in-place concrete construction, each hanger rod shall be fitted with a nut at its upper end, which shall be set into a UL-listed universal concrete insert placed in the form work before concrete is poured.
 - b. 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 a bottom joist steel, the hanger rod shall be suspended from the center of a horizontal angle iron, channel iron, I-beam, etc., spanning across to adjacent joists. The angle iron shall be bolted to nonadjustable concrete inserts of the "spot" type, of physical size small enough to avoid the bottom joist steel.
 - 2. Steel Bar Joists:
 - a. Where light loads are supported under bar joists, hanger rods may be run with a washer and two nuts.
 - b. Where larger loads 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.
 - 3. Steel Beams: Where loads are supported under steel beams, approved type beam clamps shall be used.
 - 4. Wood Framing: Where loads are supported from wood framing, hanger rods shall be attached to framing with side beam brackets or angle clips.
 - 5. Miscellaneous Steel: All miscellaneous steel members, angles, rods, supports, and similar items specified or required for this project shall be galvanized for indoor use or hot dipped galvanized for exterior use and where exposed to ambient conditions. All required miscellaneous steel shall be provided by this Division.
- F. Fastening of conduits, etc., in the building shall be as follows: To wood members - by wood screws; to masonry by threaded metal inserts, metal expansion screws, or toggle bolts, whichever is appropriate for the particular type of masonry; to steel - machine screws or welding (when specifically permitted or directed), or bolts, and to concrete by suitable inserts anchored to reinforcing steel, and poured in place unless other means are indicated on the plans. Power-actuated fasteners (shooting) will not be acceptable.

3.4 SLEEVES:

- A. Provide epoxy set sleeves or an equal water stop method approved by the Architect/Engineer for all new floor slab penetrations.
- B. In general, a conduit sleeve shall be one size larger than the size conduit which it serves, except where larger sizes are required for manufactured water stop fittings.
- C. No sleeves shall be installed through any concrete beam or other deep projection.

- D. Sleeves set in concrete floor construction shall be minimum 18 gauge, galvanized steel, and shall extend 2" above the finished floor. Where sleeve will be used to support a conduit riser clamp, sleeve gauge shall be increased accordingly.
- E. Sleeves for concrete or masonry walls shall be Schedule 40, galvanized steel, and shall be set flush with the finished wall.
- F. Sleeves for conduits passing through walls below grade shall be wall sleeves with corresponding segmented annular seals for the conduit size required as specified in Paragraph 3.11.

3.5 **OPENINGS, CUTTING AND PATCHING:**

- A. General: The Contractor shall be responsible for coordinating openings in the building construction for installation of electrical systems. Comply with the requirements of Division 1 for the cutting and patching of other work to accommodate the installation of electrical work. Except as individually authorized by the Architect/Engineer, cutting and patching of electrical work to accommodate the installation of other work is not permitted.
- B. Cut and Patch: Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.
- C. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for conduits, outlet boxes, etc., shall be core drilled to exact size.
- D. Approval: If holes or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no change in Contract amount. Undertake no cutting or patching without first securing written approval from the Architect/Engineer. Patching shall create a surface which is structurally and aesthetically equal to the surface surrounding the area patched and shall be performed by the trade whose work is involved, at no change in the Contract amount.
- E. Protection: Openings through exterior walls or roofs shall be provided with suitable covers while they are left open to protect the property or materials involved. Any openings through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.
- F. Restoration: All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes. Restoration work shall be performed by the trades who originally installed the work being restored and shall be performed at no cost to the Owner or Architect/Engineer.
- G. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.
- H. Plaster: All electrical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.
- I. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

3.6 **ACCESS DOORS:**

- A. General: This Contractor shall provide wall or ceiling access doors for installation in finished surfaces for unrestricted access to all concealed items of electrical equipment.
- B. Types: Doors shall be factory-finished as noted below and turned over to the General Contractor for installation. Refer to finish painting requirements specified herein below. Doors shall be as manufactured by Inryco/Milcor or an approved equal in the following styles:

- 1. Drywall Construction Inryco/Milcor Style DW with gray prime finish.
 - 2. Finished Acoustical Ceiling Tile insert. Inryco/Milcor Style AT with door designed for tile insert.
 - 3. Finished Plaster Ceiling or Walls finish Inryco/Milcor Style WB-PL with door designed for plastering.
 - 4. Masonry Walls Inryco/Milcor Style M with gray prime finish.
 - 5. Fire Rated Construction Inryco/Milcor Fire Rated Access Door with gray prime finish.
 - 6. Fire Rated Ceiling or Ceiling Assembly Inryco/Milcor Style ATR with door designed for tile insert.
- C. Selection: Access doors shall be furnished with a continuous piano hinge with screwdriver-operated flush locks and shall be a minimum of 12" x 12". Larger sizes shall be furnished where required for proper access. Access doors shall not be installed until location and style has been approved by the Architect.
- D. Approval: Access door shall not be installed until location and style have been approved by the Architect.

3.7 FIRESTOPPING FOR CONDUIT, WIRE AND CABLE:

- A. General: Provide a UL Systems Classified, intumescent material capable of expanding up to three to five times when exposed to temperatures beginning at 250°F for sealing all holes or voids created to extend electrical system conduit, raceways, busway, wire, cable and other components through fire-rated floors and walls to prevent the spread of smoke, fire, toxic gas and water.
- B. Fire barrier products shall be used to create through-penetration firestop systems as required. All firestop systems shall be listed in the Underwriter's Laboratories Building Materials Directory, Through Penetration Firestop Systems (XHEZ).
- C. The products manufactured by 3M/Electrical Products Division or an approved equal are acceptable subject to Shop Drawing submittal approval.
- D. Install firestop materials according to the following UL Systems Classifications and manufacturer's recommendations:

OPENING TYPE	UL SYSTEM CLASSIFICATION NUMBER
Metal Conduit/Metal Pipe Through Round Openings	No. 49, No. 95, No. 147.
Insulated Power Cables/Telephone Cables Through Openings	No. 33, No. 49, No. 149.
Blank Openings/Joints/Expansion Trenches	No. 92, No. 102, No. 61.
Cable Tray (Single or Double)	No. 105.
Metal Pipe/Conduit/Cables Through Large Openings	No. 93.
Plastic Pipe/Plastic Conduit Through Openings	No. 64b, No. 148.
All Other Firestop Systems	Per manufacturer's recommendations.

- E. Provide fire rated insulation blankets around conduits where shown on Drawings. Blankets shall be one inch (1"), 8 pound density thermo ceramic material, Thermo Ceramics Kas-Wool Fire Master Series thermal blankets or and approved equal. Blankets shall be wrapped to provide continuous

coverage and be secured with stainless steel bands in accordance with the manufacturer's UL-listed installation instructions.

3.8 FIRE-RATED PARTITIONS:

- A. Coordinate locations of raceways in fire-rated partitions so not to effect the fire rating of the partition. Notify the Architect/Engineer in writing where additional construction is required to maintain the partition fire rating.
- B. Outlet boxes installed in fire-rated partitions (2 hour or less) shall not exceed 16 square inches, with a maximum of 100 square inches of wall opening per 100 square feet of wall area.
- C. The outlet boxes shall be located whereby no two outlet boxes are installed closer than 24" on center, and securely attached to the partition studs, with at least one partition stud separating the outlet boxes.

3.9 FLAMESPREAD PROPERTIES OF MATERIALS:

- A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255 (1984), "Method of Test of Surface Burning Characteristics of Building Materials". The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke-developed rating of 50.

3.10 PENETRATION FLASHING AND SEALS:

- A. Conduit sleeves, pitch pockets, and flashings compatible with the roofing and waterproofing installation shall be provided for all roof and wall penetrations and roof-mounted equipment and supports. Coordinate flashing details with the Architectural details and the roofing/waterproofing contractors.
- B. Conduits passing through walls where exposed to weather or below grade shall pass through waterstop sleeves (new construction) or core-drilled openings (existing construction). The space between the conduit and sleeve/opening shall be sealed using segmented annular seals to prevent the entry of water or foreign materials. Segmented annular seals shall be Thunderline Incorporated, Type LS Series, Style C insulating type link seals for temperatures up to 250°F, or an approved equal. Waterstop sleeves shall be Thunderline Corporation Century-Line or equal noncorroding thermoplastic sleeves with a molded in water stop lip.

3.11 ESCUTCHEON PLATES:

- A. Except as otherwise noted, provide chrome-plated brass floor and ceiling escutcheon plates around all pipes, conduits, etc., passing exposed through walls, floors, or ceilings, in any finished spaces except under floor and attic spaces. Plates shall be sized to fit snugly against the outside of the conduit. Plates will not be required for conduit where pipe sleeves extend above finished floor. All equipment rooms are classified as finished spaces.

3.12 CLEANING AND PAINTING OF ELECTRICAL WORK:

- A. Prime, protective and touch-up painting is included in the Work of this Division. Finish painting in equipment spaces, concealed locations, and other locations not exposed to the view of building occupants is included in the work of this Division. Finished painting in areas exposed to the view of building occupants is specified under Division 9.
- B. All equipment and materials furnished by the electrical subcontractor shall be delivered to the job with suitable factory protective finish.
- C. Electrical switchgear, disconnect switches, contactors, etc., with suitable factory-applied finishes shall not be repainted; except for aesthetic reasons where located in finished areas as directed by the Architect and in a color selected by the Architect. Where factory-applied finishes are damaged in

transit, storage or installation, or before final acceptance, they shall be restored to factory-fresh condition by competent refinishers using the spray process.

- D. All exterior conduit and all equipment not finished at the factory shall be given a prime coat and then finish painted with two coats of enamel in a color as directed by the Architect/Engineer. No nameplates on equipment shall be painted, and suitable protection shall be afforded such plates to prevent their being rendered illegible during the painting operations.
- E. The surfaces to be finish-painted shall first be prepared as follows:
 - 1. Galvanized and black steel surfaces shall first be painted with one coat of galvanized metal primer.
 - 2. Aluminum surfaces shall first be painted with one coat of zinc chromate primer.
- F. All ferrous metal surfaces without a protective finish and not galvanized in exposed and concealed areas including chases, under floor and above ceilings shall be painted with two coats of zinc chromate primer as the construction progresses to protect against deterioration.
- G. All junction and pull boxes and covers which are part of raceway systems distributing emergency power shall be painted red. Where a multiple branch emergency power system is installed, the branch designation (LS, CB or EQ) shall be stenciled on the box cover in minimum one inch (1") high white letters.
- H. All junction and pull boxes and covers and terminal cabinets which are part of the raceway/wiring system for fire alarm wiring shall be painted red. A system designation (FA) shall be stenciled on the box or cabinet cover in minimum one inch (1") high white letters.
- I. All conduit exposed to view shall be finish painted as directed by the Architect/ Engineer.
- J. Before painting, all surfaces to be painted shall be suitably prepared. This shall include removing all oil, rust, scale, dirt, and other foreign material. Surfaces shall be made smooth by grinding, filing, brushing, or other approved method. In the painting operations, the primer for metal surfaces shall be of the zinc dust type unless specified otherwise, and where finish painting is specified, it shall be painted using materials and colors selected and approved by the Architect/Engineer. Refer to Division 9 for additional requirements.

3.13 **ELECTRICAL SYSTEM IDENTIFICATION:**

- A. Identification of Equipment:
 - 1. All pieces of major electrical equipment shall have a manufacturer's label identifying the manufacturer's address, equipment model and serial numbers, equipment size, and other pertinent data. Care shall be taken not to obliterate this nameplate in any way.
 - 2. The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, junction boxes, etc., by marking them. All items of equipment, pull boxes, junction boxes, etc., shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same number as shown on the Drawings, where applicable.
 - 3. Equipment nameplates shall be three ply laminated plastic, a minimum of 3/32" thick, black-white-black for normal power, red-white-red for emergency power, and blue-white-blue for UPS power. Letters shall be similar to Roman Gothic of a size that is legible (1/2" minimum for main nameplates and 3/8" minimum for branch device nameplates) and appropriate to the application. Attachment of nameplates shall be by stainless steel screws. Rivets or adhesives are not acceptable.

- a. Electrical equipment to be identified includes: All switchboards, distribution panels, transformers, panelboards, automatic transfer switches, disconnect switches, motor controller/starters, variable speed drives, pull boxes, junction boxes and similar equipment.
- b. Nameplates on switchgear, automatic transfer switches, transformers, distribution panels, disconnect switches, motor controller/starters, and panelboards shall give voltage and current characteristics and the source feeding the panel. Current characteristics shall indicate the size of the overcurrent devices serving the equipment and not the equipment current rating.

Example:

PANEL 1LA
120/208V, 3 PH, 4 W, 225 A
Fed from DPA-3
Room 1.102

- c. Individual overcurrent devices and pilot lights in switchboards, distribution panels, variable speed drives and similar equipment shall have nameplates showing the load served and its location, where remote. Nameplates on motor starters shall indicate variable speed, time delay operation, etc., where applicable.
 - d. Blank nameplates shall be mounted on each spare or bussed space in motor control centers, and on each spare or space in distribution panels.
 - e. Branch circuit panelboards shall have neatly typed circuit directories behind clear plastic. Identify circuits by room numbers. Room numbers shall be those finally selected by the Owner; not necessarily those given on contract Drawings. Spares and spaces shall be indicated with erasable pencil; not typed. Circuit numbers shall be provided in the directory and at each circuit breaker.
- B. Conduit Systems: Provide adequate marking of major conduit which is exposed or concealed in accessible spaces, to distinguish each run as either a normal power, emergency power, fire alarm, control wiring or voice/data conduit. Except as otherwise indicated, use orange banding with black lettering except that emergency power and fire alarm conduit markers shall use red banding. Provide self-adhesive or snap-on type plastic markers. Indicate voltage ratings of conductors exceeding 250 volts. Locate markers at ends of conduit runs, near switches and other control devices, near items of equipment served by the conductors, at points where conduit passes through walls or floors, or enters non-accessible construction and spaced on not more than 50' centers along each run of exposed conduit. Switch-leg conduit and short branches for power connections need not be marked, except where conduit is larger than one inch (1").
- C. Cable Tray Systems: Provide engraved nameplates identifying cable tray systems as to use, on maximum 50' centers on all exposed tray systems and whenever a tray enters a room or concealed accessible location. Nameplate text shall be submitted to the Engineer for review.
- D. Underground Cable Identification: Bury a continuous, preprinted, bright colored plastic ribbon cable marker, Brady No. 91600 Series or an approved equal with each underground cable (or group of cables), regardless of whether conductors are in conduit or direct buried. Locate each directly over cables, 6" to 8" below finished grade. Ribbons shall be detectable from above grade using a pipe or cable locator.
- E. Cable/Conductor Identification: Coordinate a uniform and consistent scheme of color identification of power wiring throughout the building system. Identification shall be by the permanent color of the selected covering. On large conductors, secure identification by means of painted color banding or plastic tape.

- 1. Color scheme shall be as follows, or as required to match the existing color coding in the building:

	208/120 Volt	480/277 Volt	5 kV/15 kV
Phase A	Black	Brown	Black

Phase B	Red	Purple	Red
Phase C	Blue	Yellow	Blue
Neutral	White	Gray	White
Ground	Green	Green	

2. Wiring for switches shall be same color as phase wire.
 3. Colored insulation in sizes up through No. 10. Conductors No. 8 and larger may have black insulation, but color coded with 1/2" wide band of colored tape, at accessible locations.
 4. Feeder cables shall be tagged in pull boxes, wireways, wiring gutters of panels, and at other accessible locations. Tags shall be fireproof, nonconductive material, approved by Architect.
 5. Maintain same conductor color from service entrance to last device.
- F. Phase Rotation: Phase rotation shall be maintained throughout the project.
1. Phase rotation shall be clockwise or counterclockwise, per serving power company standards, A-B-C, and identified as such left-to-right, top-to-bottom, and front-to-back with color coding as specified above at switchboards, panelboards, substations, transformers, motor control centers, motor starters, and similar locations.
 2. Motor phase reversal, if necessary, shall be made at motor terminals.
- G. Branch Circuit and Control Wiring Tags: All branch circuit and control wiring conductors shall be tagged using self-sticking vinyl cloth or mylar cloth wire markers. Embossed pressure sensitive plastic or metal ribbon markers will not be accepted. Tags shall be installed at all wiring splice, tap and termination points and shall correspond to the designations shown on the control wiring diagrams or panel schedules.
- H. Branch Circuit Pull Boxes and Junction Boxes: Branch circuit pull boxes shall be neatly stenciled with a black permanent marker indicating the panel name and branch circuit number. Boxes on emergency power systems shall be painted red prior to marking.
- I. Miscellaneous Switch Plates or Device Plates: Device and switch plates for all 15 and 20 amp devices circuited to "emergency" circuits, special purpose outlets, pilot lights, remote operated light switches, all remote control devices, and other devices noted on the Drawings shall be identified by engraving the switch plate or device plate.
1. Nomenclature shall include the panel and circuit of the outlet or switch, or the indication of the pilot, or the area of control, or equipment served. Consult the Architect/Engineer for label nomenclature.
 2. Plates shall be as specified in Section 16140, "Wiring Devices".
 3. Engraving shall be 3/16" condensed Gothic and shall be filled with black enamel.
- J. Manufacturers: Provide electrical identification products as manufactured by Ideal, T&B, 3M, Panduit, Seaton, EMED Co. or an approved equal.
- 3.14 **WARNING SIGNS AND OPERATIONAL TAGS:**
- A. Warning Signs: Provide warning signs where there is hazardous exposure associated with access to or operation of electrical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with recognized industry standards for color and design.
 - B. Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical systems, provide tags of plasticized card stock, either preprinted or hand printed. Tags shall convey the message, example: **"DO NOT OPEN THIS SWITCH WHEN BURNER IS OPERATING"**.

3.15 EQUIPMENT HOUSEKEEPING PADS AND ANCHOR BOLTS:

- A. Concrete pads for equipment (Housekeeping Pads) will be furnished under this Division. Pads shall be provided in locations where floor mounted equipment is to be installed.
- B. Pads shall be nominal 3-1/2" high and shall extend a minimum of 3" beyond all equipment and supports while generally conforming to the shape of the equipment. Provide pad heights to match existing pads where located in the same room.
- C. Pads shall be minimum 2500 psi (28 day) concrete reinforced with No. 6 - 6" x 6" welded wire mesh. Pad tops and sides shall be hard troweled smooth with a 3/4" bull nose on all external corners. Refer to Division 3 for additional requirements.
- D. Furnish galvanized anchor bolts with layout templates for installation in equipment pads. Bolts shall be of the size and quantity recommended by the manufacturer and where vibration isolators are used, they shall be anchor bolted to the equipment pad.

3.16 WIRING DEVICE AND EQUIPMENT MOUNTING HEIGHTS:

- A. Refer to architectural drawings to determine whether outlets occur in wainscot or cabinet spaces and coordinate mounting heights as required by architectural form. For example, mounting heights of outlets occurring in a tile or brick wall should be adjusted so that the outlet will occur entirely within a single course. However, all outlets in a given space shall be mounted at the same height.
- B. In general, unless noted otherwise on Architectural or Electrical Drawings, mounting heights to device center line shall be as follows outlets occurring in tile walls shall be shifted, slightly, to allow mounting at the best suitable point in a particular tile:
 - 1. Wall Switches 48" above finished floor.
 - 2. Receptacles 18" above finished floor, unless otherwise noted or required..
 - 3. Receptacles 6" above countertops without splash backs and 4" above splash backs for countertops with splash backs, mounted with their long axis horizontal.
 - 4. Panelboards 72" from finish floor to top of panelboard.
 - 5. Stairway Lighting Fixtures Wall mounted 7'-6" above finished floor or mid-landing.
 - 6. Fire Alarm Wall-Mounted Signals 6'8" above finish floor or 6" below ceiling, Audio/Visual whichever is lower.
- C. All receptacles shall be mounted with their long axis vertical, unless noted otherwise.

3.17 DEMOLITION AND WORK WITHIN EXISTING BUILDINGS:

- A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in service maintenance of all electrical services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.
- B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

- C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, conduit, outlet boxes, wiring, light fixtures, equipment, and similar items, to provide this access and shall reinstall same upon completion of work in the areas affected.
- D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed and reinstalled, this Contractor shall remove and reinstall, in locations approved by the Architect, all devices required for the operation of the various systems installed in the existing construction.
- E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner 2 weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.
- F. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the Drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Survey the project with the Owners representative before demolition begins and determine all materials which the Owner specifically chooses to have salvaged. Pre-establish with the Owner locations where salvaged materials are to be stored. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.
- G. All items which are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.
- H. When items scheduled for relocation are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner.
- I. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the Drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities which must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as hereinbefore specified.
- J. During the construction and remodeling, portions of the **[project]** shall remain in service. Construction equipment, materials, tools, extension cords, etc., shall be arranged so as to present minimum hazard or interruption to the occupants of the building.
- K. Certain work during the demolition and alteration phases of construction may require overtime or nighttime shifts or temporary evacuation of the occupants. Coordinate and schedule all proposed down time with the Owner's Representative at least 72 hours in advance.
- L. Make every effort to minimize damage to the existing building and the Owner's property. Repair, patch, or replace as required any damaged which might occur as a result of work at the site. Care

shall be taken to minimize interference with the Owner's activities during construction. Cooperate with the Owner and other trades in scheduling and performance of the work.

- M. Include in the contract price all rerouting of existing conduits, wiring, outlet boxes, fixtures, etc., and the reconnecting of existing fixtures as necessitated by field conditions to allow the installation of the new systems. Furnish all temporary conduit, wiring boxes, etc., as required to maintain lighting and power service for the existing areas with a minimum of interruption.
- N. All existing lighting fixtures, switches, outlets, speakers, materials, equipment and appurtenances not included in the remodel or alteration areas are to remain in place and shall remain in service.
- O. Electrical equipment, outlets, speakers, circuits to mechanical and building systems equipment, etc., which are to remain but which are served by conduit and/or circuiting that is disturbed by the remodeling work, shall be reconnected in such a manner as to leave it in proper operating condition.
- P. Existing branch circuit wiring which is to be removed, shall be pulled from the raceways and the empty conduit shall be removed to a point of permanent concealment.
- Q. Existing lighting fixtures shown to be removed and indicated to be reused, shall be cleaned, repaired, relamped and provided with such new accessories as may be needed for the proper installation in their new locations.
- R. New circuiting indicated to be connected to existing panels shall be connected to "spares" and/or "released" breakers as applicable, or new breakers provided where space is available. Contractor shall verify the existing panel load and feeder capacity prior to adding any additional loads.
- S. Within the remodeled or alteration areas where existing ceilings are being removed and new ceilings are installed, all existing lighting fixtures, other ceiling mounted devices and their appurtenances shall be removed and reinstalled into the new ceiling, unless otherwise shown or specified.
- T. Within the remodeled or alteration areas where existing walls are being removed, all existing lighting fixtures, switches, receptacles, other materials and equipment and their appurtenances shall be removed, where required by the remodel work either shown or specified.
- U. Any salvageable equipment as determined by the Owner, shall be delivered to the Owner, and placed in storage at the location of his choice. All other debris shall be removed from the site immediately.
- V. No portion of the fire alarm system shall be turned off, modified or changed in any way without the express knowledge and written permission of the Owner's Representative.
- W. Refer to Architectural "Demolition" and "Alteration" plans for actual location of walls, ceilings, etc. being removed and/or remodeled.

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SECTION 16110

ELECTRICAL RACEWAYS AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirement of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide electrical raceway and fitting work as shown, scheduled, indicated, and specified.
- B. Conduit Systems: All electrical conductors shall be installed in conduit. Conduit shall be as specified herein. In addition, empty conduit shall be installed for the voice/data system and for other systems as indicated on the Drawings and in the Specifications.
- C. Types: The types of electrical raceways and fittings required for the project include, but are not limited to, the following:
 - 1. Rigid steel (RGS) and intermediate metal conduit (IMC).
 - 2. Electrical metallic tubing (EMT).
 - 3. Flexible metal conduit.
 - 4. Liquidtight flexible metal conduit.

1.3 STANDARDS:

- A. Products and installation shall comply with applicable sections of the following standards:
 - 1. ANSI C80.1 Rigid Steel Conduit, Zinc-Coated.
 - 2. ANSI C80.6 Intermediate Metal Conduit, Zinc-Coated.
 - 3. ANSI C80.3 Electrical Metallic Tubing, Zinc Coated.
 - 4. ANSI/NEMA FB 1 Fittings and Supports for Conduit and Cable Assemblies.
 - 5. NEMA TC 3 PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.4 QUALITY ASSURANCE:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
 - 1. Rigid Steel and Intermediate Metal Conduit:
 - a. Allied Tube & Conduit Corporation.
 - b. Galvite/LTV Steel Tubular Products
 - c. Republic Steel Corporation.
 - d. Triangle PWC, Inc.
 - e. Youngstown Sheet & Tube.

- f. Wheatland.
- 2. Electrical Metallic Tubing:
 - a. Allied Tube & Conduit Corporation.
 - b. ETP-Uni-Couple.
 - c. Republic Steel Corporation.
 - d. Triangle PWC, Inc.
 - e. Youngstown Sheet & Tube.
 - f. Wheatland.
- 3. Flexible Metal and Liquidtight Flexible Metal:
 - a. AFC.
 - b. Alflex
 - c. Anaconda Metal Hose.
 - d. Electri-Flex Company.
 - e. Flexi-Guard, Inc.
 - f. Triangle PWC, Inc.
 - g. Wheatland.
- 4. Raceway Fittings:
 - a. Appleton Electric Company.
 - b. Crouse Hinds.
 - c. Efcor Division.
 - d. ETP-Uni-Couple.
 - e. O. Z. Gedney Company.
 - f. Racor, Inc.
 - g. Republic Steel Corporation.
 - h. Steel City.
 - i. Thomas and Betts.
- B. UL Label: All electrical raceways and fittings shall be UL-listed and labeled.
- C. NEMA Compliance: All electrical raceways and fittings shall comply with NEMA standards applicable to raceway construction.
- D. NEC Compliance: All electrical raceways and fittings shall comply with NEC requirements applicable to construction and installation.

1.5 SUBMITTALS:

- A. Shop drawing submittals shall include, but not be limited to, the following:
 - 1. The Contractor shall submit to the Engineer for review, a list of the proposed manufacturers of electrical raceways and fittings selected from the manufacturers listed herein. The Contractor may install conduit and fittings furnished by any manufacturer listed on the approved submittal.

2. Cut sheets of electrical raceways and fittings.
3. Manufacturers data on manholes, pull boxes and accessories.
4. Additional information as required in Section 16002.

1.6 STORAGE AND HANDLING:

- A. Handle raceways and fittings carefully to avoid damage, breaking, denting and scoring. Damaged materials shall not be installed.
- B. Store raceways and fittings in a clean dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. General:
 1. Provide metal conduit, tubing, and fittings of the type, grade, size, and weight (wall thickness) as shown and required for each service. Where type and grade are not indicated, provide proper selection determined by this Section to fulfill the wiring requirements and complying with the NEC for electrical raceways.
 2. For each electrical raceway system indicated, provide a complete assembly of conduit, tubing, or duct with fittings, including, but not necessarily limited to, connectors, nipples, couplings, expansion fittings, bushings, locknuts, other components and accessories as needed to form a complete system of the type indicated.
 3. Conduit fittings shall be designed and approved for the specific use intended. Conduit fittings, including flexible, shall have insulated throats or bushings. Rigid conduits shall have insulated bushings, except insulated throat grounding bushings shall be used on all conduits without ground conductors and where required by N.E.C. Article 250.
- B. Rigid Steel or Intermediate Metal Conduit: Rigid Steel shall be UL 6 and ANSI C80.1, hot-dipped galvanized steel. Intermediate Steel shall be UL 1242 and ANSI C80.6, hot-dipped galvanized steel. Both ends of conduits shall be threaded with factory-installed thread protectors. Fittings shall be threaded Type UL 6/1242 and ANSI C80.1 and C80.6, hot-dipped galvanized steel. Expansion fittings shall be OZ Type "DX", Appleton Type "XJ", Crouse-Hinds Type "XC" or an approved equal and shall have bonding jumpers.
- C. Electrical Metallic Tubing: Shall be UL 797 and ANSI C80.3 galvanized steel with plain ends. Fittings, couplings and connectors shall be UL 797 and ANSI C80.4 galvanized steel type. Fittings, couplings and connectors shall be compression type with machine steel body and nut. All EMT connectors shall have insulated throats or bushings.
- D. Flexible Conduit:
 1. Flexible Metal Conduit: UL 1, zinc-coated steel
 2. Flexible Metal Conduit Fittings: UL 1, zinc-coated steel, insulated throat.
 3. Liquidtight Flexible Metal Conduit: Liquidtight flexible metal conduit comprised of single strip, continuous, flexible, interlocked, double-wrapped steel, galvanized inside and outside; forming smooth internal wiring channel; with liquidtight jacket of flexible polyvinyl chloride (PVC) or neoprene.
- E. Liquidtight Flexible Metal Conduit Fittings: UL 1, liquidtight, zinc-coated steel, neoprene gaskets and O-rings, insulated throat.

- F. Conduit Tubing Accessories: Provide ANSI/NEMA FB I conduit and tubing accessories including straps, hangers and expansion joints as recommended by the conduit and tubing manufacturer and as specified in this Section.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Install electrical raceways and fittings as shown, in accordance with the manufacturer's written instructions, the applicable requirements of the NEC, and in accordance with recognized industry practices to ensure that products serve the intended function. Complete electrical raceway installation before starting the installation of wire and cable.
- B. Conduit Size: Minimum conduit size for power wiring shall be 3/4", except that 1/2" flexible metallic conduit may be used for fixture whips. Maximum conduit size for EMT shall be 42". Minimum conduit size for control wiring shall be 3/4". Minimum conduit size for voice/data wiring shall be 3/4".
- C. Rigid Steel and Intermediate Metal Conduit: Use rigid steel or intermediate metal conduit to run all electrical raceway systems where exposed to weather; in damp or wet locations; where subject to physical damage; and where cast in concrete walls or floor slabs which have waterproof membranes and where cast in masonry walls. IMC conduit shall not be used in sizes larger than 4". Use threaded type couplings and fittings. Split type couplings and fittings are not acceptable.
- D. Electrical Metallic Tubing (EMT): Use EMT for feeder branch circuit electrical raceway systems where concealed in furred ceilings or in walls; exposed inside where not exposed to physical damage; or cast in concrete walls or floor slabs which do not have waterproof membranes. EMT conduit shall not be installed where exposed to weather or in wet locations. Use compression type fittings, couplings and connectors made-up tight for for all conduit sizes. Use watertight fittings, couplings and connectors where required. Where cast in concrete and floor slabs, use concrete tight fittings, couplings and connectors and terminate conduit in a box cast in concrete, or with rigid steel conduit turnouts from concrete. Crimp type fittings, couplings and connectors are not acceptable.
- E. Flexible Metal: Use flexible metal conduit with internal ground wire and fittings for lay-in lighting fixture connections and for other electrical equipment connections where subject to movement and vibration, but where liquid-tight flexible metal conduit is not specified. Use flexible metal conduit in such lengths as required, 6'-0" maximum length and 3'-0" minimum length. 1/2" diameter conduit may be used for lighting fixture "pigtails".
- F. Liquidtight Flexible Metal: Use liquidtight flexible metal conduit and fittings for all motor connections and for other electrical equipment connections where subject to movement and vibration and when subject to one or more of the following conditions: exterior location; moist or humid atmosphere where condensate can be expected to accumulate; corrosive atmosphere; subject to water spray; subject to dripping oil, grease or water. Install internal ground wire in flexible conduit with grounding bushings. Maximum length shall be 6'-0" and minimum length shall be 3'-0".

3.2 INTERIOR CONDUIT SYSTEM:

- A. Ground all metallic conduit in accordance with the requirements of the latest edition of the NEC.
- B. Install all conduit as a complete system without conductors, continuous from outlet to outlet and from fitting to fitting. Make up threaded joints of conduit carefully in such a manner as to ensure a tight joint. Field-cut threads shall be cold-galvanized after cutting. The entire conduit system shall be secured at all joints and boxes in such a manner that each system shall be electrically continuous throughout. Fasten the entire conduit system securely into position. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of four quarter bends, including those bends located immediately at the outlet or fitting. Install approved expansion fittings in all conduit runs as specified in paragraph 3.2/P.

- C. Ream all ends of conduit properly to remove rough edges. Whenever a rigid steel or IMC conduit enters a switchboard, panelboard, enclosure, or box, it shall be securely fastened by the use of a locknut inside and outside and an approved insulating bushing shall be installed. Insulated grounding bushings shall be installed on all conduits without ground conductors and where required by NEC Article 250. Whenever an EMT conduit enters a switchboard, panelboard, enclosure, or box, it shall be securely fastened by use of an insulated throat connector or a connector with an insulating bushing. Lay out and install all conduit systems as to avoid all other services or systems, the proximity of which may prove injurious to the conduit or the wires or conductors which the conduit confines.
- D. Conceal conduit systems in finished areas. Concealed metallic conduits shall be run in a direct manner, basically parallel to, and at right angles with the lines of the building, and with as long a bend as possible. Conduit may be exposed in mechanical rooms and where otherwise shown or indicated. On exposed systems, run the conduit parallel or perpendicular to the structural features of the building and rigidly support with malleable iron conduit clamps at intervals as required by NEC or on conduit racks, neatly racked and bent in a smooth radius at corners insofar as practicable. All bends shall be field-made using an approved bending machine designed for the purpose, or using standard ells having a radius not less than that shown in Chapter 9, Table 2 of the National Electrical Code, and with approved fittings or connectors. All bends shall be free from dents or flattening.
- E. All conduit shall be run without traps. Where traps are unavoidable, a junction or pull box shall be placed at the low point. Metallic conduit systems which are exposed to the weather or water shall be made watertight. As soon as conduit has been permanently installed in place, conduit shall be capped or plugged with standard accessories. All metallic conduit shall be swabbed after plaster and dry wall is finished and dry.
- F. Support exposed raceway or grouped concealed raceways on galvanized channel using compatible galvanized fittings (bolts, beam clamps and similar items) and galvanized threaded rod pendants to secure raceway to channel and channel to structure. Support single conduit runs using a properly sized galvanized conduit hanger with galvanized closure bolt/nut and threaded rod. Support-spacing shall not exceed 10' apart for all EMT/IMC conduit and rigid conduit 2" and smaller and 15' apart for rigid conduit 2-1/2" and larger and within 3' from boxes and changes in direction. Support flexible conduit on maximum 4-1/2' centers and within one foot (1') of boxes. All raceway support system materials shall be galvanized and manufactured by Kindorf, Unistrut, Superstrut, Caddy, or Spring Steel Fasteners, Inc. Provide chrome or nickel-plated escutcheon plates on all conduit passing through walls and ceilings in finished areas.
- G. Support 1" and smaller EMT conduit concealed in ceiling cavities with No. 13 AWG galvanized iron wire pendants, spaced not to exceed 10' apart and 3' from boxes and changes in direction, secured to conduit with clips and properly secured to structure. Perforated strap shall not be used for conduit supports.] [Branch circuit EMT conduit 3/4" trade size and smaller may be suspended using "caddy clips" attached to the ceiling support system in a manner acceptable to the ceiling contractor. Support conduit sized one inch (1") and larger as described in Paragraph F.]
- H. Make all joints and connections to ensure mechanical strength and electrical continuity. [PVC conduit shall be joined, or have fittings attached, by using a fusing (solvent) compound recommended by and applied as instructed by, the conduit manufacturer.]
- I. Run conduit to avoid proximity to heat producing equipment, piping and flues, keeping a minimum of 8" clear. Whenever possible, install horizontal raceway runs above water piping. Unless shown otherwise, do not install conduit horizontally in concrete slabs without written approval. All roof penetrations shall be made in adequate time to allow the roofer to make proper flashings.
- J. Carefully review architectural, structural, mechanical, plumbing, and electrical Drawings and place boxes and conduit to avoid conflicts with structural members or other general construction.
- K. Conduit shall not be embedded in structural slabs without prior written permission from the Structural Engineer. Conduits embedded in structural slabs shall be installed in the middle of the slab below the

top and above the bottom reinforcing steel. Maintain a minimum concrete coverage of one inch (1") except where penetration is made.

- L. Furnish sleeves for timely placing in construction for all conduit passing through concrete walls, partitions, beams, floors, and roofs while same are under construction.
- M. All conduit passing through the housing on connected equipment, shall pass through a cleanly cut hole protected with an approved grommet.
- N. Metallic conduit installed below grade shall have its entire length painted with two coats of protective finish unless encased in concrete. Each coat shall consist of 5 mils of PPG "Coat Cat Epoxy Coating" applied in accordance with the manufacturer's recommendations. The entire length of metallic conduit, including fittings, shall be protected to a point 6" above finished grade (or concrete slab).
- O. Coordinate locations of raceways in fire rated partitions so as not to affect the fire rating of the partition. Notify the Architect in writing where additional construction is required to maintain the partition fire rating.
- P. Install expansion fittings in all conduit as follows:
 - 1. All conduits crossing building expansion joints; unless some other form of thermal expansion compensation is approved in writing by the Engineer.
 - 2. All conduit straight runs in excess of 200' and on 400' centers in all longer conduit runs.
 - 3. Conduits entering environmental rooms.
 - 4. Locations subject to thermal expansion and as required by NEC.
 - 5. Unless expansion fitting has an integral bonding braid an external braid, approved for the purpose, shall be installed around the fitting.

3.3 VOICE/DATA AND SIGNAL SYSTEM RACEWAYS:

- A. General: Conduit shall be installed in accordance with the previous specified requirements for conduit and tubing and with the additional requirements that no length of run shall exceed 100' and 3/4" trade sizes, and 150' for one inch (1") or larger trade sizes, and shall not contain more than two 90 degree bends or the equivalent thereof. Pull or junction boxes shall be installed to comply with these requirements. Empty voice/data and signal system raceways shall include a pull wire or cord, as described in Paragraph 3.8 hereinbelow.

3.4 EMPTY CONDUIT RACEWAY SYSTEMS:

- A. General: Empty conduit in which wire is to be installed by others shall have pull wires installed. The pull wire shall be No. 14 AWG zinc-coated steel, or plastic having not less than 200 pounds tensile strength. Not less than 12" of slack shall be left at each end of the pull wire.

3.5 IDENTIFICATION:

- A. General: Refer to Section 16100, "Basic Materials and Methods", for requirements concerning painting and marking of raceways and fittings.

END OF SECTION

SECTION 16112
ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide electrical box and fitting work as shown, scheduled, indicated, and as specified.
- B. Types: The types of electrical boxes and fittings required for the project include, but are not limited to, the following:
 - 1. Outlet boxes.
 - 2. Junction boxes.
 - 3. Pull boxes.
 - 4. Cabinets.
 - 5. Conduit bodies.
 - 6. Bushings.
 - 7. Locknuts.

1.3 STANDARDS:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
 - 1. ANSI/NEMA OS 1 Sheet Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
 - 2. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).

1.4 QUALITY ASSURANCE:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
 - 1. Interior Outlet Boxes:
 - a. Appleton Electric Company.
 - b. Arrow Conduit and Fittings Corporation.
 - c. Bowers.
 - d. O. Z. Gedney Company.
 - e. National Electric Products Company.
 - f. Raco
 - g. Star Sheet Metal.

- h. Steel City, Midland-Ross Corporation.
- 2. Weatherproof Outlet Boxes:
 - a. Appleton Electric Company.
 - b. Crouse-Hinds Company.
 - c. Harvey Hubbell, Inc.
 - d. Pyle-National Company.
 - e. Racco
 - f. Red Dot.
- 3. Junction and Pull Boxes:
 - a. Appleton Electric Company.
 - b. Arrow-Hart, Inc.
 - c. O. Z. Gedney Company.
 - d. General Electric Company.
 - e. Hoffman Engineering Company.
 - f. Keystone Columbia, Inc.
 - g. Square D Company.
 - h. Unity.
- 4. Cabinets:
 - a. General Electric Company.
 - b. Hoffman Engineering Company
 - c. Square D Company.
 - d. Westinghouse.
- 5. Conduit Bodies:
 - a. Appleton Electric Company.
 - b. Crouse-Hinds Company.
 - c. Killark Electric Manufacturing Company.
 - d. Pyle-National Company.
- 6. Bushings, Knockout Closures and Locknuts:
 - a. Allen-Stevens Conduit Fittings Corporation.
 - b. Allied Metal Stamping, Inc.
 - c. Appleton Electric Company.
 - d. Carr Company.
 - e. Racco, Inc.
 - f. Steel City, Midland-Ross Corporation.
 - g. Thomas and Betts Company, Inc.

- B. UL Label: All electrical boxes and fittings shall be UL-labeled.

1.5 **SUBMITTALS:**

- A. Shop Drawing submittals shall include, but not be limited to, the following:
 - 1. The Contractor shall submit to the Engineer for review, a list of proposed manufacturers of electrical boxes and fittings selected from the manufacturers listed herein. The Contractor may install electrical boxes and fittings furnished by any manufacturer listed on the approved submittal.
 - 2. Cut sheets of electrical boxes and fittings.
 - 3. Cut sheets on cabinets.
 - 4. Drawings of any special boxes which must be fabricated, including construction details.
 - 5. Additional information as required in Section 16002.

1.6 **STORAGE AND HANDLING:**

- A. Handle electrical boxes and fittings carefully to avoid damage, breaking, denting, and scoring. Damaged equipment or materials shall not be installed.
- B. Store electrical boxes and fittings in a clean dry space and protect from weather.

PART 2 - PRODUCTS

2.1 **FABRICATED MATERIALS:**

- A. Interior Outlet Boxes: Provide galvanized steel interior outlet wiring boxes, of the type, shape, and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices. Provide "gang" boxes where devices are shown to be grouped.
 - 1. Type for Various Locations:
 - a. Ceilings: 4" square, 2-1/8" deep.
 - b. Standard Partitions, Where 1/2" and 3/4" Conduits are Employed: 4" square by 2-1/8" deep boxes with one-gang or two-gang plaster covers shall be used.
 - c. Thin Partitions Measuring 3-1/2" or Less: 4" square by 1-1/2" deep boxes with one-gang or two-gang covers shall be used.
 - d. Standard Partitions, Where Conduits of a Size Greater than 3/4" are Employed: 4-11/16" square by 2-1/8" deep boxes with one-gang or two-gang plaster covers shall be used.
 - e. Masonry Walls: Galvanized switch boxes made especially for masonry installations; depths of boxes must be properly coordinated for each specific installation.
 - f. Poured Concrete: Provide plenum type boxes without any holes and with reset knockouts. Where extension rings are used to offset conduit between wall reinforcing steel, joint between extension ring and box shall be sealed to prevent concrete from entering box during pour.
 - g. Return Air Ceiling Plenum Boxes: In return air ceiling plenums, where 1/2" and 3/4" conduits are employed, 4" square by 2-1/8" deep plenum boxes shall be used.
 - h. Surface: Type "FS" or Type "FD" box with surface cover.
 - i. Special: Where above types are not suitable, furnish boxes to suit the use taking into account space available, appearance, and Code requirements.

2. Switch Boxes:
 - a. One-gang/Two-gang Switch Boxes in Standard Walls or Partitions: Shall be 3" x 2" square corner boxes by 2-1/2" deep with appropriate mounting bracket for attachment to studs.
 - b. One-gang/Two-gang Switch Boxes in Thin Walls or Partitions: Shall be 3" x 2" square corner boxes by 1-1/2" deep with appropriate mounting bracket for attachment to studs.
 - c. Three-gang and Up Switch Boxes in Standard Walls or Partitions: Shall be 4-1/2" wide solid gang boxes, with appropriate "gang" plaster covers as required.
3. Interior Outlet Box Accessories: Provide outlet box accessories as required for each installation, including proper covers or wall device plates, mounting brackets, wallboard hangers, extension rings, plaster rings for all boxes in plaster construction, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used, and meeting requirements of individual wiring situations.
- B. Weatherproof Outlet Boxes: Provide hot-dipped galvanized cast iron weatherproof outlet wiring boxes, of the type, shape, and size, including depth of box, with threaded conduit ends, cast metal coverplate with spring-hinged waterproof caps suitably configured for each application, including face plate gasket and corrosion resistant fasteners.
- C. Junction and Pull Boxes: Provide galvanized sheet steel junction and pull boxes, with screw-on covers and welded seams with stainless steel nuts, bolts, screws and washers, of the type, shape, and size, to suit each respective location and installation.
 1. Type for Various Locations:
 - a. 100 Cubic Inches in Volume or Smaller: Standard outlet boxes with stamped knockouts.
 - b. 150 Cubic Inches in Volume or Larger: Code gauge steel with sides formed and welded, screw covers unless shown to have hinged doors. Hinged doors with locking device same as furnished on panelboards. Knockouts factory-stamped or formed in field with a cutting tool to provide a clean symmetrically-cut hole.
 - c. Exterior or Wet Areas: Weatherproof galvanized steel construction with proper gaskets and corrosion resistant fasteners. A parking garage is considered a wet area.
- D. Cabinets: Provide cabinets of size and style noted on the Drawings.
 1. Cabinet fronts shall be steel. Other sheet metal for boxes shall be galvanized steel. Details of construction and methods of assembly shall meet the requirements of the Underwriters' Laboratories, Inc.
 2. The panel doors of cabinets shall be provided with locks. Single panel doors of cabinets shall have a lock with ring pull. Single doors 48" or longer and pairs of doors shall have a lock with vertical bolt operation, 3-point locking. Locks shall be keyed alike. Two keys shall be supplied for each cabinet.
 3. Cabinets shall have concealed hinges.
 4. Flush-mounted trim shall be fastened to cabinet with adjustable trim clamps. Fasteners for cabinets in concealed areas shall be concealed.
 5. Each voice/data cabinet shall be equipped with 3/4" plywood backboard covering entire inside rear surface and painted matte white.
 6. Trims and doors shall have a suitable primer coat and a finish coat of the manufacturer's standard color.

- E. Conduit Bodies: Provide galvanized cast metal conduit bodies, of the type, shape and size, to suit each respective location and installation, constructed with threaded conduit ends, removable cover, and corrosion resistant screws.
- F. Bushings, Knockout Closures, and Locknuts: Provide corrosion resistant punched-steel box knockout closures, conduit locknuts, gasketed locknuts, insulated conduit bushings and insulated grounding conduit bushings of the type and size to suit each respective use and installation.

PART 3 - EXECUTION

3.1 INSTALLATION OF BOXES AND FITTINGS:

- A. Install electrical boxes and fittings as shown, in compliance with NEC requirements, or in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that the boxes and fittings serve the intended purposes. Where boxes are concealed in exterior walls, the continuity of the vapor barrier shall be maintained behind the box.
- B. Use outlet and switch boxes for junctions on concealed conduit systems except in utility areas where exposed junction or pull boxes may be located.
- C. Determine from the Drawings and by actual determination on the site, the exact location of each outlet. The outlet locations shall be modified from those shown to accommodate changes in door swings or to clear other interferences that may arise from job construction details, as well as modification to center them within room spaces. These modifications shall be made with no change in contract price and shall be a matter of job coordination. Check these conditions throughout the entire job and notify the Architect of discrepancies, as they may occur, to verify the modifications, if any, before proceeding with the installation of the work. Set wall boxes in advance of wall construction, blocked in place and secured. Set all wall boxes flush with the finish and install extension rings as required to extend boxes to the finished surfaces of special furring or wall finishes.
- D. Install outlet boxes at heights as specified in Section 16100, "Basic Materials and Methods".
- E. On exposed conduit systems provide pull boxes, junction boxes, wiring troughs, and cabinets wherever necessary for proper installation of various electrical systems.
- F. Provide weatherproof boxes for interior and exterior locations exposed to weather or moisture.
- G. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- H. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.
- I. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly imbed boxes in concrete or masonry. Boxes shall not be permitted to move laterally. Boxes shall be secured between two studs. Two gang (single or double device) boxes may be connected to one stud using an approved bracket, except where specific dimensioned locations must be met. Box recessing depths shall comply with Article 314.24 of the National Electrical Code.
- J. Boxes for any conduit system shall not be secured to the ceiling system, HVAC ductwork, or mechanical piping.
- K. Provide junction and pull boxes for feeders and branch circuits where shown and where required by the NEC, regardless of whether boxes are shown or not.
- L. Coordinate locations of boxes in fire rated partitions and slabs so as to not affect the fire rating of the partition or slab. Notify the Architect in writing where modifications or additional construction are required to maintain the partition or slab fire rating.
- M. All junction boxes in accessible locations shall be marked with a permanent marker to identify the circuit(s) within the box.
- N. Junction boxes utilized for emergency circuits shall be painted red in color.

- O. Do not install boxes back-to-back in walls. Provide minimum 6" separation. Provide minimum 24" separation in acoustic-rated walls. If boxes are connected together, install flexible connection between the boxes and pack openings with fiberglass.
- P. The following requirements shall apply to exposed as well as concealed conduit systems when "gang" boxes shall be used. These "gang" boxes shall have dimensions which are not smaller than those shown in the following table:

IN GANG	NUMBER SIZE
3	4-1/2" x 8-5/8"
4	4-1/2" x 10-1/2"
5	4-1/2" x 10-1/2"
6	4-1/2" x 14"

- Q. Switch boxes shall not be used as junction boxes.
- R. Install boxes in walls without damaging wall insulation.
- S. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- T. In inaccessible ceiling areas, position outlets and junction boxes within 6" of recessed luminaire, to be accessible through luminaire ceiling opening.
- U. Outlet boxes supporting fixtures shall be securely anchored in place in an approved manner. Support outlet boxes and fixtures in acoustic ceiling areas from building structures, not from acoustic ceilings. Light fixture outlets shall be coordinated with mechanical and architectural equipment and elements to eliminate conflicts and provide a workable neat installation.
- V. Set floor boxes level and flush with floor. Install nonrated floor boxes as detailed on the Architectural Drawings.
- W. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.
- X. Where outlet or switch boxes are not supported from studs or joists directly, they shall be supported by expandable clip type bar hangers, Appleton Catalog No. SX-18 or SX-26. In no case shall conduit be used to support switch or outlet boxes.
- Y. Outlet boxes in plaster partitions shall be "shallow-type" set flush in wall so there is at least 5/8" plaster covering back of box.
- Z. Refer to Section 16100 for applicable painting and marking of electrical boxes.

END OF SECTION

SECTION 16115

ELECTRICAL GUTTERS AND WIREWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide electrical gutter and wireway work as shown, scheduled, indicated, and as specified.
- B. Types: The types of electrical gutters and wireways required for the project include, but are not limited to, the following:
 - 1. Electrical wiring gutters and wireways.

1.3 STANDARDS:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
 - 1. NEC Article 362 Wireways.
 - 2. NEC Article 374 Auxiliary Gutters.
 - 3. NEC Article 374 Multioutlet Assembly.

1.4 QUALITY ASSURANCE:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
 - 1. Gutters and Wireways:
 - a. General Electric Company.
 - b. Hoffman Manufacturing Company.
 - c. Square D Company.
 - d. Westinghouse.
- B. UL Label: All gutters, wireways, and raceways used for power wiring shall be UL-labeled.

1.5 SUBMITTALS:

- A. Shop Drawing submittals shall include, but not be limited to, the following:
 - 1. Cut sheets of surface-mounted and over floor raceways, gutters, wireways, fittings, connectors, associated accessories and mounting hardware.
 - 2. Additional information as required in Section 16002.

1.6 STORAGE AND HANDLING:

- A. Handle gutters and wireways carefully to avoid damage, breaking, denting, and scoring. Damaged equipment or materials shall not be installed.
- B. Store gutters and wireways in a clean dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 ELECTRICAL GUTTERS AND WIREWAYS:

- A. General: Provide galvanized steel electrical gutters and wireways in the types and sizes indicated, minimum 16 gauge thickness, with rounded edges and smooth surfaces and knock-outs; constructed in compliance with applicable standards; and with additional features as indicated or required. Provide hinged or removable cover on raceway where noted on drawings. All power wiring raceways shall have a cover.
- B. Size: Provide size as indicated, where size is not indicated, construct in accordance with the NEC and other applicable standards.
- C. Accessories: Provide gutter and wireway accessories where indicated or required, constructed of same metal and finish as gutters or wireways.
- D. Supports: Provide gutter and wireway supports where indicated or required, conforming to the NEC, as recommended by the manufacturer.
- E. Fittings: Fittings shall be so constructed to continue the "lay-in" feature through the entire installation.
- F. Finish: Provide all sheet metal parts with a rust inhibiting phosphatizing primer coating and finished in gray enamel. All hardware shall be cadmium plated to prevent corrosion.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Install gutters and wireways where shown, in accordance with the manufacturer's written instructions, NEC, NECA's "Standard of Installation", and with recognized industry practices to ensure that the gutters, wireways and surface raceways comply with the specified requirements and serve the intended purposes. Comply with requirements of NEMA and the NEC pertaining to installation of electrical gutters.
- B. Finishing: Remove burrs and sharp edges of gutters and wireways wherever these could possibly be injurious to wiring insulation or jacket.
- C. Grounding: Electrically ground gutters and wireways to ensure continuous electrical conductivity.
- D. Cables:
 - 1. Complete gutter and wireway installation before starting the installation of cables.
 - 2. Provide sufficient space to permit access for installing, splicing, and maintaining the cables.
 - 3. Provide slack in voice/data and power cables in raceways, where noted on the Drawings, to provide flexibility for future taps and modifications.
 - 4. Provide retaining clips on minimum 5'centers where the raceway orientation will allow cables to shift or fall out when the cover is opened and removed.
- E. Mounting: Mount surface raceways in accordance with the manufacturer's UL-listed installation instructions and the requirements of the local Electrical Inspection Department.

3.2 **IDENTIFICATION:**

- A. Refer to Section 16100, "Basic Materials and Methods", for applicable painting and nameplates for gutters and wireways.

END OF SECTION

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SECTION 16120

300/600 VOLT CABLE, WIRE AND CONNECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide 300 and 600 volt electrical cable, wire, and connector work as shown, scheduled, indicated, and as specified.
- B. Types: The types of 300 and 600 volt cables, wire, and connectors required for the project include, but are not limited to, the following:
 - 1. 600 volt building wire and cable.
 - 2. 600 volt building wire and cable connectors.
 - 3. 300 volt control/signal wire and cable.
 - 4. 300 volt control/signal wire and cable connectors.
- C. Application: The applications for cable, wire, and connectors required on the project are as follows:
 - 1. Power distribution circuitry.
 - 2. Lighting branch circuitry.
 - 3. Appliance, receptacle and equipment branch circuitry.
 - 4. Motor branch circuitry.
 - 5. Control wiring.

1.3 STANDARDS:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
 - 1. NEMA WC 3 Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - 2. NEMA WC 5 Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - 3. ASTM B3 Standard for Specification for Soft or Annealed Copper Wire for Electrical Purposes.
- B. Where application of applicable codes, Trade Association standards, or publications appears to be in conflict with the requirements of this Section, an interpretation shall be obtained from the Architect/Engineer.

1.4 **QUALITY ASSURANCE:**

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. 600 Volt Building Wire and Cable:
 - a. Aetna.
 - b. Alcan.
 - c. American Insulated Wire Corporation.
 - d. Cerro Wire and Cable Company.
 - e. Essex Group, Inc.
 - f. General Cable Corporation.
 - g. General Cable.
 - h. Okonite Company.
 - i. Republic Wire.
 - j. Southwire Company.
 - k. United Copper.
2. Type MC Cable:
 - a. AFC.
3. 300 Volt Wire and Cable:
 - a. Alpha.
 - b. Belden.
 - c. West Penn.
4. Connectors:
 - a. AMP, Inc.
 - b. Buchanan.
 - c. Burndy Corporation.
 - d. O. Z. Gedney Company.
 - e. General Electric Company.
 - f. Ideal Industries, Inc.
 - g. NSI.
 - h. Mac Products, Inc.
 - i. Minnesota Mining and Manufacturing Company.
 - j. Thomas & Betts Company.

B. UL Label: All cable, wire, and connectors shall be UL-labeled.

1.5 **SUBMITTALS:**

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. The Contractor shall submit to the Engineer for review, a list of the proposed manufacturers of wire and cable, cable lugs, cable connectors and termination fittings listed herein. The Contractor may install wire and cable, cable lugs, cable connectors and termination fittings furnished by any manufacturer listed on the approved submittal.
2. Cut sheets on all 300 and 600 volt conductors with manufacturers name, ratings and capacities, insulation characteristics, and available colors, clearly listed.
3. Cut sheets indicating all cable lugs, termination fittings and cable connectors.
4. Cut sheets indicating types of conductor identification bands.
5. Additional information as required in Section 16002.

1.6 DELIVERY, STORAGE AND HANDLING:

- A. Provide factory-wrapped waterproof flexible barrier material for covering wire and cable wood reels, where applicable; and weather resistant fiberboard containers for factory-packaging of cable, wire and connectors, to protect against physical damage in transit. Damaged cable, wire, or connectors shall be removed from project site.
- B. Store cable, wire, and connectors in their factory-furnished coverings, and in a clean, dry indoor space which provides protection against the weather.

PART 2 - PRODUCTS

2.1 600 VOLT BUILDING CABLE, WIRE AND CONNECTORS:

- A. General: Except as otherwise indicated, provide cable, wire, and connectors of manufacturer's standard materials, as indicated by his published product information, designed and constructed as instructed by the manufacturer, and as required for the installation.
- B. Wire and Cable: Provide factory-fabricated wire and cable of the size, rating, material, and type as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. The minimum size wire to be used for power or lighting circuits shall be No. 12 copper (No. 14 for light fixture pigtails) with insulation as noted below. Minimum size for control wiring shall be No. 14 copper.
- C. Conductors: Provide soft or annealed copper wires meeting, before stranding, the requirements of ASTM B3, "Standard Specification for Soft or Annealed Copper Wire for Electrical Purposes", latest edition.
 1. Conductors for power wiring sized No. 10 AWG and smaller shall be stranded or solid at the Contractors option, except that solid conductors shall be provided where conductors are terminated under terminal screws and stranded conductors shall be provided for connections to vibrating or movable equipment. Stranded conductors may be terminated on back wired wiring devices where wiring is mechanically secured via a side screw. Conductors for control wiring sized No. 10 AWG and smaller shall be stranded, except that solid conductors or stranded conductors with UL Listed crimp on connectors shall be provided where conductors are terminated under terminal screws.
 2. Conductors sized No. 8 AWG and larger shall be stranded. Stranding shall be Class B meeting the requirements of ASTM B8, "Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft".
- D. Insulation: Insulation shall meet or exceed the requirements of UL 83, "Standard for Thermoplastic Insulated Wires".

1. Insulation for conductors sized No. 10 AWG and smaller shall be UL Type "THHN/THWN" (rated at 90°C in dry locations and 75°C in wet locations).
 2. Insulation for conductors sized No. 8 AWG and larger shall be UL Type "THHN/THWN" (rated at 90°C in dry locations and 75°C in wet locations).
 3. All wiring inside lighting fixtures shall be temperature rated per the NEC.
 4. Branch circuit wiring within 3" of fluorescent ballasts shall be temperature rated for 90°C.
- E. Connectors for Building Wire and Cable: Provide factory-fabricated, metal connectors of the size, rating, material, type, and class required for each use.

2.2 TYPE MC CABLE:

- A. Metal-clad Type MC Cable: At the Contractor's option, and subject to the approval in writing by the Engineer and where allowed in the NEC, Type MC cable may be used for receptacle circuits, switch legs, and lighting fixture connections to the junction box grid system in finished areas. Type MC cable shall consist of two No. 12 AWG copper THHN insulated phase conductors and one No. 12 AWG green THHN insulated copper ground conductor, all enclosed in cable tape and an aluminum or galvanized steel flexible armor. Type MC cable terminations shall be made using approved anti-short fittings.

2.3 300 VOLT CONTROL/SIGNAL CABLE, WIRE AND CONNECTORS:

- A. General: Except as otherwise indicated, provide cable, wire, and connectors of manufacturer's standard materials, as indicated by his published product information, designed and constructed as instructed by the manufacturer, and as required for the installation.
- B. Wire and Cable: Provide factory-fabricated wire and cable of the size, rating, material, and type as indicated for each use.
- C. Conductors: Provide soft or annealed copper wires as individual conductors, twisted together or shielded, where required, and meeting, before stranding, the requirements of ASTM B3, "Standard Specification for Soft or Annealed Copper Wire for Electrical Purposes", latest edition.
- D. Conductor Gauge: Provide conductor gauge as required for the application with a minimum of 24 AWG. Conductors shall be stranded or solid as required by the application or manufacturer.
- E. Insulation: Insulation shall meet or exceed the requirements of UL 83, "Standard for Thermoplastic Insulated Wires", and the requirements of NEC Article 725 for Class 2 wiring.
1. Insulation shall be rated for a maximum working voltage of 300 volts; PVC jacket; UL-listed.
 2. Insulation of cables used in environmental air spaces shall be nonmetallic jacket UL-listed for use in air plenums.
- F. Connectors: Provide factory-fabricated, metal connectors of the size, rating, material, type, and class required for the application.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Install electrical cable, wire and connectors as shown, in accordance with the manufacturer's written instructions, the applicable requirements of NEC, the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.

B. Coordination:

1. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.
2. Installer shall examine the areas and conditions under which cable, wire and connectors are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect wire and cable for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

C. 600 Volt Building Wire and Cable:

1. Pull all conductors together when more than one conductor is being installed in a raceway. Where more than nine power conductors are installed in a single conduit, a minimum 50% derating factor shall be applied. Refer to NEC Table 310-15(B)(2)(a).
2. 2 HR rated cables shall be installed in conduit and supported per UL to provide 2 hour rating.
3. Mains and feeders are to be run their entire length in continuous pieces without joints or splices, unless otherwise indicated or noted.
4. Conductors may be run in multiple on sizes No. 1/0 AWG through 600 kcmil inclusive, provided all multiple conductors are the same size, length, and type of insulation, and are so arranged and terminated as to ensure equal division of the total current between all conductors involved.
5. Before any wire is pulled into any conduit, the conduit shall be thoroughly swabbed in such a manner as to remove all foreign material and to permit the wire itself to be pulled into a clean, dry conduit.
6. Cables shall be selected on the basis of their purpose and UL-listing. Generally, use Types "THWN" and "THHN" in building interiors and other dry locations. Outdoors and underground in raceways, use Type "THWN". Conductors subject to abrasion, such as in lighting poles, shall be Type "THWN" or "THHN".
7. Only non-wax based cable lubricants may be use as manufactured by American Polywater or approved equal may be used as a lubricant where necessary. Wire pulling lubricant shall not be used when installing branch circuit conductors from panelboards with "isolation" transformers.
8. No conductor smaller than No. 12 AWG shall be used for power or lighting purposes (except light fixture tails). Switch legs shall be No. 12 AWG. Control circuit wiring may be No. 14 AWG minimum, and shall not be run in same conduit with power wiring.
9. For 120 volt, 20 amp branch circuits with a length of 75' or more to the homerun junction box or first outlet, provide minimum No. 10 AWG conductors to the homerun junction box or first outlet. Where the additional circuit length from the homerun junction box or first outlet to the last outlet exceeds 75', provide minimum No. 10 AWG conductors to the last outlet.
10. For 208 volt, 20 amp branch circuits with a length of 100' or more, provide No. 10 AWG conductors for the entire branch circuit. For 208 volt, 30 amp branch circuits with a length of 100' or more, provide No. 8 AWG conductors for the entire branch circuit.
11. For 277 volt, 20 amp branch circuits with a length of 150' or more, to the first outlet provide No. 10 AWG conductors to the center of the load (minimum first outlet, where there is only one outlet).
12. Conductors for lighting and power branch circuits shall be of such a size that the drop in potential from the panelboards to the farthest point on the circuits shall not exceed 2% at maximum load and 70% power factor, at 120/208 volts and 1% at maximum load at 277/480 volts.
13. Lighting fixtures shall not be used for raceways for circuits other than parallel wiring of fixtures.

14. Conductors for connection to individual light fixtures in grid type ceilings from their associated junction boxes, shall be 3 No. 14 AWG THHN copper 600 volt, solid conductors in 72" long 3/8" flexible metal conduit fixture-tails, or by Type MC cable fixture tails where permitted by the local authority having jurisdiction, in lengths not to exceed 8'.
15. All conductors in vertical conduits or raceways shall be supported in the manner set forth in the latest edition of the National Electrical Code.
16. Do not use a pulling means, including fish tape, cable, or rope which can damage the raceway.
17. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
18. Install exposed wire and cable, parallel and perpendicular to surface or exposed structural members and follow the surface contours, where possible.
19. All wire on this project shall be new, unused, in good condition, and shall be delivered in standard coils, package, or rolls. Samples of all wire shall be submitted by the Contractor when requested by the Engineer for the purpose of determining acceptability of the wire.
20. Wire which has been rejected by the Engineer shall not be used again. Decisions as to the quality of the wire furnished and the acceptance of such wire shall be made by the Owner's duly authorized representative.
21. Do not permit conductors entering or leaving a junction or pull box to deflect so as to cause pressure on the conductor insulation.
22. Splices and taps on branch circuits shall occur only when such circuits divide as shown on the drawings and shall consist of one "through" circuit to which the circuit shall be spliced or tapped. Through wiring of receptacles and other devices is not allowed, except for GFI devices noted on the drawings to protect downstream devices..
23. No splices or taps shall be made in any conductor except in outlet boxes, junction boxes, splice boxes, or other devices and equipment in exposed and accessible locations approved for the purpose by the latest edition of the NEC.
24. All wire connections or splices on conductors No. 18 AWG through No. 8 AWG shall be made with pre-insulated spring type connectors. No other type of mechanical connector shall be used for No. 8 AWG and smaller conductors.
25. All No. 6 AWG and larger copper conductors terminated on the "load" side lugs of all switchboard circuit devices, and the "line" and "load" side lugs of all other devices shall be terminated with set-screw type pressure connectors approved for the purpose.
26. All No. 6 AWG and larger copper conductors which are to be spliced or tapped in wireways, gutters, or junction boxes shall be spliced or tapped using hydraulically applied, high conductivity compression connectors, or with set-screw type pressure connectors approved for the purpose, using 3-M electrical tape or manufactured connector covers approved for the purpose.
27. The manufacturer's recommended installing tool shall be used for the installation of all hydraulically applied compression type lugs or connectors.
28. Connections to devices (receptacles, switches, etc.) shall be made with individual conductors. The devices shall not be used for "feed-thru" purposes. Where "feed-thru" conditions exist, use "pig-tail" splices as described above. Color coding of "pig-tail" splices shall conform to Section 16100, "Basic Materials and Methods".
29. Support cables above accessible ceilings; do not rest on ceiling tiles. Use spring metal clips or plastic cable ties to support cables from structure. Include bridle rings or drive rings.

30. Multiple circuit wires in bundles or harnesses terminating in control panels, switchboards, panelboards, etc., shall be loosely bundled, trained, and laced to achieve a neat and workmanlike appearance.
31. Surplus wire shall be trimmed to proper length. Do not fold and stuff surplus wires into wiring gutters.
32. Wires exiting harness shall be trained at 90 degree angles to termination point.
33. Refer to Section 16100 for color coding and identification of conductors.

D. Type MC Cable:

1. Type MC cable may be used, where approved in writing by the Engineer and allowed in the NEC: for drops in partitions to receptacles; for single circuit branch circuit wiring to individual receptacles; for lay-in fixture pigtails (10' maximum length); for switch leg drops; from fixture junction boxes to nonlay-in fixtures; or for single circuit branch circuit wiring from fixture to fixture (except lay-in fixtures) and fixture to junction box.
2. Type MC cable shall not be used for branch circuit homeruns. Type MC cable shall not be used for receptacle to receptacle wiring in partitions; where more than three conductors (phase/neutral/ground) are required; where exposed; or in lengths exceeding 20'.
3. Type MC cable in partitions shall be protected in accordance with the requirements of the NEC.
4. Type MC cable shall be supported as specified herein and in accordance with the NEC.

E. 300 Volt Control/Signal Cable and Wire:

1. Install all low voltage wiring in a suitable raceway except in areas with accessible (lay-in) ceilings unless otherwise noted on Drawings or other Division 16 sections. Where cable is routed without a raceway, bundle all cables and suspend to one foot above ceiling using loop rings on 5' centers. Do not run cable loose on top of suspended ceilings. Do not attach cables to suspended ceiling supports or any mechanical, plumbing, or sprinkler piping. Conceal conduit except in mechanical rooms and areas where other conduit and piping are exposed. Fasten flexible conductors, which bridge cabinets and doors, neatly along hinge side and protect against abrasion. Tie and support the conductors neatly.
2. Remote control wires shall be no smaller than No. 14 AWG. Control wires shall be run in separate conduits. Departures from the sizes so determined shall be made only in those cases in which the National Electrical Code required the use of larger conductors. The sizes as determined from these tables shall be regarded as the acceptable minimum under all other circumstances. In no case, however, shall there be a voltage drop greater than that specified in any feeder or branch circuit. This voltage drop shall be based on the full load, 70% power factor, the total impedance drop of 60 Hz alternating current and with the reactance drop in the respective metal conduits duly considered. The Contractor may, if he deems it necessary or advisable, use larger sized conductors than those shown. Under no circumstances, however, shall the Contractor use any conductors sized in a manner which does not conform to the above mentioned tables without having first secured the written approval of the Owner's duly authorized representative.
3. Number code or color code conductors appropriately for future identification and servicing of the system. Refer to Section 16100 for additional requirements.
4. Make all splices and connections in stranded conductors using UL-approved solderless crimp connectors.

3.2 **TESTING:**

- A. Feeder Insulation Resistance Test: Each new and reused existing 600 volt feeder conductor shall have its insulation resistance tested after the installation is complete except for connection at its source and point of termination.
1. Tests shall be made using a Biddle Megger or equivalent test instrument at a voltage of not less than 1000 volt dc. Resistance shall be measured between phase, neutral, and ground conductors and from conductors to raceway (ground). Readings shall be taken after 30 seconds and 60 seconds of Megger operation at slip speed and insulation resistance shall not be less than the following:
- | Wire Size (AWG) | Insulation Resistance (Ohms) |
|-----------------------|------------------------------|
| No. 12 | 1,000 K |
| No. 10 through No. 8 | 250 K |
| No. 6 through No. 2 | 100 K |
| No. 1 through No. 4/0 | 50 K |
| Larger than No. 4/0 | 25 K |
2. New conductors which do not meet or exceed the insulation resistance values listed above shall be removed, replaced, and retested.
 3. Where reused existing feeders fail to meet the above insulation requirements, notify the Engineer in writing for direction prior to placing the existing feeders back in service.
- B. Neutral Testing: After all feeder and branch circuit conductors are terminated, neutral to ground testing shall comply with the following:
1. The resistance of the system's neutral to ground shall be greater than 10 Kohms with the system bonding jumper disconnected.
 2. Repeat neutral ground test for neutrals of separately derived systems.
- C. Pre-energization Check: Prior to energization, check all new and reused existing branch circuit cable and wire for continuity of circuitry and for short circuits. Correct malfunction when detected. No submittal is required for this test.
- D. Voltage and Current Values: The voltage and current in each main feeder conductor shall be measured and recorded after all connections have been made and the feeder is under load.
- E. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit four copies of certified test results to Architect for review. Test reports shall include conductor tested, date and time of test, test results, relative humidity, temperature, and weather conditions. Refer to Section 16020, "Electrical Testing", for additional requirements.

3.3 AS BUILT DRAWINGS:

- A. Refer to Section 16002 for applicable requirements.

3.4 IDENTIFICATION:

- A. Refer to Section 16100 for color-coding and markings for all conductors.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide wiring device work as shown, scheduled, indicated, and as specified.
- B. Types: The types of wiring devices required for the project include, but are not limited to, the following:
 - 1. Receptacles.
 - 2. Switches.
 - 3. Wall plates.

1.3 STANDARDS:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
 - 1. NEMA WE 1 General-purpose wiring devices.
 - 2. NEMA WD 5 Specific-purpose wiring devices.

1.4 QUALITY ASSURANCE:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
 - 1. Harvey Hubbell, Inc.
 - 2. Leviton.
 - 3. Pass and Seymour, Inc.
 - 4. Prescolite.
- B. UL Label: All wiring devices shall be UL-labeled.

1.5 SUBMITTALS:

- A. Shop Drawings submittals shall include, but not be limited to, the following:
 - 1. Cut sheets of the receptacles, switches, wall box dimmers, and pushbuttons.
 - 2. Cut sheets of the wall plates.
 - 3. Additional information as required in Section 16002.

1.6 DELIVERY, STORAGE AND HANDLING:

- A. Deliver wiring devices individually wrapped in factory-fabricated containers.
- B. Handle wiring devices carefully to avoid damage, breaking, and scoring.
- C. Store in a clean dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 WIRING DEVICES:

- A. General: Provide factory-fabricated wiring devices in the type, color, and electrical rating for the service indicated. Where type and grade are not indicated, provide proper selection to correspond with branch circuit wiring and overcurrent protection. Attachment of wires to devices shall be by screw pressure under the head of binding screws. Arrangements depending on spring pressure or tension are not acceptable. All binding screws shall be brass or bronze.
- B. Receptacles: Comply with NEMA Standard WD1 and as follows:

- 1. General Duty Standard: Provide simplex or duplex commercial specification grade standard type receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, with metal mounting straps, back and side wired with screw type terminals, molded high impact thermoplastic compound, NEMA configuration as indicated.

- | | |
|---|--|
| a. 20 amp, 125 volt grounded simplex NEMA #5-20R | Pass & Seymour #5361-*.
Leviton #5891-* |
| b. 15 amp, 125 volt grounded duplex NEMA #5-15R | Pass & Seymour #5252-*.
Leviton #BR15-* |
| c. 20 amp, 125 volt grounded duplex NEMA #5-20R | Pass & Seymour #5352-*.
Leviton #BR20-* |
| d. 20 amp, 125 volt, Class A, GFCI duplex receptacle with integral ground fault current interrupter, back and side wired with indicator light. | Pass & Seymour #2095*L.
Leviton #8898-* |
| e. 20 amp, 125 volt, Class A, GFCI duplex #2094HG*L.
receptacle with integral ground fault current interrupter, back and side wired with indicator light hospital grade. | Pass & Seymour
Leviton #8898HG-* |

* Color designation, refer to Paragraph 2.3.

Wiring devices connected to emergency power circuits shall be as specified hereinabove except that wiring devices shall be red in color with coverplates color-matching other devices in the room.

- 2. Wiring devices connected to emergency power circuits shall be as specified hereinabove except that wiring devices shall be red in color with coverplates color-matching other devices in the room.
- 3. Heavy-duty Simplex: Provide single heavy-duty type receptacles, with green hexagonal equipment ground screw, with metal mounting straps, back wiring, black molded phenolic compound, NEMA configuration as indicated.

2. Special purpose switches and/or outlets not covered by the specifications, but noted on the Drawings shall be of the amperage, voltage rating, and NEMA configuration indicated. The switches and/or outlets shall be specification grade of the same quality as those specified.
 3. When "**EQUIPMENT ONLY**" or "**JUNCTION BOX ONLY**" is indicated for equipment, it shall be the responsibility of the Electrical Subcontractor to obtain from the supplier, the complete data as related to the electrical portion of the equipment, including rough-ins, mounting height, type of outlet, items furnished by the supplier, etc. The Electrical Subcontractor shall be responsible for furnishing and installing all materials which are usually the Electrical Subcontractor's responsibility with the installation of the equipment.
 4. The approximate location of switches, power outlets, floor boxes, etc., is indicated on the Drawings. These Drawings, however, may not give complete and accurate information in regard to locations of such items. Determine exact locations by reference to the general building Drawings and by actual measurements during construction of the building before rough-in, subject to the approval of the Construction Inspector.
- B. Box Condition: Install receptacles and switches only in electrical boxes which are clean, free from excess building materials, debris, and similar matter.
- C. Alignment: Install all wiring devices plumb and aligned in the plane of the wall, floor, or ceiling in which they are installed.
- D. Switches and Dimmers: Install switches and wall box dimmers at a height as specified in Section 16100, "Basic Materials and Methods", to switch center line, unless otherwise noted on Drawings, on the strike side of doors as hung and in a uniform position so that the same direction will open and close the circuit throughout the project. Where shown near doors, install switches and dimmers not less than 2" and not more than 12" from door trim. Where more than one switch is in the same location, install switches in a multigang box with a single coverplate. Use toggle switches for motor disconnect switches only when installed in a ceiling plenum or in a mechanical, electrical, or telephone room.
- E. Receptacles: Install receptacles vertically at a height as specified in Section 16100, to receptacle center line above finished floor and horizontally at a height as specified in Section 16100 to receptacle center line above counter tops unless shown or specified otherwise. Where splash backs occur above counters, mount devices horizontally at a height as specified in Section 16100 to receptacle center line above splash backs. Receptacles shall be installed with ground pin receiver down. All devices shall be installed complete with coverplates. Use 20 ampere receptacle when only one receptacle is installed on a branch circuit.[add where hospital grade receptacle are to be installed.
- F. Coverplates:
1. Install stainless steel coverplates on all heavy-duty receptacles. Install weatherproof coverplates on all exterior and wet area receptacles. Refer to Paragraph 2.03 for additional requirements.
 2. Multi-gang wall plates shall be used for each group of ganged devices. Mounting screws shall be installed for each device covered by the wall plate.
 3. Wall plates for concealed work shall be flush against the finished wall, and shall completely cover the wall opening. Wall plates shall not be installed until all painting has been completed. Devices shall be protected by masking tape or other coverage until painting is complete. Any device with paint on it shall be replaced at no expense to the Owner. Jumbo plates are not acceptable.
 4. Engrave and black paint fill text descriptions and branch circuit numbers on switch and receptacle coverplates where shown on the Drawings or specified herein.
- G. Mounting Heights: Refer to Section 16100 for wiring device mounting heights.

3.3 PROTECTION OF WALL PLATES AND RECEPTACLES:

- A. General: Upon installation of wall plates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

3.4 IDENTIFICATION:

- A. Refer to Section 16100 for wiring device identification requirements.

3.5 TESTING:

- A. General: Prior to energization, check for continuity of circuits, for short circuits and check grounding connections. After energization, check wiring devices to demonstrate proper operation and receptacle polarization.

END OF SECTION

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SECTION 16160

PANELBOARDS AND ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide panelboard and enclosure work, including cabinets, as shown, scheduled, indicated, and as specified.
- B. Types: The types of panelboards and enclosures required for the project include, but are not limited to, the following:
 - 1. Power distribution panelboards.
 - 2. Lighting and appliance panelboards.
 - 3. Circuit breakers for existing building panelboards.

1.3 STANDARDS:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
 - 1. NEMA AB 1 Molded Case Circuit Breakers.
 - 2. NEMA KS 1 Enclosed Switches.
 - 3. NEMA PB 1 Panelboards.
 - 4. NEMA PB 1.1 Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1.4 QUALITY ASSURANCE:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
 - 1. Cutler-Hammer, Inc.
 - 2. General Electric Company.
 - 3. Square D Company.
 - 4. Siemens.
- B. UL Standards: Panelboards and enclosures shall conform to all applicable UL standards and shall be UL-labeled.

1.5 SUBMITTALS:

- A. Shop Drawing submittals shall include, but not be limited to, the following:
 - 1. Cut sheets of the circuit breaker and fusible switch distribution panels and panelboards with construction, fuse and circuit breaker amperage and poles, interrupting ratings, and quantities clearly listed, and with bus amperage, voltage, phase and wires, integrated equipment ratings and all associated accessories clearly indicated.
 - 2. Include dimensioned drawings of panelboards and enclosures. Submit, if requested, transparencies of circuit breaker characteristics with unlatch times and fuse characteristics with melting/clearing times.
 - 3. Additional information as required in Section 16002.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver distribution panels and panelboards in factory-fabricated water-resistant wrapping.
- B. Handle panelboards carefully to avoid damage to material component, enclosure and finish.
- C. Store distribution panels and panelboards in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. General: Lighting and appliance panelboards shall be dead front safety type equipped with molded case circuit breakers as shown and scheduled. Power distribution panelboards shall be dead front type equipped with fusible switches or circuit breakers as shown and scheduled.
- B. Busing Assembly: Panelboard and power distribution panel board busing shall be tin or silver-plated copper. Bus structure and mains shall have ratings as shown and scheduled and shall be phase sequence construction. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or busbar not to exceed 65°C rise above 40°C ambient. Heat rise test shall be conducted in accordance with UL 67. The use of conductor dimensions will not be accepted instead of actual heat tests. All bus joints shall be bolted with medium carbon steel, zinc or cadmium plated hardware equipped with lock washers and torqued to the manufacturer's recommended settings (usually ASTM standards). All bolted connections shall have Belleville washers. Furnish a bare uninsulated or an isolated, where noted, ground bus inside each 208Y/120 volt panelboard enclosure and elsewhere where noted on the Drawings. Furnish an isolated full size neutral bus in all panels where the neutral is present. All multi-section panelboards shall be connected with copper cable, with an ampacity meeting or exceeding the main bus ampacity. All distribution and 120/208 volt panels shall have a ground bus. All 277/480 volt panels shall have a ground bus where a ground wire is shown in the panel feeder or branch circuits.
- C. All panels serve by K-rated or phase cancellation transformers shall have 200% rated neutral.
- D. Molded Case Circuit Breakers:
 - 1. Circuit breakers shall be of the molded case, thermal magnetic type equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF". Provisions for additional breakers shall be such that no additional connectors will be required to add breakers. Circuit breakers shall bolt in to the main bus for 480/277 volt panels (except Square D I-line panels which shall have plug-in breakers) and bolt on to the main bus for 208/120 volt panels. All 2 and 3-pole breakers shall have common trips. Where "series rated" breakers are shown, scheduled or specified and the manufacturer does not

have a series rated breaker combination for the application shown, fully rated breakers with the required minimum interrupting capacity shall be provided.

2. Circuit breakers installed in existing building panelboards shall be from the same manufacturer as and compatible with the existing panelboard and shall have an interrupting rating equal to or greater than the interrupting rating of the existing breakers installed in the panelboard.
3. All single-pole circuit breakers shall be either ambient or case-compensated (calibrated 40°C) thermal-magnetic type breakers, with inverse time delay on overloads and instantaneous magnetic trip on short circuits. (Twin, tandem and half-size single-pole breakers and breaker tie handles are not acceptable.) All multiple breakers shall be common trip, thermal-magnetic type, calibrated 40°C.
4. The breakers shall employ quick-make, toggle mechanism for manual operation, as well as automatic operation. The breakers shall have provisions for manually testing the tripping mechanism with the breaker removed from the panel. Automatic tripping shall be indicated by the breaker handle assuming a clearly distinctive position from the manual "on" and "off" positions.
5. Circuit breakers used as switches in 120 volt and 277 volt fluorescent lighting circuits, the circuit breakers shall be approved for such switching duty and shall be marked "SWD".
6. Provide panelboard circuit breakers with conventional interrupting capacity unless scheduled shown or noted otherwise, but in no case less than the following symmetrical amperes RMS:

Voltage (volts)	Interrupting Capacity
120/208	10,000 AIC
277/480	14,000 AIC
7. Provide distribution panel circuit breakers with conventional interrupting capacity unless scheduled shown or noted otherwise, but in no case less than the following symmetrical amperes RMS:

Frame Size/Voltage (volts)	Interrupting Capacity
100AF to 225AF/240V	10,000 AIC
400AF to 1000AF/240V	42,000 AIC
1200AF/240V	100,000 AIC-
100AF/480V	18,000 AIC
225AF/480V	25,000 AIC
400AF to 1000AF/480V	30,000 AIC
1200AF/480V	50,000 AIC
8. Ground fault interrupter (GFI) circuit breakers, where shown, shall be 5 ma ground fault trip and shall include a TEST button.
9. Distribution panel circuit breakers shall be equipped with solid-state programmable trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip. The solid-state electronic programmable trip device shall have the following features and tripping functions.
 - a. Adjustable current setting.
 - b. Adjustable long-time delay.
 - c. Adjustable instantaneous pick-up.
 - d. Adjustable short time delay.
 - e. Adjustable short time pick-up.
 - f. Adjustable ground fault delay where ground fault is specified.

- g. Adjustable ground fault pick-up where ground fault is specified.
- E. Lugs: Panelboards and distribution panels shall be provided with main lugs, main overcurrent devices, and feed-thru lugs as noted on the Drawings. Lugs shall be suitable for use with the cable size and material installed. Panel wireways shall provide adequate space for wiring to all lugs.
- F. Spaces: Where space for future breakers is shown, panelboard enclosure shall include removable blank panels or knockouts to allow installation of future breakers and panelboard busing shall be complete, including all required connectors.
- G. Integrated Equipment Rating: Each panelboard, as a complete unit, shall have short circuit bracing and a short-circuit rating equal to the interrupting rating of the weakest overcurrent device installed in the panelboard. This rating shall equal or exceed the rating shown, scheduled or noted on the Drawings. Such ratings shall have been established by tests on similar panelboards with the circuit breakers installed.
- H. Short Circuit Bracing: Distribution panel bussing shall have short circuit bracing as shown, scheduled or noted on the drawings and this rating shall be clearly indicated on the distribution panel nameplate.
- I. Panelboard Enclosures: Panelboard enclosures shall be code gauge galvanized steel with wire bending space per the NEC. Panelboard enclosures shall be NEMA Type 1 surface or flush mounted as shown, scheduled or noted for indoor locations and NEMA 3R for outdoor locations, minimum 16 gauge thickness, minimum 20" width, with multiple knockouts, unless shown, scheduled or noted otherwise. Panelboard fronts shall be full-height hinged door-in-door front covers with an interior access door hinged to the main front cover providing dead-front access to the panelboard overcurrent devices (interior) and the dead front main cover over the interior and wireway full-height hinged to the panelboard back box with fastening, concealed on flush mounted panelboards, on the non-hinged side. Provide flush spring latch and keyed lock for all panelboard access doors with all distribution panel and panelboard locks keyed alike. Provide an interior circuit directory frame, card and clear plastic covering inside the interior access door for all lighting and appliance panelboards. Door and cover trim shall be painted with manufacturers standard gray enamel finish over a rust inhibitor. Trim on flush mounted panels shall have concealed fasteners. Enclosures shall be fabricated by the same manufacturer as panelboards to be enclosed. Multi-section panelboards shall have separate covers and trims. Multi-section panel cans shall be installed side by side with covers butted together.
- J. Distribution Panel Enclosures: Distribution panel enclosures shall be code gauge galvanized steel with wire bending space per the NEC. Distribution panel enclosures shall be NEMA 1 surface or flush mounted as shown, scheduled or noted for indoor locations and NEMA 3R for outdoor locations. The distribution panel interior assembly shall be dead front with panel front removed. Main lugs or main circuit breakers shall have barriers on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall have barriers. Interior surface distribution panels shall have full height front covers full height hinged to the distribution panel back box with fastening on the non-hinged side. Interior flush and exterior distribution panel fronts shall be full-height hinged door-in-door front covers with an interior access door hinged to the main front cover providing dead-front access to the panelboard overcurrent devices (interior) and the dead front main cover over the interior and wireway full-height hinged to the panelboard back box with concealed fastening on the non-hinged side. Cabinet interior doors shall be equipped with a latch and tumbler type lock. Doors over 48" long shall be equipped with a three point latch and vault lock with all distribution panel and panelboard locks keyed alike. Cabinets shall be of sufficient size to allow a width of gutter to conform with Underwriters' Laboratories, Inc. Standards. Panel trim shall be full finish sheet steel finished with two coats of paint, the first being a prime coat and the second a finish coat of light gray lacquer.

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELBOARDS AND ENCLOSURES:

- A. General: Install panelboards and enclosures as shown, including electrical connections, in accordance with the manufacturer's written instructions, the applicable requirements of NEC, the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended function.
- B. Coordination: Coordinate installation of panelboards and enclosures with cable and raceways installation work. Verify that wall thickness is adequate where recessed panels are shown.
- C. Anchoring: Anchor enclosures firmly to walls and structural surfaces ensuring that they are permanently and mechanically secured.
- D. Concrete Pads: Install each floor-mounted power distribution panelboard on a reinforced concrete housekeeping pad. The housekeeping pad shall extend 3" beyond the housing of the distribution panel, unless otherwise shown. Furnish the exact position of any block outs, dimensions, and location of the housekeeping pads in time to prevent delay of the concrete work. Refer to Section 16100, "Basic Materials and Methods", for additional requirements.
- E. Directory Card: Type the enclosure's circuit directory card upon completion of work. Refer to Section 16100 for additional requirements.
- F. Fuses: Install fuses, of the rating and class shown, in each power distribution and motor control panelboards.
- G. Circuit Arrangement: Branch circuit connections to 3-phase lighting and appliance panelboards shall be arranged such that when two or three circuits are run with a common neutral, each circuit shall be connected to a different phase unless otherwise shown. At the completion of the electrical system this Contractor shall check each phase of all panels under full load and arrange so that all phases shall carry the same load as near as possible.
- H. Spare Conduits: Stub three empty one inch (1") conduits to accessible location above ceiling out of each recessed panelboard.

3.2 TESTING:

- A. General: Prior to energization, check for continuity of circuits and for short circuits.
- B. Thermographic Testing: Refer to Section 16020, "Electrical Testing", for thermographic testing.

3.3 IDENTIFICATION:

- A. Refer to Section 16100 for applicable painting, nameplates, and labeling requirements.

END OF SECTION

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SECTION 16170

SAFETY AND DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide safety and disconnect switch work as shown, scheduled, indicated, and as specified.
- B. Types: The types of safety and disconnect switches required for the project include, but are not limited to, equipment disconnects and motor-circuit disconnects.

1.3 STANDARDS:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
 - 1. Federal Spec. W-S-865 Switch, Box (Enclosed), Surface-Mounted.
 - 2. NEMA KS 1 Enclosed Switches.

1.4 QUALITY ASSURANCE:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
 - 1. Cutler-Hammer, Inc.
 - 2. General Electric Company.
 - 3. Square D Company.
 - 4. Siemens.
- B. UL-approved: Safety and disconnect switches must have Underwriters' Laboratories, Inc., approval and bear the UL label.

1.5 SUBMITTALS:

- A. Shop drawing submittals shall include, but not be limited to, the following:
 - 1. Cut sheets of the safety and disconnect switches with ratings, voltage, poles, capacity, horsepower, short circuit rating, and all associated accessories clearly indicated.
 - 2. Include dimensioned drawings of electrical safety and disconnect switches which have a rating of 100 amperes or larger, showing the accurately scaled switches, their layout, and relation to associated equipment.
 - 3. Additional information as required in Section 16002.

1.6 DELIVERY, STORAGE AND HANDLING:

- A. Deliver switches individually wrapped in factory-fabricated water-resistant type containers.
- B. Handle switches carefully to avoid damage to material components, enclosure and finish. Damaged switches shall not be installed on project.
- C. Store switches in a clean and dry space and protect from weather.

PART 2 - PRODUCTS

2.1 MATERIAL:

- A. General: Provide heavy-duty type, dead front, sheet steel-enclosed, surface-mounted safety switches of the type and size indicated. Safety switches shall be rated for the voltage of the circuit in which they are installed. Safety switches used as motor disconnects shall be horsepower rated for the motor served.
- B. Switch Mechanism:
 - 1. Safety switches shall be quick-make quick-break type with permanently attached arc suppressors and constructed such that switch blades are visible in the "OFF" position with the door open. The operating handle shall be an integral part of the box, not of the cover. Switch shall have provision to padlock in the "OFF" position. Safety switches shall have a cover interlock to prevent unauthorized opening of the switch door when the switch mechanism is in the "ON" position or closing of the switch mechanism when the switch door is open.
 - 2. Cover interlock shall have an override mechanism to permit switch inspection by authorized personnel. All current-carrying parts shall be constructed of high conductivity copper with silver-plated switch contacts. Lugs shall be copper-plated or aluminum, suitable for copper or aluminum cable and front removable. Switch blades shall be copper.
- C. Fusing: Provide fusible safety switches where indicated. Fuse clips shall be positive pressure rejection type fuse clips suitable for use with UL Class R fuses.
- D. Neutral: Provide safety switches with number of switched poles as indicated. Where a neutral is present in the circuit, provide a solid neutral with the safety switch.
- E. Enclosures:
 - 1. All safety switches installed in indoor locations shall be NEMA 1 general purpose enclosures unless otherwise shown.
 - 2. Safety switches installed in exterior locations or where exposed to outdoor conditions shall be NEMA 3R (water resistant) unless otherwise shown or specified.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Installer shall examine the areas and conditions under which safety and disconnect switches are to be installed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SAFETY AND DISCONNECT SWITCHES:

- A. General: Install safety and disconnect switches where shown, in accordance with the manufacturer's written instructions, the applicable requirements of the NEC, the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended function.

- B. Location: Provide safety switches where shown and at each motor which is out-of-sight-of or greater than 50' from the switch or panel from which the motor circuit is fed, unless another NEC complying disconnecting method is utilized.
- C. Supports: Provide all safety and disconnect switches with galvanized angle or other suitable supports where mounting on wall or other rigid surface is impractical. Switches shall not be supported by conduit alone. Where safety and disconnect switches are mounted on equipment served, the switch shall not inhibit removal of any service panels or interfere with any required access areas.
- D. Disconnect Switches: Install disconnect switches used with motor-driven appliances, motors, and controllers within sight of the controller position unless otherwise indicated.
- E. Coordination: Coordinate safety and disconnect switch installation work with electrical raceway and cable work as necessary for proper interface.

3.3 **TESTING:**

- A. General: Prior to energization, check for continuity of circuits and for short circuits.

3.4 **IDENTIFICATION:**

- A. Refer to Section 16100, "Basic Materials and Methods", for applicable painting, nameplates, and labeling requirements.

END OF SECTION

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SECTION 16181
250/600 VOLT FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: The extent of fuse work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications.
- B. Types: The types of fuses required for the project include, but are not limited to, the following:
 - 1. 250 volt current-limiting fuses.
 - 2. 600 volt current-limiting fuses.

1.3 STANDARDS:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
 - 1. ANSI/UL 198E Class R Fuses.
 - 2. ANSI/UL 198C High-Interrupting-Capacity Fuses, Current Limiting Types, Class L.
- B. Where application of applicable codes, Trade Association standards, or publications appears to be in conflict with the requirements of this Section, an interpretation shall be obtained from the Architect/Engineer.

1.4 QUALITY ASSURANCE:

- A. Manufacturers: Provide products produced by Bussmann Manufacturing.
 - 1. The Contractor shall base his proposal upon Bussmann fuses. If the Contractor wishes to use fuses other than specified, and produced by one of the manufacturers listed below, written request shall be submitted to the Engineer for approval review as required in Section 16002 under "Prior Approval", together with proof that the substituted fuses "are equal", and that all proposed fuses have been selected for proper fuse coordination with all components of the power system.
 - a. Gould Shawmut Company.
 - b. Littlefuse.
- B. Coordination: All fuses shall, to the maximum extent possible, be from the same manufacturer to facilitate positive selective coordination of protective devices.

1.5 SUBMITTALS:

- A. Shop drawing submittals shall include, but not be limited to, the following:
 - 1. Cut sheet submittals shall be provided for all fuse types required for the project.

2. Additional information as required in Section 16002.

1.6 **PRODUCT DELIVERY, STORAGE AND HANDLING:**

- A. Store fuses in a clean and dry space and protected from weather. When necessary to store outdoors, elevate materials well above grade and enclose with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.1 **250/600 VOLT CURRENT-LIMITING FUSES:**

- A. General: Provide 200,000 amperes interrupting capacity (AIC) current-limiting fuses of the current ratings shown and with a voltage rating equal to or greater than the voltage at the point of application.
- B. Types:
 1. Fuses in circuits supplying individual motors, groups of motors or loads including motors, 600 amperes or less, shall be UL Class RK1 true dual-element, time-delay fuses, unless otherwise shown. Dual-element fuses must hold 500% of rated current for a minimum of 10 seconds and clear 20 times rated current in 0.01 seconds or less.
 2. Fuses in circuits supplying individual motors, groups of motors or loads including motors, 601 to 4000 amperes, shall be UL Class L time-delay fuses, unless otherwise shown. Time delay fuses shall hold 500% of rated current for 4 seconds and clear 20 times rated current in 0.01 seconds or less.
 3. Fuses in circuits supplying other than motor loads, 600 amperes or less, shall be UL Class RK1 true dual-element, time-delay fuses, unless otherwise shown. Dual-element fuses must hold 500% of rated current for a minimum of 10 seconds and clear 20 times rated current in 0.01 seconds or less.

2.2 **SPARE FUSES:**

- A. General: Provide spare fuses in the amount of 5% of each type and size installed, but not less than three spares of a specific size and type. Deliver these spares to the Owner at the time of acceptance of the project. Fuses shall be neatly encased in a properly labeled steel enclosure with padlock provision, to be wall mounted as directed.

PART 3 - EXECUTION

3.1 **INSTALLATION:**

- A. General: Install fuses in fuse holders immediately prior to energization of the circuit in which the fuses are installed. Fuses shall not be installed and shipped with equipment.
- B. Labels: Place fuse identification labels, showing fuse size and type installed, inside the cover of each switch or other location where fuses are installed.

END OF SECTION

SECTION 16190

ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: The extent of electrical connections for equipment is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications.
- B. Types: The types of electrical connections required for the project include, but are not limited to, the following:
 - 1. Motors and equipment power connections.
 - 2. Contractor and Owner-furnished equipment power connections.
 - 3. Miscellaneous control power connections.
 - 4. Other equipment requiring power connections.
 - 5. Relocated existing equipment.
- C. Work of Other Sections:
 - 1. Refer to Section 16195, "Miscellaneous Electrical Controls and Control Wiring", for miscellaneous electrical controls and control wiring.
 - 2. Refer to other Divisions of these Specifications for specific individual equipment electrical requirements.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
 - 1. AMP, Inc.
 - 2. Burndy Corporation.
 - 3. Cadweld.
 - 4. O. Z. Gedney Company.
 - 5. General Electric Company.
 - 6. Ideal Industries, Inc.
 - 7. Mac Products, Inc.
 - 8. Minnesota Mining and Manufacturing Company.
 - 9. Thomas & Betts Company.
- B. UL Label: All products shall be UL-labeled to the maximum extent possible.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. General: For each electrical connection indicated, provide a complete assembly of materials, including, but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices and terminations.
- B. Raceways: Refer to Section 16110, "Electrical Raceways and Fittings", and Section 16112, "Electrical Boxes and Fittings".
- C. Cable, Wire, and Connectors: Refer to Section 16120, "300/600 Volt Cable, Wire, and Connectors".
- D. Motor Starters and Safety Switches: Refer to Section 16155, "Motor Starters", and Section 16170, "Safety and Disconnect Switches".
- E. Terminals: Provide electrical terminals as instructed by the terminal manufacturer for the intended application.

PART 3 - EXECUTION

3.1 MOTOR AND EQUIPMENT POWER CONNECTIONS:

- A. All power connections to motors and equipment furnished by other Divisions shall be made by this Division unless noted otherwise on the Drawings. This Division shall provide and install all power wiring and shall make all final connections.
- B. Refer to the Drawings, approved Shop Drawings and Division 14, Division 15, and other applicable Divisions for required power connections to equipment and motors.
- C. All motorized or electrically operated equipment will be set in place by the furnishing Division with all integrally mounted starters, controls and disconnect switches installed. The furnishing Division will furnish for installation and connection to this Division all starters, controllers and disconnect switches which are furnished with their equipment but not integrally mounted.
- D. This Division shall furnish, install, and connect all required starters and disconnect switches which are not provided with the served equipment. Where disconnect switches are not provided with served equipment and are required by the NEC or the local inspection department, then they shall be provided by the Electrical Contractor.
- E. This Division shall furnish and install all interconnecting power wiring and make all connections ready for operation between motors, starters and control devices, as required by wiring diagrams (on approved Shop Drawings) provided by the Division furnishing the Equipment.
- F. Unless otherwise indicated or specified, motors 1/2 hp and smaller shall be 120 or 277 volt, single phase, and shall be furnished with integral thermal overload protection. Provide manual disconnect switches as required. Where motors are not furnished with integral thermal overload protection, provide manual or magnetic starters as required.
- G. Unless otherwise indicated or specified, motors 3/4 hp size and larger shall be 3-phase.
- H. Motors 3/4 hp through 50 hp shall be furnished with "across-the-line", full-voltage nonreversing (FVNR) magnetic starters, unless otherwise indicated or specified.
- I. Motors 60 hp and larger shall be furnished with reduced voltage nonreversing (RVNR) magnetic starters of the type indicated.

- J. Where starters require disconnect switches in the immediate vicinity, combination motor starters shall be used. Where starters are mounted on equipment served, the switch shall not inhibit removal of any service panels or interfere with any required access areas.

3.2 CONTRACTOR AND OWNER-FURNISHED EQUIPMENT POWER CONNECTIONS:

- A. All power connections to motors and equipment furnished by other Divisions or by Owner shall be made by this Division unless noted otherwise on the Drawings. This Division shall provide and install all power wiring and shall make all final connections.
- B. Refer to the Drawings, approved Shop Drawings, other applicable Divisions and Owner-furnished equipment drawings for required power connections to equipment and motors.
- C. All motorized or electrically operated equipment will be set in place by the furnishing Division with all integrally mounted starters, controls, and disconnect switches installed. The furnishing Division will furnish for installation and connection to this Division all starters, controllers, and disconnect switches which are furnished with their equipment but not integrally mounted.
- D. This Division shall furnish, install, and connect all required starters and disconnect switches which are not provided with the served equipment. Where disconnect switches are not provided with served equipment and are required by the NEC or the local inspection department, then they shall be provided by the Electrical Contractor.
- E. This Division shall furnish and install all interconnecting power wiring and make all connections ready for operation between equipment, starters and control devices, as required by wiring diagrams (on approved Shop Drawings) provided by the Division furnishing the Equipment.
- F. All connections to Contractor and Owner-furnished equipment shall be made in a suitable manner.
- G. Plug types on cord connected equipment shall be coordinated with the receptacle to provide compatibility. Where the installed plug and receptacle are not compatible, then this contractor shall be responsible for changing either the plug or receptacle as required for compatibility.
- H. Where starters, disconnect switches, conduit boxes, or other items are mounted directly on the equipment served, the mounting location shall not inhibit removal of any required service panels or interfere with any required access areas.
- I. All conduits shall terminate in conduit boxes on equipment where possible. A piece of flexible or liquidtight flexible conduit (Refer to Section 16110) not less than 12" long nor more than 24" long, shall be connected between the conduit and the equipment. Where equipment is not provided with conduit boxes, terminate the conduit in a suitable manner at the equipment.
- J. Outlets of various types have been shown at equipment locations, but no indications of exact locations or scope of work is intended on the accompanying Drawings. The Contractor shall determine the exact location of all items:
 - 1. From the applicable Drawings and Specifications and Shop Drawings of the Divisions furnishing the equipment.
 - 2. From the Contractors responsible for the equipment involved.
 - 3. By actual measurements at the site.
 - 4. By direction from the Owner.
- K. Prior to installation, coordinate power, rough-in and control provisions shown on the drawings for radiology equipment with the provisions shown on approved Shop Drawings for the furnished radiology equipment. Where the power, rough-in and control requirements are less than or equal to those shown, then modifications to power, rough-in and control provisions shown shall be made at no cost as a matter of job coordination. Where power and control requirements are in excess of those shown, notify the Engineer in writing of the requirements.

- L. Prior to installation, coordinate power and control provisions for Contractor and Owner-furnished equipment with approved equipment shop drawings. Where power and control provisions are significantly different than those shown, notify the Engineer in writing of the requirements. Where minor modifications to provisions are required, they shall be made at no cost as a matter of job coordination.

3.3 INSTALLATION OF ELECTRICAL CONNECTIONS:

- A. General: Install electrical connections as shown, in accordance with applicable portions of the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.
- B. Conductors: Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Wherever possible, match conductors of the electrical connection for proper interface between the electrical supply and the installed equipment.
- C. Splice Insulation: Cover splices with electrical insulation equivalent to, or of a higher rating than, insulation on the conductors being spliced.
- D. Appearance: Prepare cables and wires by properly cutting and stripping covering, jacket and insulation to ensure a uniform and neat appearance where cables and wires are terminated.
- E. Routing: Trim cables and wires to be as short as practicable and arrange routing to facilitate inspection, testing, and maintenance.
- F. Polyvinyl Chloride (PVC) Coated Conduit: Provide PVC-coated rigid steel conduit and fittings where required for highly-corrosive atmospheres.
- G. Flexible Conduit: Provide flexible conduit, minimum 18" for connection of lighting fixtures and other electrical equipment connections, where subject to movement and vibration.
- H. Liquidtight Conduit: Provide liquidtight flexible conduit, minimum 18" for connection of all motors and for other electrical equipment where subject to movement and vibration, and also where subjected to one or more of the following conditions:
 - 1. Exterior location.
 - 2. Moist or humid atmosphere where condensate can be expected to accumulate.
 - 3. Corrosive atmosphere, subjected to water spray or subjected to dripping oil, grease, or water.
- I. Conduit Location: All horizontal runs of conduit (not strapped to walls) shall be above 8' high, with a vertical drop to equipment. Conduit blocking walk and service space will not be acceptable and will require relocation. Conduit on and adjacent to equipment shall be located to allow free access to all removable panels for equipment service.
- J. Motor Connections: Where possible, terminate conduit in conduit boxes at motors. Where motors are not provided with conduit boxes, terminate the conduit in a suitable conduit, and make motor connections. All conduit passing through the housing on connected equipment shall pass through a cleanly cut hole protected with an approved grommet.
- K. Coordination: Coordinate installation of electrical connections for equipment with equipment installation work.
- L. Identification: Refer to Section 16100, "Basic Materials and Methods", for identification of electrical power supply conductor terminations with markers approved as to type, color, letter, and marker size by the Architect. Affix markers at each point of termination, as close as possible to each point of connection.

END OF SECTION

SECTION 16195

MISCELLANEOUS ELECTRICAL CONTROLS AND CONTROL WIRING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included:
 - 1. This Division shall furnish miscellaneous 120 volt control power circuits and control wiring as required for systems and equipment furnished by this and other Divisions. This control power and control wiring shall be furnished by this Division for all systems and equipment and where shown on the Drawings or approved Shop Drawings by the Division furnishing the system or equipment.
 - 2. In general, all starters and controllers for non 120 volt equipment and motors shall be furnished with control power transformers, and control power circuits will not be required. Where control power transformers are not furnished, then 120 volt control power circuits shall be furnished by this Division.
 - 3. Miscellaneous Control Power and Control Wiring: Systems and devices requiring control power circuits and control wiring include, but are not limited to:
 - a. BCAS/HVAC temperature control systems control power.
 - b. Contractor-furnished equipment controls.
 - c. Owner-furnished equipment.
 - d. Emergency generator/automatic transfer switch controls.
 - e. Start/Stop stations where required for remote motor controllers.
 - f. Additional control power, control wiring and safety devices as shown, specified, or required.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
 - 1. Relays:
 - a. Automatic Switch Company.
 - b. RussElectric, Inc.
 - c. Square D Company.

PART 2 - PRODUCTS

2.1 WIRING AND RACEWAYS:

- A. Line Voltage Control Wiring: This wiring shall be as specified in Section 16120, "300/600 Volt Cable, Wire and Connectors".

- B. Low Voltage Control Wiring: This wiring shall be as specified in Section 16120 except that conductors shall consist of a multi-conductor jacketed cable whenever possible.
- C. Raceways: Raceways for line voltage and low voltage control wiring shall be as specified in Section 16110, "Electrical Raceways and Fittings", and Section 16112, "Electrical Boxes and Fittings".

PART 3 - EXECUTION

3.1 INSTALLATION OF MISCELLANEOUS ELECTRICAL CONTROLS AND CONTROL WIRING:

- A. General: Install miscellaneous electrical control devices as shown, in accordance with applicable portions of the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.
- B. Requirements:
 - 1. Miscellaneous control power circuits shall be obtained from spare breakers in building normal power panels. Where emergency system control power is required, or control power circuit requirements are large or significantly greater than normal, notify the Engineer in writing of the requirements.
 - 2. All control devices which are part of the Life Safety System and for equipment and devices served with emergency power shall have their control power derived from an emergency source.
 - 3. Control wiring shown on the Drawings or specified in other Division 16 sections is not an inclusive listing of all control wiring required on the project. All required control wiring, unless noted otherwise herein, shall be furnished and installed by the Division 16 Contractor.
 - 4. BCAS/HVAC temperature control wiring is specified and provided under Division 15 and is included in the Work of this Division. The only HVAC temperature control wiring and work included in the Work of this Division is providing 120 volt control power circuits for temperature controls (see Miscellaneous Control Power hereinabove) and coordination of Fire Alarm and Fireman's HVAC Override Panel connections to the temperature control system.
- C. Conductors: Connect electrical conductors to miscellaneous electrical control devices in accordance with equipment manufacturer's written instructions and wiring diagrams. Wherever possible, match conductors of the electrical connection for proper interface between the electrical supply and the installed equipment.
- D. Contactors and Relays: Install contactors and relays mounted in panelboards or individual enclosures as shown and be complete, including all control wiring and devices.
- E. Line and Low Voltage Control Wiring: Line and low voltage control wiring shall be installed in a suitable raceway.
- F. Connections: Refer to Section 16190, "Electrical Connections for Equipment", for connections to equipment.
- G. Number Code/Color Code: Code all control power and control power conductors appropriately for future identification and servicing.

END OF SECTION

SECTION 16450
ELECTRICAL GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide electrical service, distribution, and equipment grounding as shown, scheduled, indicated, and as specified.
- B. Types: The types of electrical service and equipment grounding specified in this Section include, but are not necessarily limited to, grounding all equipment and devices shown and as required by the National Electrical Code (NEC), the local electrical inspection department, and The Power Company.

1.3 STANDARDS:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the following Standards:
 - 1. ANSI/IEEE Standard 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - 2. ANSI/UL 467 Safety Standard for Grounding and Bonding Equipment.
 - 3. NFPA 70 National Electrical Code.

1.4 QUALITY ASSURANCE:

- A. NEC Compliance: Comply with Article 250 of the NEC (NFPA 70) for grounding.
- B. Approval: All grounding shall be in accordance with the requirements of, and shall be subject to the approval of the Engineer and the local electrical inspection department.
- C. UL Label: All grounding products shall be UL-labeled.
- D. Manufacturers: Provide grounding products complying with these specifications and as manufactured by Copperweld and Cadweld.

1.5 SUBMITTALS:

- A. Shop Drawing submittals shall include, but not be limited to, the following:
 - 1. A complete grounding system diagram for special grounding systems.
 - 2. Cut sheets of grounding products.
 - 3. Additional information as required in Section 16002.

1.6 STORAGE AND HANDLING:

- A. Store grounding products in a clean, dry space.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. General: For each electrical grounding connection, provide a complete assembly of materials to construct a completely grounded electrical system.
- B. Raceways: Raceways for grounding conductors shall be as specified in Section 16110, "Electrical Raceways and Fittings", and Section 16112, "Electrical Boxes and Fittings".
- C. Cable, Wire, and Connectors: Grounding cable, wire and connectors shall be as specified in Section 16120, "300/600 Volt Cable, Wire and Connectors".
- D. Ground Clamps: Ground clamps for connecting grounding conductors to copper, brass, or lead pipes shall be made of copper and if pipes are of steel or iron, the ground clamps should be made of galvanized iron. These clamps shall be designed to provide permanent and positive pressure and to avoid mechanical injury to the pipe. Use exothermic welds for connecting ground wires to ground rods, for all below grade counterpoise ground grids, and elsewhere where noted on the Drawings.
- E. Ground Conductors and Jumpers: Grounding conductors and jumpers shall be connected to each other and to items to be grounded by means of approved type pressure connectors, clamps and other suitable methods approved by the Engineer. No solder connections shall be made.
- F. Grounding Electrode Rods: Grounding electrode rods used shall be a minimum of 3/4" diameter by 10' long, steel core and thick copper jacket. All concrete encased or direct buried underground grounding electrode conductors shall be of lead alloy-coated copper, Class B, stranded, conforming to ASTM A189.
- G. Exothermic Welds: Use cadweld or an approved equal system of exothermic welding for welded grounding connections where shown on the Drawings or specified.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL GROUNDING:

- A. General: Install grounding connections as shown and specified, in accordance with applicable portions of the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.
- B. Grounding Electrode System: Each substation neutral and ground bus shall be connected to the incoming cold water piping system to the building on the street side of the building water meter. Provide a bonding jumper around the water meter. The main grounding conductor shall be sized as shown and shall be run in conduit. The cold water pipe ground shall be supplemented as required by NEC, Article 250 H, and as required by the local inspection department.
- C. Bonding: All metallic piping systems and building steel shall be effectively bonded to the electrical grounding system in accordance with Article 250 of the NEC. Install bonding jumpers to all piping systems and building steel.
- D. Building Equipment Grounding System: The building equipment grounding system shall consist of the ground wire and electrically continuous metallic conduit system as shown. Every item of equipment served by the electrical system shall be bonded to the building equipment ground. Portions of metallic piping and duct systems which are electrically isolated shall be bonded to the equipment grounding system with a flexible bonding jumper.
- E. System Neutral: The system neutral shall be grounded to the grounding electrode system at the service entrance only, and shall be kept isolated from the building grounding system throughout the building. The neutral of separately derived systems shall be grounded at one point as specified hereinbelow.

- F. Miscellaneous: Provide bonding and grounding wires run in conduit and sized per the NEC in accordance with the local electrical inspection department and the NEC. Metallic piping and duct systems which enter the building shall be grounded at the point of entry to the building, in accordance with the NEC.
- G. Continuity: Continuity of the building equipment grounding system shall be maintained throughout the project. Grounding jumpers shall be installed across conduit expansion fittings, all liquidtight flexible metal and flexible metal conduit, light fixture pigtails in excess of 6', and all other nonelectrically continuous raceway fittings.
- H. Main Conductors: All main grounding conductors shall be stranded copper conductors, sized as shown or per the NEC, and run in a suitable raceway. All main grounding conductors shall be continuous without joints or splices over their entire length.
- I. Special Grounding: Provide special grounding systems where shown on the Drawings.
- J. Separately Derived System Grounding: Bond the case and neutral of each transformer directly to the nearest available effectively grounded structural metal member of the structure, the nearest available effectively grounded metal water pipe, or in accordance with the local electrical inspection department. Flexible conduit shall not be used as a ground path to a transformer.
- K. Standby Electric Power System: This is a non-separately derived system and shall have its neutral grounded to the building electrical distribution system.
- L. Voice/Data Equipment Grounding: Provide a ground conductor from voice/data terminal provisions to the building grounding system as required by the local Telephone Company and as specified in Section 16741, "Voice/Data System Provisions".
- M. Fluorescent Fixtures: Carefully and securely ground all fluorescent fixture bodies to the conduit grounding system. Flexible conduit longer than 6' shall not be considered a ground path.
- N. Receptacles: Ground all grounding type receptacles with a separate ground wire, where present in the branch circuit. Further, ground each outlet by the use of an approved grounding clip attached to the junction box in such a position to be readily inspected on removal of the coverplate; or by the use of an approved grounding yoke type receptacle.
- O. Isolated Ground Receptacles: Where isolated ground receptacles are shown on the Drawings, ground each isolated ground receptacle with a separate insulated ground wire; this ground wire shall not be connected to the outlet box. Ground each isolated ground receptacle outlet box with a separate grounding conductor unless a metal raceway is to be used and effectively grounds the outlet box.
- P. Motor Frames: Ground the frame of each motor with a properly sized separate ground wire around the liquidtight flexible conduit.
- Q. Rigid Nonmetallic Conduit Systems: Install a continuous grounding conductor in accordance with NEC.
- R. Feeder and Branch Circuits: Provide a separate, insulated equipment grounding conductor in each feeder or branch circuit. Terminate each end on a grounding lug, bus, or bushing.
- S. Bolted Connections: Connections requiring bolting shall be made up with Monel metal bolts, washers, and nuts. Connections shall be made only after surfaces have been cleaned, or ground to expose virgin metal. No strap grounding clamps shall be used.
- T. Isolated Grounding Systems: Use insulated equipment grounding conductor and connect only to service grounding electrode.
- U. Power Feeders: Ground the raceway, and ground conductors in 600 volt power feeders in accordance with the NEC. Bond all pull boxes and splice boxes in accordance with the NEC.
- V. Branch Circuit: Install an insulated ground wire, sized per the NEC, in all branch circuits.

3.2 COORDINATION:

- A. General: Coordinate installation of grounding connections for equipment with equipment installation work. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Connections: Use exothermic welds for connecting bonding and grounding conductors to ground rods, to counterpoise, structural steel, piping systems, and elsewhere where shown on the Drawings. Provide all accessories required for a complete installation.

3.3 TESTING:

- A. Ground Resistance Test: Perform a ground resistance test on the building grounding systems for comparison to future inspection and testing data by the Owner. Service ground resistance shall not exceed 5 ohms. Overall system resistance shall not exceed 15 ohms. Test shall be performed using a Biddle Megger or equivalent test instrument operated in accordance with the test instrument manufacturers operating/test procedure. Test readings shall be taken after 30 and 60 seconds of Megger operation at slip speed. The test shall not be performed immediately following wet weather conditions.
- B. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit two copies of certified test results for Owner's record and submit four copies of certified test results to Architect for review. Test reports shall include date and time of tests, relative humidity, test results, temperature, and weather conditions.

END OF SECTION

SECTION 16500
LIGHTING FIXTURES AND LAMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: The extent of lighting fixture work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this Contract shall be furnished by the Contractor.
- B. Types: The types of lighting fixtures required for the project may include, but are not limited to:
 - 1. Fluorescent fixtures.
 - 2. LED fixtures.
 - 3. Exit signs.
- C. Applications: The applications of lighting fixtures required for the project include, but are not limited to:
 - 1. General lighting.
 - 2. Emergency, egress and exit lighting.
- D. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.
- E. Minor details, not usually indicated on the drawings nor specified, but that are necessary for the proper execution and completion of the fixtures, shall be included, the same as if they were herein specified or indicated on the Drawings.
- F. The Owner shall not be held responsible for the omission or absence of any detail, construction feature, etc. which may be required in the production of the fixtures. The responsibility of accurately fabricating the fixtures to the fulfillment of this specification rests with the Contractor.

1.3 STANDARDS:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
 - 1. NFPA 101 Code for Safety to Life from Fire in Buildings and Structures.
 - 2. NEMA WD1 General-Purpose Wiring Devices.
 - 3. ANSI C82.1 Specification for Fluorescent Lamp Ballasts.
 - 4. NEMA LE HID Lighting System Noise Criterion (LS-NC) Ratings.
 - 5. LM-79-08 Electrical and Photometric Measurement of Solid-State Lighting Products.
 - 6. LM-80-08 Measuring Lumen Maintenance of LED Light Sources.

7. LM-82-12 LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature.
8. LM-84-14 Measuring Luminous Flux and Color Maintenance of LED Lamps, Light Engines and Luminaires.
9. LM-85-14 Electrical and Photometric Measurement of High-Powered LED Products.

1.4 **QUALITY ASSURANCE:**

- A. **Manufacturers:** Provide products produced by manufacturers as shown or scheduled for each type of lighting fixture. Identification in the fixture schedule by means of manufacturers' names and catalog numbers is to facilitate establishment of basic features, construction and performance standards. Any substitutions must, in the opinion of the Engineer, meet or exceed these standards. Provide products complying with these specifications and produced by one of the following for ballasts, lamps, and battery back-up units:
 1. **Light Fixtures:**
 - a. Cooper.
 - b. Hubbell.
 - c. Kenall.
 - d. Lithonia.
 - e. Phillips.
 - f. Other manufacturers as listed or scheduled on the Drawings.
 2. **Ballast/Driver Manufacturers:**
 - a. General Electric.
 - b. Osram/Sylvania.
 - c. Lutron.
 - d. Phillips.
 - e. Universal/Magnetek.
 3. **Lamps/LED Engines:**
 - a. General Electric Company.
 - b. North American Phillips.
 - c. Osram Sylvania.
 - d. Phillips Lighting Corporation.
- B. **CBM Label:** Provide fluorescent ballasts which comply with Certified Ballast Manufacturers' Association (CBM) standards and carry the CBM mark on the label.
- C. **Conformance:** Fixtures shall be manufactured in strict accordance with the Drawings and Specifications.
- D. **Codes:** Materials and installation shall be in accordance with the latest revision of the National Electrical Code and any applicable federal, state, and local codes and regulations.
- E. **UL-listing:** All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of the Underwriters' Laboratories, Inc. "Standards for Safety," and others as they may be

applicable. A UL-listing shall be provided for each fixture type, and the appropriate label or labels shall be affixed to each fixture in a position concealing it from normal view.

- F. Warranty: All ballasts shall be provided with a five (5) year parts and labor warranty from the date of project acceptance. All LED sources and LED drivers shall be provided with a five (5) year parts and labor warranty from the date of project acceptance.

1.5 SUBMITTALS:

- A. Shop Drawings submittals shall include, but not be limited to, the following:
1. Submit manufacturer's data on interior and exterior lighting fixtures in booklet form, with separate sheet for each fixture, assembled by luminaire "type" in alphabetical order, with the proposed fixture and accessories clearly labeled. Ballast and lamp product data shall accompany fixture submittals.
 2. Submit dimensioned drawings and performance data including coefficients of utilization, candela distribution, spacing to mounting height ratio, efficiency and visual comfort probability.
 3. Submit details of fixture mounting including frames, trims, canopies, support requirements, and other data pertinent to fixture installation.
 4. Solid state luminaire data shall also include:
 - a. Total input watts.
 - b. Delivered lumens.
 - c. Color temperature, color rendering index (CRI) and individual R-values, measures in accordance with
 - d. LED life, measured in accordance with IESNA standards.
 - e. LM-80 lumen depreciation test results and L70 rated life test results for each type of LED source package, array or module being submitted for the project.
 - f. Lumen maintenance protocols, if applicable.
 - g. Driver manufacturer, model number and cut sheet.
 - h. Driver type (0-10 VDC, constant voltage, constant current).
 - i. Luminaire/driver voltage.
 - j. Luminaire/driver total harmonic distortion (THD).
 - k. Driver life.
 - l. Driver type (0-10V, constant voltage, constant current).
 - m. Lumen management protocols as applicable.
 - n. Luminaire/driver dimming range and control compatibility list.
 5. Submit details of air handling provisions for fixtures with supply and return air capabilities including, but not limited to: Airflow capacities, pressure drops, boot and connection types and other pertinent data.
 6. Additional information as required in Section 16002.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver lighting fixtures individually wrapped in factory-fabricated fiberboard type containers.
- B. Handle lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures.
- C. Store lighting fixtures in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. General: Provide lighting fixtures, of the size, type and rating indicated on the Lighting Fixture Schedule, complete with, but not necessarily limited to, lamps, lampholders, reflectors, diffusers, louvers, wire guards, tube guards, ballasts, fuses, starters, and wiring. Fixtures shall be furnished with all required accessories and trim, including hold-down clips, as required for a complete installation in the ceiling type shown on the Architectural Drawings.
 - 1. Lighting equipment shall be complete, wired, and including supporting means, such as plaster frames, supports, hangers, canopies, sockets, holders; current or voltage modifiers, such as ballasts, starters; light control materials; specifically diffusers, louvers, lenses, reflectors and refractors; and lamps.
 - 2. Lighting fixtures shall be designed for highest relative efficiency and service. Maintenance to be simple and relamping possible without use of special tools.
 - 3. Lighting fixtures shall be constructed and installed in accordance with local building codes and shall bear label of approved testing agent. Materials shall be new and of best grade of approved manufacturing standards. Workmanship shall be of highest order.
 - 4. Recessed fixtures shall be provided with frames appropriate construction encountered.
 - 5. Ferrous fixture components shall receive treating to assure corrosion resistance and paint adherence. Aluminum parts, unless made of alloys having inherent corrosion resistance, shall be anodized or coated with oxidation-preventing treatment. Finish shall be baked enamel where color is indicated.
 - 6. Plastic shall be 100% virgin acrylic.
- B. General Fixture Construction:
 - 1. All materials, accessories, and other related fixture parts shall be new and free from defects which in any manner may impair their character, appearance, strength, durability and function, and effectively protected from any damage or injury from the time of fabrication to the time of delivery and until final acceptance of the work.
 - 2. Fabricate fixture enclosures with a minimum of No. 22 gauge cold rolled sheet steel. Enclosures may be constructed of other metals, provided they are equivalent in mechanical strength, and acceptable to the Engineer.
 - 3. All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true of adequate strength and structural rigidity to prevent any distortion during shipping, installation, and while in normal use.
 - 4. Housings shall be so constructed that all electrical components are easily accessible and replaceable without removing fixtures from their mountings, or disassembly of adjacent construction.

5. All custom light fixtures shall be thoroughly tested in Manufacturer's shop prior to shipment to ensure mechanical and electrical integrity.
6. All fixtures shall be completely wired at the factory.
7. If ceiling system requires, each recessed and semi-recessed fixture shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed. The frames and rings shall be one piece or constructed with electrically-welded butt joints, and of sufficient size and strength to sustain the weight of the fixture.
8. Fixture to be sealed against light leaks between ceiling trims of recessed and semi-recessed lighting equipment and the ceilings. If fixture is used in partially transparent ceiling, fixtures to be sealed against light leaks above the ceiling line.
9. Yokes, brackets and supplementary supporting members needed to mount lighting fixtures to carrier channels or other suitable ceiling members shall be provided as required.
10. Fixtures for use outdoors or in areas designated as wet locations shall be suitably gasketed to prevent the entrance of moisture. Provide approved wire mesh screens for ventilation openings. Damp location fixtures to be of corrosion resistant parts and hardware.
11. In the application and mounting condition specified, fixtures and ballasts must operate within the temperature limits of their design and as specified by Underwriters' Laboratories, Inc.
12. Each lighting fixture which has a beam angle adjustment shall have reliable angle locking device capable of long and continuous use.
13. Each lighting fixture which has a lamp with an oval shape beam pattern shall contain a lamp orientation locking device which will insure that beam orientation is not disturbed during lamp replacement and fixture cleaning.
14. Each light fixture which has a spread lens shall contain lens orientation locking device which will insure that lens orientation is not disturbed during lamp replacement and fixture cleaning.
15. All lamp sockets in lighting fixtures shall be suitable for the specified lamps and shall be set so that lamps are positioned in optically correct relation to all lighting fixture components. If adjustable socket positions are provided, socket should be preset in factory for the specified lamp. If different socket positions are specified for various types of the same fixture, sockets shall be preset for each type, and cartons marked accordingly.

C. Reflectors and Trims:

1. Reflectors, reflector cones and visible trim of all lighting fixtures shall not be installed until completion of plastering, ceiling tile work, painting and general clean-up. They shall be carefully handled to avoid scratching or finger-printing and shall be, at the time of acceptance by the Owner, completely clean.
2. All Alzak parabolic cones shall be guaranteed against discoloration for a minimum of 10 years, and, in the event of premature discoloration, shall be replaced at the expense of the manufacturer for both materials and the cost of labor.
3. Aluminum reflectors shall be finished specular, semispecular, or diffuse as specified and shall meet or exceed Alzak specifications.

D. Lenses:

1. Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.

2. Glass used for lenses, refractors, and diffusers in incandescent and HID lighting fixtures shall be tempered for impact and heat resistance; the glass shall be crystal clear with a transmittance of not less than 88%.
 3. All lenses, louvers, or other light diffusing elements shall be removable, but positively held so that hinging or other normal motion will not cause them to drop out.
 4. All lenses shall be clean and free of dust at the time of substantial completion.
- E. Lamp Holders:
1. Fluorescent:
 - a. Body: White urea plastic.
 - b. Contacts: Phosphor bronze.
 2. Lamp holders in lighting fixtures shall be suitable for indicated lamps and shall be positioned to place lamps in optically correct locations in relation to fixture components. If adjustable socket positions are provided, socket should be present in factory for lamp specified. If different socket positions are specified for same fixture, sockets shall be preset for each type, and cartons marked accordingly.
 3. Furnish lamp holders which are UL-listed and designed for proper lamp operation and life. Outdoor lamp-holders shall be neoprene-gasketed and compression type. Lamp holders to be appropriate to the specified lamp.
- F. Finishes:
1. Painted Surfaces: Synthetic enamel, with acrylic, alkyd, epoxy, polyester, or polyurethane base, light stabilized, baked on at 350°F minimum, catalytically or photochemically polymerized after application.
 2. White Finishes: Minimum of 85% reflectance.
 3. Frames: Ceiling opening frames shall either be manufactured of nonferrous metal, or be suitably rustproofed after fabrication.
 4. Selection: Unless otherwise noted, finishes shall be as selected by the Architect.
 5. Undercoat: Except for stainless steel, provide ferrous metal surfaces with a five stage phosphate treatment or other acceptable base bonding treatment before final painting.
 6. Unpainted Surfaces: Unpainted nonreflecting surfaces shall be satin-finished and coated with a baked-on clear lacquer to preserve the surface. Where aluminum surfaces are treated with an anodic process, the clear lacquer coating may be omitted.
 7. Unpainted Aluminum Surfaces: Finish interior aluminum trims with an anodized coating of not less than 7 mg per square inch, of a color and surface finish as selected by the Architect. Finish exterior aluminum and aluminum trims with an anodized coating of not less than 35 mg per square inch, of a color and surface finish as selected by the Architect.
 8. Porcelain Enamel Surfaces: Apply porcelain finishes smoothly. Finish shall be not less than 7.5 mils thick of non-yellowing, white, vitreous porcelain enamel with a reluctance of not less than 85%.
- G. Fixture Fabrication:
1. General: Design components to allow for expansion and contraction for a minimum ambient temperature range of 150°F (37.8°C) without causing buckling, excessive opening of joints or over-stressing of welds and fasteners.

2. Sheet Metal Work: Form metalwork to required shapes and sizes with true curves, lines, and angles. All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of required metal. Form intersections and joints true with adequate strength and structural rigidity to prevent distortion after assembly. Provide necessary rebates, lugs and brackets for assembly of units. Use concealed fasteners wherever possible.
3. Welding: Comply with AWS for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded joints of all welded flux and dress on all exposed and contact surfaces.
4. Assembly: Accurately fit all parts of fixture. All joints in metal, not checked, shall be brazed and not soldered. Joints shall be invisible. Where screws are necessary for adjustment of applied ornament, they shall be concealed, as far as possible, and finished to match other metalwork. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form joints exposed to weather to exclude water penetration. Assembled fixtures shall be well braced, and of adequate strength to resist sagging or deforming.

H. Glass:

1. Glassware shall be mechanically strong, properly annealed, and free from internal strain that might cause breakage. Where possible glassware shall be tempered for impact and heat resistance. Unless otherwise noted, all enclosing globes shall match glass of existing fixtures, or if none exists, glassware shall match approved prototype in size, contour, finish and general appearance. Supplied globes shall faithfully reproduce existing globes or approved prototypes in every way, having qualities equal to or better than the approved prototype without sacrifice of any other characteristics such as transparency or translucency and reflection/refraction properties. Glassware supplied shall be of consistently high quality and free from such imperfections as streaks, corns, stones, blisters, checks or other flaws that affect glassware strength or appearance.
2. Dimensional Tolerances of Glass: All other dimensions of supplied globes shall not vary more than 1% more or less than the respective dimension on the approved prototype. Tolerances for glass thickness shall be set by the Architect and adhered to by the contractor. Each unit of glassware supplied shall be identical to others of that type and faithful to the approved prototype.
3. All glass ornament in relief and globes shall be blown up fully in molds so as to faithfully replicate approved samples.
4. Where shown, etch, chase or carve ornament on globes as detailed.
5. Glass Overage: Furnish 10% additional in number of each size and kind of globe (or a minimum of two, whichever is greater).

I. Wiring:

1. Generally use SF-2 insulated wire for rewiring existing or new wire at replicated light fixture. SF-1 may be substituted in those locations where space will not permit the installation of SF-2 and where the load is 6 amps or less. Provide 600 volt insulation.
2. Factory-wire all fixtures. Provide leads no shorter than 1'-0" or as required to suit the project application.

J. Fixture Types:

1. Fluorescent Fixtures: Provide fluorescent fixtures of the type scheduled on the Lighting Fixture Schedule, complete with ballasts and lamps of the type, color, wattage and size scheduled.
 - a. Provide fluorescent fixtures with heavy white lampholders with definite locking-in feature and contacts for proper lamp operation and life. Outdoor lampholders shall be neoprene

- gasketed and compression type. Sockets with open-circuit voltage over 300 volts to be safety type and designed to open the supply circuit on lamp removal.
- b. Fixture body parts, comprising fixture housing, reflectors, wire channels, end plates, ballast housings, and similar body parts, shall be made of extruded aluminum, galvanized stampings, or bonderized steel, as indicated. Housing end plates, socket bridges, reflectors, wiring channels and ballast covers shall be die formed of not less than No. 22 gauge cold rolled steel unless specified otherwise. Mount lamps on rapid-start circuits within one inch (1") of grounded metal, one inch (1") wide minimum and as long as the lamp. Wireways shall have adequate wiring space, accessible after fixture installation. Construct fixtures so that ballast may be serviced or replaced without removal of fixture housing from adjacent construction. Housing shall be adequately ventilated where required. Hardware shall have rustproof finish. Fixture bodies shall be painted before or after fabrication.
 - c. Temperatures around ballast and in fixture housing shall not exceed 90°C with ambient room temperature at 27°C.
 - d. Lighting fixtures shall have continuous light-seal gaskets seated in such manner as to prevent any light leaking through any portion or around any edge of the trim frame. Other sealing methods shall be individually reviewed.
 - e. Diffusers shall be framed in hinged continuous assembly, except where frameless units are indicated. Frameless units shall be removable without tools and opened or closed by hand pressure. Diffuser frame latches shall be spring-loaded or cam-operated.
 - f. Fluorescent fixture lenses, where required, shall be 100% extruded virgin acrylic, prismatic-type, nominal 0.125" thick, unless specified otherwise. Provide a minimum of eight hold-down lens retaining clips for troffers utilizing framed diffuser lenses.
 - g. Fluorescent fixtures in continuous rows shall be supplied with all fixture couplings, chase nipples, and other accessories recommended by the manufacturer for continuous row installation.
 - h. Fluorescent troffers shall be shipped prelamp, unless noted otherwise.
 - i. Parabolic louver fluorescent troffers shall be shipped with a plastic bag or film to protect the louvers from site conditions. Louver protection shall not be removed until the space where the fixture is installed is complete.
 - j. Supply air-type fluorescent fixtures shall be provided with adjustable air pattern control blades.
 - k. Lay-in fixtures shall be provided with hold-down clips per the NEC, minimum two clips per fixture.
2. LED Fixtures: Provide LED fixtures as scheduled on the Lighting Fixture Schedule, complete with LED light sources and drivers of the type, color, wattage and size scheduled.
 - a. Provide recessed LED fixtures with trim rings compatible with the ceiling material where fixture is to be installed. LED fixtures shall be prewired equipped with integral thermal protection. LED lighting fixtures shall be appropriately listed and labeled by Underwriters' Laboratories, Inc. for their final installation, i.e., damp or wet locations, etc.
 - b. Fixture body parts, comprising fixture housing, reflectors, wire channels, end plates, driver housings, and similar body parts, shall be made of extruded aluminum, galvanized stampings, or bonderized steel, as indicated. Housing end plates, socket bridges, reflectors, wiring channels and driver covers shall be die formed of not less than No. 22 gauge cold rolled steel unless specified otherwise. Mount lamps on rapid-start circuits within one inch (1") of grounded metal, one inch (1") wide minimum and as long as the lamp. Wireways shall

- have adequate wiring space, accessible after fixture installation. Construct fixtures so that driver may be serviced or replaced without removal of fixture housing from adjacent construction. Housing shall be adequately ventilated where required. Hardware shall have rustproof finish. Fixture bodies shall be painted after fabrication.
- c. Lighting fixtures shall have continuous light-seal gaskets seated in such manner as to prevent any light leaking through any portion or around any edge of the trim frame. Other sealing methods shall be individually reviewed.
 - d. Diffusers shall be framed in hinged continuous assembly, except where frameless units are indicated. Frameless units shall be removable without tools and opened or closed by hand pressure. Diffuser frame latches shall be spring-loaded or cam-operated.
 - e. Fixture lenses, where required, shall be 100% extruded virgin acrylic, prismatic-type, nominal 0.125" thick, unless specified otherwise. Provide a minimum of eight hold-down lens retaining clips for troffers utilizing framed diffuser lenses.
 - f. Lay-in fixtures shall be provided with hold-down clips per the NEC, minimum two clips per fixture.
 - g. Fixtures in continuous rows shall be supplied with all fixture couplings, chase nipples, and other accessories recommended by the manufacturer for continuous row installation.
 - h. LED Light Source Packages: LED light source packages, arrays and modules used in luminaires shall be tested in accordance with LM-80 lumen depreciation tests and shall have a L70 rated minimum life of 50,000 hours.
 - i. Solid state modules and driver shall be provided and warranted by luminaire manufacturer.
 - j. Utilize Zhaga compliant modules wherever applicable.
 - k. Solid-state modules shall have:
 - 1) Uniform color temperature of 3500K. Color temperature measurement shall have a maximum 3 SDCM on the MacAdam Ellipse for frosted lensed luminaires, and 2 SDCM for other luminaire types.
 - 2) Minimum color rendering index (CRI) of 80.
 - 3) LED module light output and efficacy shall be measured in accordance with IES LM-79 standards.
 - 4) Driver and LED module shall have a minimum rated life of 50,000 hours. LED life and lumen maintenance shall be measured in accordance with IES LM-80 standards.
 - 5) Individual LEDs shall be connected such that a failure of one LED will not result in a light output loss of the entire luminaire.
 - l. LED fixtures shall be properly heat sunk to assure LED junction temperature ratings are not exceeded. Manufacturer shall provide ambient operating temperature range for which product is warranted.
 - m. For instances where LED sources are mounted directly to architecture, such as installing a strip LED using an adhesive tape, the LED manufacture shall provide a recommended heat sink volume adequate to achieve rated L70 life.
 - n. Recessed fixtures shall be designed and installed to eliminate light leakage.
 - o. For recessed LED fixtures where junction box is required, shall be accessible when fixture is removed. Connect to conduit system with flexible conduit containing #14 (minimum) fixture wire.
 - p. Aluminum reflectors shall be Alzak (finish as selected) or as authorized and not less than 0.057" thick, unless specified otherwise.

- q. All fixtures specified for recessing in ceilings shall be supplied with prewired junction boxes.
 - r. LED fixtures shall have a minimum 5 year warranty covering failure of all electrical components.
3. Exit Signs: Provide LED exit signs as scheduled on the Lighting Fixture Schedule. Exit lighting fixtures shall meet the requirements of all applicable federal, state, and local codes.
- a. Exit sign battery packs, where scheduled, shall meet all specified requirements for Emergency Battery Backup Units as specified herein.
- K. Ballasts:
- 1. Energy Saving Electronic Ballasts - Indoor Fluorescent: Provide UL-listed, low noise, high power factor, rapid start, Class P, thermally protected, encased solid state energy saving ballasts for **all** indoor lighting fixtures. Ballasts shall operate at a frequency between 20 and 35 kHz and shall produce no visible lamp flicker. Ballasts shall operate lamps on parallel or series circuits and shall deliver normal lamp life. Lamp failure shall not affect ballast life. Ballasts shall comply with all applicable FCC and NEMA standards concerning EMI and RFI emissions and shall meet applicable ANSI standards related to harmonic distortion and surge suppression. Provide ballasts with a maximum power input wattage of 65 watts when installed in a surface-mounted, 2-lamp, strip fixture with standard F32 lamps. Ballasts power factor shall be 95% or greater and input current harmonic content shall not exceed **10%**. Electronic ballasts shall be program start. Ballasts shall be mounted in fixtures so as to provide maximum sound attenuation.
 - 2. Voltage: Ballasts for use on 120 volt systems shall be suitable and guaranteed for a voltage range of 100 to 130 volts. Ballasts for use on 277 volt systems shall be suitable and guaranteed for a voltage range of 225 to 290 volts.
 - 3. Warranty: All ballast shall carry a unconditional warranty against defects in materials or workmanship, including replacement, for five years from date of manufacture.
 - 4. Disconnects: Provide quick disconnect for disconnecting all fluorescent ballasts per the NEC.
- L. Drivers:
- 1. LED Drivers: Non-dimming and dimming LED drivers shall operate LEDs within the current limit specifications of the LEDs being driven.
 - a. LED drivers and LED modules shall have a minimum rated life of 50,000 hours. LED life and lumen maintenance shall be measured in accordance with IES LM-80 standards.
 - b. LED drivers shall be compatible with solid-state modules and control devices specified.
 - c. LED drivers shall operate from 60 Hz input source of 120V through 277V with sustained variations of +/- 10 percent (voltage and frequency).
 - d. All LED drivers shall have a Class A sound rating.
 - e. LED drivers shall operate from a 60 Hz power source, have a power factor >90%, a minimum efficiency of 70% at the full rated load of the driver.
 - f. LED driver input current shall have Total Harmonic Distortion (THD) of less than 10 percent when operated at nominal line voltage.
 - g. LED drivers shall have a Power Factor greater than 0.90.
 - h. LED drivers shall avoid interference with infrared devices and eliminate visible flicker.
 - i. LED drivers shall have integral short circuit and overload protection.
 - j. LED drivers shall comply with ANSI C62.41 Category A for Transient protection.

- k. LED Driver output voltage shall be regulated to $\pm 5\%$ over the published driver load range.
 - l. LED drivers shall have a minimum starting temperature of 0 degrees F and a maximum case temperature of 70 degrees C. Operating temperature range must be suitable field temperature conditions within exterior and gasketed fixtures.
 - m. LED Drivers shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
 - n. Dimming LED drivers shall be 3-wire, 0-10 VDC or phase shift as noted or scheduled on the drawings. Dimmable drivers shall be capable of continuous dimming over a range of 100% to 1% of rated lumen output where noted or scheduled on the drawings. Dimming drivers shall allow light output to be maintained at the lowest control setting, prior to off, without dropping out.
 - o. Control device must be compatible with type of LED driver, and coordinated prior to submission of shop drawings. List of compatible dimming controllers must include the range of perceived brightness. Flicker shall not be visible throughout the dimming range.
 - p. Operating temperature range must be suitable field temperature conditions within exterior and gasketed fixtures.
 - q. If driver is remote-mounted, provide maximum allowable distances for secondary wire runs to luminaires and provide remote mounting hardware and enclosures as required.
- 2. Remote Drivers: Where drivers are remote mounted from LED light engines, driver packs provided shall be capable of operating LED light engines under the LED light engines/Driver separation and temperature conditions encountered in the installation proposed for the project.
 - 3. Dimming Drivers: Wherever LED fixtures are to be dimmed, the fixture supplier shall coordinate the type of dimming driver to be used with the dimming/lighting control equipment supplier to ensure compatibility. Solid state dimming drivers shall be factory-furnished and installed in light fixtures. Dimming drivers shall be 0-10 VDC or as noted or scheduled on the drawings. Dimming drivers shall be capable of continuous dimming over a range of 100% to 1% of rated lumen output where noted or scheduled on the drawings. Dimming drivers shall allow light output to be maintained at the lowest control setting, prior to off, without dropping out.
 - 4. Voltage: Drivers for use on 120 volt systems shall be suitable and guaranteed for a voltage range of 100 to 130 volts. Drivers for use on 277 volt systems shall be suitable and guaranteed for a voltage range of 225 to 290 volts.
 - 5. Warranty: All LED drivers shall carry a unconditional warranty against defects in materials or workmanship, including replacement, for five years from date of manufacture including replacement for operation above the specified maximum case temperature. For LED sources and drivers, warranty shall include replacement for defects resulting in a fixture lumen depreciation $>30\%$.
 - 6. Disconnects: Provide quick disconnect for disconnecting all LED drivers per the NEC.
- M. Lamps:
- 1. General: Provide lamps of the wattage, type, color, and reflector lamps with type of beams indicated, as shown, and as scheduled. Provide extended service lamps that are inside frosted. Provide energy saving lamps for all fluorescent fixtures installed in indoor conditioned locations, unless otherwise noted. Incandescent and tungsten halogen lamps shall not be operated, other than for initial testing, prior to final inspection, or shall be replaced immediately prior to final inspection.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General:

1. Install lighting fixtures of the types indicated, where shown, and at the indicated heights in accordance with the fixture manufacturer's written instructions and recognized industry practices to ensure that the fixtures comply with the requirements and serve the intended purposes. Do not scale drawings for exact location of the lighting fixtures. In general, refer to the architectural reflected ceiling plans for proper locations of lighting fixtures. Fixtures shall exactly fit the type of ceiling system scheduled for the space.
2. Fixtures shown on the fixture schedule to be recessed shall be complete with plaster frames, mounting yokes, rod hangers, etc., and/or any other accessories required to fit the fixture to the ceiling construction. However, where ceiling system cannot maintain said support, fixture supports shall be provided and rigidly attached to the structural members of the building capable of carrying the weight of the fixture plus 200 pounds at each support without sagging. Provide the necessary supports for hangers located between structural members.
3. All lighting fixtures shall be grounded and bonded to the case with a green wire color and green screw originated from the panelboard.
4. All lighting fixtures that are installing butted together shall be properly grounded and bonded to the case with a green conductor wire color originated from the panelboard.
5. All lighting fixtures lenses must be clean before installing to the light fixtures.

B. Standards: Comply with NEMA standards, applicable requirements of the NEC pertaining to installation of interior lighting fixtures, and with applicable portions of the NECA's "Standard of Installation".

C. Connection: All individual lay-in fixtures in suspended ceilings, shall be connected back to the associated lighting grid outlet box by wire in 3/8" (minimum) flexible metallic conduit fixture-tails in lengths not to exceed 72"; or by Type MC cable fixture-tails where permitted by the local authority having jurisdiction, in lengths not to exceed 8'. All fixture tails shall have ground wire pulled with conductors.

D. Mounting: Fasten fixtures securely to the indicated structural support members of the building. Provide separate supports or mounting clips for all recessed ceiling-mounted lighting fixtures in accordance with the NEC. Check to ensure that solid pendant fixtures are plumb.

E. Appurtenances: Install each fixture properly and safely. Furnish and erect hangers, rods, mounting brackets, supports, frames, and other equipment required.

F. Coordination: Furnish lighting fixtures complete with appurtenances required for the proper, safe and distortion-free installation in the various surfaces in which they appear. Determine surface types from the Architectural drawings.

G. Instructions: Each lighting fixture shall be packaged with complete instructions and illustrations showing how to install. Install lighting fixtures in strict conformance with manufacturer's recommendations and instructions.

H. Lay-In Fixtures: Each lay-in light fixture shall be independently supported from the building structure with four wires; one at each corner. This requirement is separate and apart from ceiling grid wire supports. Also, fixtures shall be secured to the ceiling grid on all four sides by clips to the webs of ceiling grid tees. For renovation projects with ceiling replacements, reinstall existing light fixtures with the same support requirements as new fixtures: wires at each corner to the structure independent of the ceiling grid and with clips to webs of tees on 4 sides.

- I. Continuous Row Fixtures: Rigidly align all continuous rows of lighting fixtures for true in-line appearance.
- J. Pendant Fixtures: Install pendant lighting fixture plumb and at a height above the finished floor as specified in the drawings. In cases where conditions make this impractical, refer to the Architect for a decision. Use ball aligners and canopies on pendant fixtures unless noted otherwise.
- K. Surface Mount Fixtures: Install surface mounted ceiling luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- L. Chain Hung: Unless otherwise indicated all fluorescent fixtures in Mechanical, Electrical and Elevator Equipment Rooms shall be chain hung. Verify exact mounting height with Architect before installing fixtures. Chain-suspended lighting fixtures shall be connected to the outlet box mounted directly above the fixture using flexible metallic conduit or Type MC cable strapped to the fixture chain. Suspension chain shall be heavy duty nickel or cadmium-plated.
- M. Suspended Fixtures:
 - 1. Provide means of support for luminaires per NEC 410-36. T-bar clips shall be installed on the luminaire and shall be field secured to the inverted ceiling tees so that the luminaire is securely fastened to the ceiling system framing members.
 - 2. Ceiling tiles shall not bear the weight of luminaires. Surface mount luminaires, recessed downlights, light track, exit signs, etc. shall be supported by proper frames or other attachment to main ceiling system grid or building structure above ceiling.
 - 3. Luminaires shall be centered in ceiling tile.
 - 4. Luminaire shall have flange or trim ring for closure of ceiling cutout or opening.
 - 5. Provide four support wires to structure for each 2x4 fixture, one per corner.
 - 6. Fixture studs shall be provided in all outlet boxes from which fixtures are suspended. Fixtures shall not be suspended by means of cover or canopy screws. Canopies shall completely cover the ceiling opening of all ceiling fixtures except lay-in fixtures in T-bar construction, and trimless fixtures.
 - 7. Surface-mounted lighting fixtures (i.e. exit lights, etc.) are installed on lay-in panels in T-bar ceiling construction, the outlet boxes shall be rigidly supported to the ceiling system using metal channels spanning perpendicular across the T-bars and securely attached to each side of the outlet box.
- N. Outlet Boxes: The locations indicated for outlet boxes of lighting fixtures are diagrammatic. Outlets shall be located as required to coincide with suspension hangers where they occur and with structural and architectural elements of the building and shall be located in accordance with the Architectural Reflected Ceiling Plan.
- O. Fixture Designations: If a fixture-type designation is omitted, furnish fixture of the same type as shown for rooms of similar usage. Verify with Engineer before purchase and installation.
- P. Installation Sequence: Do not install fixtures or such parts as finishing plates and trims for recessed fixtures until all plastering and painting that may mar fixture finishes has been completed. Install reflector cones, baffles, aperture plates, light controlling elements for air handling fixtures, and decorative elements after completion of ceiling tiles, painting and general cleanup.
- Q. Mechanical Rooms: Lighting fixture locations in mechanical and electrical equipment rooms are approximate. Coordinate mounting height and location of lighting fixtures to clear mechanical, electrical and plumbing equipment and to illuminate adequately meters, gauges and equipment. Support all lighting fixtures independently of ductwork, piping and their supports.

- R. Concealment: Whenever a fixture or its hanger canopy is applied to a surface mounted outlet box, a finishing ring shall be utilized as necessary to conceal the outlet box.
- S. Wire Guards/Tube Guards: Wire guards or tube guards shall be provided for all fixtures with exposed lamps where installed in mechanical/electrical spaces; in all locations below 8'-0" above finished floor;] [and where lamps are exposed to damage.
- T. Emergency Backup Units: For non-switched applications connect ac input to switched and unswitched unit inputs, unless noted otherwise on Drawings. For switched applications provide a switched ac input to the unit switched input and a non-switched ac input to the unit non switched input.

3.2 AIMING AND ADJUSTMENT:

- A. All adjustable lighting units shall be aimed, focused, locked, etc., by the Contractor under the supervision of the Lighting Consultant. The Lighting Consultant shall indicate the number of crews (foreman and apprentice) required. All aiming and adjusting shall be carried out after the entire installation is complete.
- B. All ladders, scaffolds, etc. required for aiming and adjustment shall be furnished by the Contractor at the direction of the Lighting Consultant. As aiming and adjustment is completed, locking setscrews and bolts and nuts shall be tightened securely.
- C. Units shall be focused during the normal working day, where possible. However, where daylight interferes with precise focusing, aiming shall be accomplished at night.

3.3 CLEANUP:

- A. At the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturers, all broken parts shall have been replaced, and all lamps shall be operative. Replace blemished, damaged, or unsatisfactory fixtures as directed by Architect.

3.4 MAINTENANCE:

- A. The Contractor shall be responsible for obtaining from his supplying lighting manufacturers, for each type of lighting fixture, a recommended maintenance information which shall be included in the Project Operating and Maintenance Manuals. Minimum information shall include:
 - 1. Tools required.
 - 2. Types of cleaners to be used.
 - 3. Replacement parts identification list.
 - 4. Final as-built shop drawings.

3.5 WARRANTY:

- A. The Contractor shall warrant all fixtures, their finishes, and all of their component parts, to be free from defects for a period of one year from date of acceptance, if operated within rated voltage range. LED fixtures shall have a minimum 5 year warranty covering failure of all electrical components. Fixture installation shall be warranted for one year from the date of acceptance of the installation. During the warrantee period, repair or replacement of defective materials and/or repair of faulty workmanship or installation shall be provided at no cost to the Owner within 10 days of written notice of the defects as recorded and submitted by the Owner and/or Architect.

3.6 TESTING:

- A. General: Upon completion of installation of lighting fixtures and after building circuitry has been energized, apply electrical energy to demonstrate proper operation of lighting fixtures and controls.

When possible, correct malfunctioning units at the site, then retest to demonstrate proper operation; otherwise, remove and replace with new units and proceed with retesting.

- B. Fluorescent and LED Light Sources: Fluorescent and LED light sources may be utilized in the final finishing of the building.
- C. Pre-Inspection Tasks: Immediately before final inspection, thoroughly clean all fixtures inside and out, including plastics and glassware, adjust all trim to properly fit adjacent surfaces, replace broken or damaged parts and lamp, and test all fixtures for electrical and mechanical operation. Any fixtures or parts of fixtures, which have begun to show signs of rust or corrosion at the time of completion of the job, shall be removed and replaced with properly protected metal parts.
- D. Exit, Egress and Emergency Light Fixture Testing and Mapping: Test all installed exit, egress and emergency lighting per NFPA Standard 101 and compliance with applicable City of Houston Ordinances to confirm that all exit, egress and emergency lighting is installed as shown on the drawings and required by the Authority Having Jurisdiction (AHJ) and provide highlighted lighting plans, in the O&M manuals and in electronic format, clearly indicating all exit, egress and emergency lighting fixture locations.

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SECTION 16720

LOW-RISE ADDRESSABLE DEVICE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 1.01 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements" and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: The extent of fire alarm system work is as shown and scheduled and includes, but is not limited to, designing and providing new fire alarm devices connected to the existing building fire alarm system as shown on the drawings and required by applicable codes and standards. New devices shall be compatible with and UL listed for use with the existing fire alarm system.

1.3 STANDARDS:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the latest edition of the following standards:
 - 1. National Fire Protection Association Standards:
 - a. NFPA 70 National Electrical Code.
 - b. NFPA 72 Installation, Maintenance and Use of Protective Signaling Systems.
 - c. NFPA 72E Automatic Fire Detectors.
 - d. NFPA 72G Installation, Maintenance and Use of Notification Appliances for Protective Signaling Systems.
 - e. NFPA 72H Testing Procedures for Local, Auxiliary, Remote Station and Proprietary Protective Signaling Systems.
 - f. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
 - g. NFPA 101 Life Safety Code.
 - h. NFPA 13 Sprinkler Systems.
 - 2. Underwriters' Laboratories, Inc. Requirements and Listing for use in Fire Protective Signaling Systems as follows:
 - a. UL 864 Control Panels.
 - b. UL 268 Smoke Detectors - Systems.
 - c. UL 268A Duct Smoke Detectors.
 - d. UL 217 Smoke Detectors - Single/Multiple Station.
 - e. UL 521 Heat Detectors.
 - f. UL 228 Door Holders - Closers.
 - g. UL 464 Audible Signaling Appliances.

- h. UL 1638 Visual Signaling Appliances.
 - i. UL 38 Manual Alarm Stations.
 - j. UL UOJZ.
3. International Building Code 2006 edition and the requirements of state and local authorities having jurisdiction.
4. Comply with requirements of the Texas Accessibility Standards(TAS), 1994 and the Americans with Disabilities Act of 1990.

1.4 QUALITY ASSURANCE:

- A. Manufacturers: The existing building fire alarm system is a Simplex 4100ES, contractor to confirm, and all new fire alarm devices shall be product by the existing system manufacturer or UL listed for use with and compatible with the existing Simplex fire alarm system.
- B. Programming and Installation: All system programming, modifications and device installation shall be performed by Simplex Grinnell.
- C. UL and FM-listing: All fire alarm system components shall be UL and FM listed for fire alarm use. The UL listing shall be under category UOJZ to assure that the entire system has been tested as an integral life safety system.
- D. All equipment furnished shall be the current standard products of a single manufacturer and shall bear the label of the Underwriters' Laboratories for use in fire alarm system designed in compliance with the requirements of NFPA codes. Raceways, wiring and terminations shall be accomplished in compliance with the requirements of the National Electric Code, Article 760, except that all exposed fire alarm wiring shall be in EMT or an approved raceway.
- E. The system as installed shall, upon completion, be certified by a state licensed fire alarm installation superintendent to the Owner as being installed in compliance with the specification, the requirements of all state and local codes, and as being operational and free from defects.
- F. All system equipment supplied shall be listed by the Underwriters' Laboratories for NFPA 72 system use, and all applicable NFPA Codes.
- G. The installing contractor shall be authorized and designated representative of the fire alarm system manufacturer to sell, install and service the manufacturer's equipment and shall stock the required spare parts to keep the system in operation. The installing contractor shall maintain a staff of specialists for technical assistance and system maintenance.
- H. The installing contractor must be licensed by the State Fire Marshal to sell, install, and service fire alarm system as required by Article 5.43-2 of the Texas Insurance Code.
- I. The installing contractor shall have on his staff a minimum of five installation superintendents who are licensed by the State Fire Marshal's office for such purpose and under whose supervision installation, final connections and check out will take place, as required by the Texas Insurance Code.
- J. The installing contractor or equipment supplier shall have a staff a minimum of one certified NICET Level III state licensed fire alarm planning superintendent under whose supervision system design shall take place.
- K. Where approved in writing by the system manufacturer and installing contractor, the Electrical Contractor may install all conduit and boxes. The system wiring shall be pulled in by the installing contractor. All system connections, device installation, system start-up and testing shall be performed by the installing contractor. Rough-in by the electrical contractor shall not in any way affect the system manufacturer's and installing contractor's full responsibility for the installed fire alarm system.
- L. All wiring shall be listed for limited energy fire alarm use and rated for 300 volts minimum.

- M. The complete combination fire alarm system shall comply with the State of Texas Building and Fire codes. Modifications required to provide compliance shall be made at no cost to the Owner. Where Contract Document requirements are in excess of Code requirements are permitted under the Code, the Contract Documents shall govern.

1.5 **SUBMITTALS:**

- A. Shop Drawings submittals shall include, but not be limited to, the following:
1. A written description of the system operation (written in this specification format), with all exception and/or deviations clearly highlighted or identified.
 2. A block diagram showing system components, wire runs, wire counts and wire sizes.
 3. Calculations justifying battery size, power supply size, amplifier size, and wiring sizes based on worst case occurrence.
 4. Manufacturer's descriptive literature for all panels, modules and peripheral equipment describing size, color, finish, capacity and electrical characteristics.
 5. A complete listing of all associated software showing the relationship of alarm points, control outputs, control inputs and indicators.
 6. An alarm matrix showing alarm and control function for an alarm in each device/zone.
 7. Scaled floor plan drawings locating and naming each device/zone and showing wiring and conduit sizes from each device back to the transponders.
 8. Completely identified and marked catalog cuts of all associated equipment and devices, with all non-applicable items crossed out, or applicable devices clearly highlighted and/or identified.
 9. Complete and detailed point-to-point wiring diagrams for all devices in the system.
 10. Complete Bill of Material for all equipment.
 11. A printout showing the proposed custom software messages for each device/zone and for each control function.
 12. A copy of the form to be used for final tests, 100% audit and checkout shall be submitted for approval.
 13. Additional information as required in Section 16002.

1.6 **DELIVERY, STORAGE AND HANDLING:**

- A. Deliver fire alarm system components in factory-fabricated containers.
- B. Store in a clean, dry space and protect from the weather.
- C. Handle control and annunciator panels carefully to avoid damage to material components, enclosure and finish.

PART 2 - PRODUCTS

2.1 **MATERIALS AND COMPONENTS:**

- A. General: Provide the required fire alarm system products in the sizes and capacities required or indicated, complying with the manufacturer's published product information of standard materials and components, designed and constructed for the applications indicated.

2.2 SYSTEM OPERATION:

- A. Sequence of operation for new system components shall match the existing fire alarm system sequence of operation for similar components.

2.3 SYSTEM DEVICES:

- A. System devices shall be located as shown on the Drawings and all applicable codes and standards as determined by the fire alarm system designer. The Contractor shall refer to all the drawings and all applicable codes and standards to determine where devices are to be located.

2.4 SYSTEM ZONING:

- A. System zoning is existing and shall be maintained.

2.5 SMOKE AND HEAT SENSORS/DETECTORS:

- A. Intelligent "Ceiling-mounted" Photoelectric Smoke Sensors: Provide analog photoelectric smoke sensors where indicated on the Drawings.
 - 1. The intelligent photoelectric smoke sensors shall connect via two wires to one of the intelligent control panel loops.
 - 2. The sensors shall use the photoelectric principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
 - 3. The sensors/control panel shall provide automatic sensitivity "drift" compensation to provide longer term stability and reliability. The sensor shall also provide a "maintenance alert" feature whereby the detector shall initiate a trouble condition should the units sensitivity approach the outside limits of the normal sensitivity window.
 - 4. The sensor shall be provided with extensive RF and EMF noise reduction circuitry.
 - 5. The sensor shall employ sophisticated self-compensating solid state LED light source and photosensitive circuitry.
 - 6. The sensor/control panel shall provide a calibrated test method whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself, by activating a magnetic test switch, or may be activated remotely on command from the control panel.
 - 7. The sensors shall provide address-setting means on the sensor head using rotary decimal switches. No binary coding shall be required. The sensors shall also store an internal identification code which the control panel shall use to identify the type of sensor.
 - 8. The sensors shall provide dual alarm and power/status LEDs. Status LEDs shall flash under normal conditions, indicating that the sensor is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected and verified. An output connection shall be provided in the base for connecting an external remote alarm LED.
 - 9. The sensor shall be semiflush ceiling-mounted and be provided with modular detector head with twist-lock base. Sensors shall also be suitable for surface-mounting below the raised floor or above the ceiling. Sensors shall be provided in smooth attractive white finish, and sealed against dirt, vermin, and back pressure. Sensors shall be provided with fine mesh insect/contaminate screen.
 - 10. Sensors shall be UL listed with respective control panel.

- B. Intelligent "Duct Mounted" Photoelectric Smoke Sensors: Provide duct-mounted analog photoelectric smoke sensor where shown on the Drawings.
1. Sensors shall operate on the same principles and exhibit the same basic characteristics as area type "intelligent" smoke sensors. The unit shall be capable of interchanging/accepting either photoelectronic or ionization type sensors.
 2. The sensor shall operate in air velocities of 300 FPM to 4,000 FPM without adverse effects in detector sensitivity.
 3. Each sensor shall operate directly with the intelligent control panel loop, without an interface module.
 4. The unit shall consist of a Noryl molded plastic enclosure with molded integral conduit knock-outs. The unit shall be provided with clear faceplate cover to provide visual viewing of detector/sensor for monitoring sensor operation and chamber condition. The duct housing shall be provided with gasket seals to provide proper sealing of housing to mechanical ductwork and to ensure proper air flow into the detector sampling chamber. Duct housing shall be designed to easily mount to rectangular or round ducts.
 5. The duct sensor unit shall be UL listed to the most current UL 268A standard and be cross-listed for use with the fire alarm control panel.
 6. Each duct sensor unit shall be equipped with sampling tubes protruding into the associated ductwork. Sampling tubes shall extend the width of the duct. Sampling tubes shall be provided with integral porosity filter system to aid in reducing detector contamination. Sensors shall be installed per NFPA 90A.
 7. Duct sensors shall be provided with remote alarm indicator (remote alarm indicator/test switch). Remote unit shall be mounted on single gang, stainless plate and be located in an accessible location for easy viewing and monitoring.

2.6 OUTPUT DEVICES:

- A. Control Module (Addressable Output Device): Provide control/relay modules where required to provide audible alarm interface and/or relay control interface.
1. The control module shall be used to connect a supervised zone of conventional indicating devices (any 24 volt polarized audiovisual indicating appliance) to an intelligent loop. The zone may be wired Class A or Class B field-selected. The control module may be optionally-wired as dry contact (Form C) relay.
 2. The control module will mount in a standard 4" electrical box.
 3. Power for the relay actuation shall be provided by the intelligent detector loop to reduce wiring connection requirements. Audio/visual power shall be provided by a separate loop from the main control panel or from supervised remote power supplies.
 4. The control module shall provide address-setting means using rotary decimal switches and shall also store an internal identification code which the control panel shall use to identify the type of device. No binary coding shall be required. A status LED shall be provided which shall flash under normal conditions, indicating that the control module is operational and in regular communication with the control panel. The LED shall illuminate steady when the device is actuated via the Fire Alarm Control Panel.
- B. Auxiliary Control Relays: Air Products, Notifier or approved equal relays shall be provided for control interface. Relays shall be heavy duty type and rated up to 20 amps at 120 volts ac, 60 Hz. Relays shall be provided with NEMA 1 dust cover assembly and be provided with DPDT contacts.

2.7 ALARM SIGNAL DEVICES:

- A. Ceiling Mounted Fire Alarm Horns in Finished Areas: Flush mounted fire alarm horns shall be provided.
 - 1. Horns shall be listed under UL Standard 1480, meet all specifications of the Life Safety Code and be capable of reproducing both tone alerts. Horns shall have built in matching transformer, field selectable multiple power taps and circuitry for speaker/line supervision. Horns shall be provided with screw terminal connection points.
 - 2. Horns shall be 4" round or square with textured white decorative metal grill. Horns shall be tapped to produce a minimum sound-pressure level of 87 dBA at 10'.
 - 3. Horns shall be ceiling mounted and located as required by NFPA 72 and as located on the drawings.
- B. Wall Mounted Fire Alarm Horns /Visual Signals in Unfinished Areas: Recess/surface mounted fire alarm speakers with integral visual signals or equal shall be provided.
 - 1. Horns shall be listed under UL Standard 1480, meet all specifications of the Life Safety Code and be capable of reproducing both tone alerts Horns. Horns shall have built in matching transformer, field selectable multiple power taps and circuitry for speaker/line supervision. Horns shall be provided with screw terminal connection points.
 - 2. Horns shall be 4" round or square with textured white decorative metal grill. Horns shall be tapped to produce a minimum sound-pressure level of 87 dBA at 10'.
 - 3. Horns shall be and located as required by NFPA 72 and as located on the Drawings.
 - 4. Visual alarm signals shall be integral with audible alarm device where shown on the Drawings. Strobe lettering shall be oriented with lettering properly oriented with letters vertical, with strobe unit installed.
 - 5. Visual units shall be of the electronic flashing xenon strobe type and operate on 24 volts dc. Lights shall operate in unison with audible alarm signals and continue flashing upon silencing of alarm signals. Each unit shall produce NPFA 72 required candela.

2.8 SYSTEM WIRING:

- A. System wiring shall match and be compatible with the existing fire alarm system. All exposed fire alarm wiring shall be installed in conduit.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Installer shall examine the areas and conditions under which the fire alarm system devices are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 SYSTEM DESIGN:

- A. General: The basic device locations have been shown on the contract drawings. Specific wiring between equipment/devices has not been shown. It is the Contractor's responsibility to submit for approval the COMPLETE ENGINEERED system configuration and layout showing all devices, wiring, conduit, and locations along with other required information as specified herein.

3.3 PROGRAMMING:

- A. General: Provide all required programming to add new devices to the existing fire alarm system.

3.4 **INSTALLATION:**

- A. **General:** Install system and materials in accordance with manufacturer's instructions, roughing-in drawings, and details on the Drawings. Install electrical work and use electrical products complying with the requirements of the applicable Division 16 sections of these Specifications. Mount manual stations and alarm devices at heights specified in Section 16100, "Basic Materials and Methods".
- B. **Wiring:** All wiring shall be in accordance with NFPA 72, the National Electrical Code, Local Codes, and Article 760 of NFPA Standard 70. All wiring sizes shall conform to recommendations of the equipment manufacturer, and as indicated on the engineered shop drawings.
 - 1. Install fire alarm system line voltage and low-voltage wiring in a suitable raceway. Conceal fire alarm system conduit except in mechanical rooms and areas where other conduit and piping are exposed. Fasten flexible conductors, which bridge cabinets and doors, neatly along hinge side and protect against abrasion. Tie and support the conductors neatly.
 - 2. All wiring shall be run in a supervised fashion (i.e. no branch wiring or dog-legged wiring) per NFPA requirements such that any wiring disarrangement will initiate the appropriate trouble signals via the main control panel per NFPA and UL requirements. Intelligent SLC loops may be T-tapped/branch wired due to inherent dynamic supervision.
 - 3. Wiring splices shall be kept to a minimum with required splices to be made in designated terminal boxes or at field device junction boxes. Transposing or color code changes of wiring will not be permitted. End-of-line supervisory devices shall be installed with the last device on the respective circuit. Said device shall be appropriately marked designating it as the terminating device on the respective circuit.
 - 4. No AC wiring or any other wiring shall be run in the same conduit as fire alarm wiring.
 - 5. Number code and color code conductors appropriately and permanently for future identification and servicing of the system.
- C. **Conduit/Raceway:** All wire shall be installed in an approved conduit/raceway system (except where permitted by NEC and the local authority having jurisdiction). Maximum conduit "fill" shall not exceed 40% per NEC.
 - 1. Conduit and raceway system shall be installed as specified other Sections of the Specifications.
 - 2. Minimum conduit size shall be 3/4" EMT. Install conduit per engineered shop drawings. Conduit and raceway system shall be installed as specified under the general electrical sections of the specifications and per NEC. Maximum conduit "fill" shall not exceed 40% per NEC.
 - 3. Systems utilizing open wiring techniques with low smoke plenum cable shall provide conduit in all inaccessible locations, inside concealed walls, all mechanical/electrical rooms, or other areas where wiring might be exposed and subject to damage.
- D. **Labeling:** All system controls, indicators and other devices shall be labeled with names, designations and operating instructions as applicable. Labels shall be either engraved nameplates or covered printed labels and shall be approved by the Engineer. All water flow switches which are hidden shall have identification points. These identification points shall be red tags with white lettering indicating location of the water flow switch.
- E. **Checkout:** Check wiring to ensure that wiring is in accordance with the system manufacturer's wiring diagrams and that the system is free of open circuits, short circuits, and grounds.
- F. **Identification:** Refer to Section 16100 for additional requirements concerning painting, nameplates, and labeling.

3.5 COORDINATION:

- A. It shall be the responsibility of the installing contractor to coordinate all requirements surrounding installation of the fire alarm system with all trades. Adequate coordination shall be provided to ensure proper installation and interface to all peripheral items required to interact with the fire alarm to provide a complete and functional life safety system.
- B. The installing contractor shall be fully responsible for coordinating all system and device messages and system operation with UTHealth EH&S and Operating Personnel.

3.6 SYSTEM CHECKOUT AND TEST:

- A. All final control panel connections shall be made by a state licensed, factory-trained technical representative of the manufacturer and who shall supervise a System Checkout and Test to demonstrate and confirm to the Engineer, UTHealth EH&S and the fire department, that the fire alarm system is 100% operational upon completion of the installation, and that it complies with all local code requirements and these specifications. It is intended that the System Checkout and Test be followed by a continuing program of inspection testing and maintenance. The Contractor shall provide a proposal to the Owner for a Maintenance, Inspection and Quarterly Testing Contract in compliance with NFPA 72H, upon completion and system checkout.
- B. The System Checkout and Test shall be performed within 30 days after the fire alarm installation and all peripheral systems are completed. The System Checkout and Test shall be performed by a minimum of two licensed fire alarm system technicians, one of which is licensed by the State of Texas, and acceptable to the Engineer and the authority having jurisdiction. The test shall be performed in two parts and two-way radios for use by the test observers shall be provided. The first part shall be a full dry-run test with all subcontractors present, but without UTHealth EH&S or fire department present. After the dry-run test is successfully completed, then the final test with UTHealth EH&S and fire department present shall be performed.
- C. This Contractor shall coordinate the test schedule with all necessary parties and subcontractors required to be present for a complete and functional test.
- D. The System Checkout and Test which is a comprehensive 100% inspection and test of all new fire alarm system equipment and shall include, but not be limited to the following:
 - 1. Fire Alarm Control Equipment:
 - a. A visual and functional test of all fire alarm control and auxiliary control equipment.
 - b. A visual inspection shall be conducted to establish that all electrical connections and equipment as required are properly installed and operating.
 - c. A remote functional fault simulation test shall be conducted on all relevant field wiring terminations to ensure that all wiring is properly supervised as required.
 - d. All indicators shall be tested to ensure proper function and operation.
 - e. All device messages shall be verified to be correct, as installed.
 - f. All system auxiliary functions including, but not limited to, CPU reporting, elevator recall, fire/smoke door and shutter control, security interface, HVAC equipment control and shutdown, smoke control initiation, and other specified control functions shall be functionally tested to verify proper operation and proper system messages.
 - g. Control panel supervisory and alarm current readings shall be taken to verify that the control panel has the appropriate power supplies and standby batteries to operate the system as required. A 3 minute general alarm stress test both under ac power and standby power shall be conducted to further ensure complete operation of the system.

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SECTION 16741

VOICE/DATA SYSTEM PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 16002, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide voice/data provisions and raceway system work as shown, scheduled, indicated, and as specified.
- B. System Installation: Voice/data system wiring, connections, outlets, instruments, devices and accessories will be provided under a separate contract.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. Wall Type Voice/Data Outlets (Accessible Ceiling Areas): Provide a Caddy MPS1 (new partitions) or Caddy MP1 (existing partitions) or equal single gang drywall mounting plate with a Caddy MSG or equal grommeted hole in the wall top plate above the outlet and a pullcord from the outlet to the ceiling space for voice/data outlets located in accessible ceiling areas.
- B. Wall Type Voice/Data Outlets (No Ceiling and Non-accessible Ceiling Areas): Provide a single gang wall outlet box with a 3/4" conduit with pull string to an accessible ceiling area for voice/data outlets located in inaccessible ceiling areas.

PART 3 - EXECUTION

3.1 INSTALLATION OF RACEWAY SYSTEM:

- A. General: Refer to Section 16100, "Basic Materials and Methods", Section 16110, "Electrical Raceways and Fittings" and Section 16112, "Electrical Boxes and Fittings" for installation requirements of the voice/data raceway systems.
- B. Pullcords: Provide a polypropylene pullcord in all voice/data conduits and to all voice/data outlets.
- C. Air Plenums: All cable in return air plenums shall be installed in an approved raceway or shall be of a cable construction UL-approved for installation in air plenums.

END OF SECTION

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MSB 1st Floor Infill LRC 3 & 4



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ABBREVIATIONS

Table with 2 columns: Abbreviation and Description. Includes entries for AIR (COMPRESSED), ABOVE, AIR CONDITIONING, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for INSIDE DIAMETER, INCH, INCANDESCENT, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for TRENCH DRAIN, TOTAL DYNAMIC HEAD, TELEPHONE, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for BELOW COUNTER, BUILDING, BENCHMARK, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for LENGTH, LAVATORY, LINEAR FEET, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for VOLT, VENT, VACUUM, VOLT-AMPERE, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for CONDUIT, CELSIUS, CUBIC FEET PER MINUTE, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for METER, MAXIMUM, THOUSAND OF BTU'S, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for WATT, WASTE, WIDTH, WITH, WITHOUT, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for DEPTH, DRAIN, DECIBEL, DRY BULB, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for NORMALLY CLOSED, NATIONAL ELECTRICAL CODE, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for ELBOW UP, ELBOW DOWN, DIRECTION OF FLOW, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for EACH, ENTERING AIR TEMPERATURE, ECCENTRIC, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for PUMP, PLUMBING EQUIPMENT, PRESSURE DROP, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for FLOOR CLEANOUT, FLOOR CLEANOUT, FLOOR CLEANOUT, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for FARENHEIT, FIRE, FIRE ALARM, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for RISER, RETURN AIR, RETURN AIR GRILL, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for MISCELLANEOUS, PLUMBING FIXTURES, POINT OF NEW CONNECTION, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for GAS, GAGE, GALLON, GALVANIZED, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for SUPPLY AIR, SUPPLY AIR FAN, SANITARY SEWER, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for DRAWING/DETAIL REFERENCE KEY, REFER TO DRAWING/DETAIL NUMBER, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for HEIGHT, HOSE BIBB, HEAD, HUB DRAIN, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for SQUARE FEET, SQUARE FEET, SQUARE FEET, etc.

Table with 2 columns: Abbreviation and Description. Includes entries for ELECTRICAL EQUIPMENT, DISTRIBUTION PANEL, SWITCHBOARD, etc.

MEP SYMBOLS (ALL SYMBOLS SHOWN ARE NOT NECESSARILY USED ON THE DRAWINGS)

PIPING TYPES

Table of piping symbols including CHS (CHILLED WATER SUPPLY), CHR (CHILLED WATER RETURN), HWR (HEATING HOT WATER SUPPLY), etc.

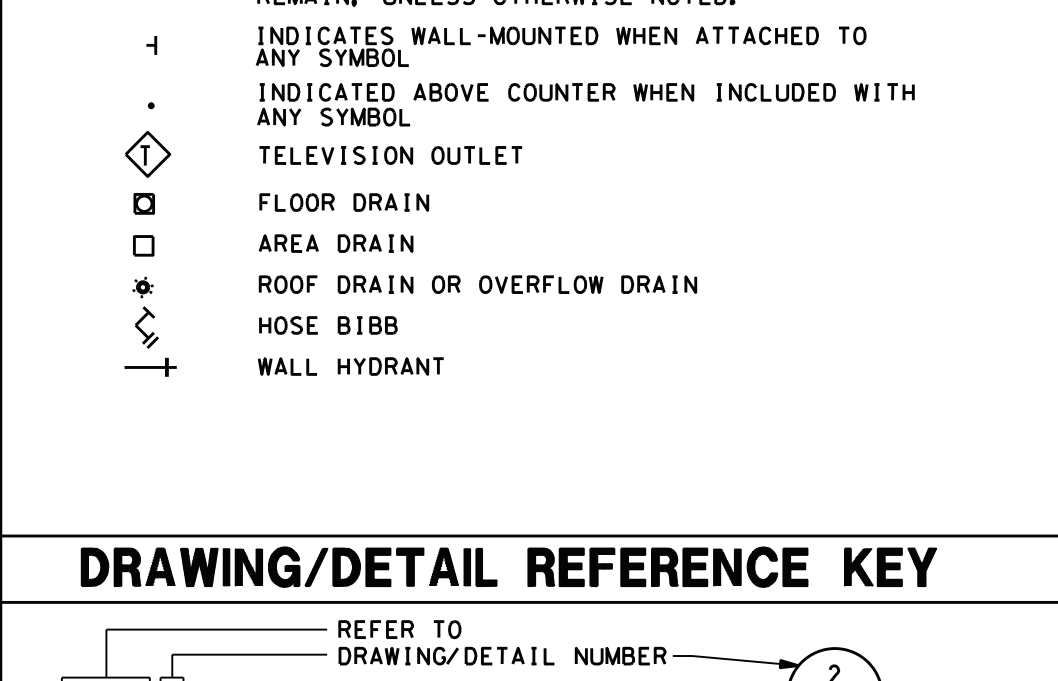
PIPING SYMBOLS

Table of piping symbols including ELBOW UP, ELBOW DOWN, DIRECTION OF FLOW, CONCENTRIC REDUCER, etc.

MISCELLANEOUS

Table of miscellaneous symbols including PLUMBING FIXTURES, POINT OF NEW CONNECTION, DRAWING NUMBER REFERENCE, etc.

DRAWING/DETAIL REFERENCE KEY



DUCTWORK

Table of ductwork symbols including SUPPLY AIR DIFFUSER, EXISTING SUPPLY AIR DIFFUSER, RETURN AIR OR EXHAUST GRILL, etc.

FIRE ALARM

Table of fire alarm symbols including FIRE ALARM CONTROL PANEL, FIRE ALARM REMOTE ANNUNCIATOR, FIRE ALARM AUDIO VISUAL SIGNAL, etc.

PANEL DESIGNATIONS

Table of panel designations including 2HEA-3, 2* DENOTES FLOOR WHERE PANEL IS LOCATED, etc.

ELECTRICAL EQUIPMENT

Table of electrical equipment symbols including DISTRIBUTION PANEL, SWITCHBOARD OR MOTOR CONTROL CENTER, NEW PANELBOARD, etc.

MOTORS AND CONTROLS

Table of motor and control symbols including SINGLE OR THREE PHASE MOTOR, ELECTRIC DUCT HEATER, DISCONNECT (SAFETY) SWITCH, etc.

LIGHTING

Table of lighting symbols including NEW INCANDESCENT OR HID LIGHTING FIXTURE, EXISTING INCANDESCENT OR HID LIGHTING FIXTURE, etc.

SWITCHES

Table of switch symbols including NEW SWITCH, RELOCATED EXISTING SWITCH, EXISTING SWITCH TO REMAIN, etc.

RECEPTACLES AND OUTLETS

Table of receptacle and outlet symbols including SIMPLEX WALL RECEPTACLE, NEW DUPLEX WALL RECEPTACLE, EXISTING DUPLEX RECEPTACLE, etc.

CIRCUITING AND WIRING

Table of circuiting and wiring symbols including CIRCUIT CONCEALED IN WALL OR CEILING, CONDUIT CAST IN CONCRETE OR BELOW SLAB, EXPOSED CONDUIT, etc.

CIRCUITING NOTES

- 1. THE LIGHTING PLANS INDICATE SWITCHING AND BRANCH CIRCUIT NUMBERS FOR ALL LIGHTING FIXTURES... 2. BRANCH CIRCUIT HOMERUNS SHALL BE LIMITED TO THREE PHASE CONDUCTORS... 3. ALL LAY-IN LIGHTING FIXTURES SHALL BE CONNECTED TO A BRANCH CIRCUIT...

GENERAL NOTES

- A. ALL MECHANICAL, ELECTRICAL & PLUMBING WORK SHALL COMPLY WITH ALL APPLICABLE STATE AND LOCAL BUILDING CODES... B. THE MECHANICAL, ELECTRICAL & PLUMBING CONTRACTORS SHALL VISIT THE PROJECT... C. ALL DUCTWORK SIZES SHOWN ARE FREE AIR STREAM DIMENSIONS... D. ALL SUPPLY AIR DIFFUSERS ARE 4-WAY THROW... E. AIR DEVICES WHICH ARE INDICATED TO BE REMOVED AND REUSED SHALL BE CLEANED PRIOR TO REUSE... F. WIRING DEVICES WHICH ARE INDICATED TO BE REMOVED AND REUSED SHALL BE CHECKED PRIOR TO REUSE...

DRAWING LIST

Table listing drawing titles and sheet numbers, including MEPO.0 MECHANICAL/ELECTRICAL/PLUMBING SCHEDULES AND DETAILS, M1.0GAE MECHANICAL DEMOLITION AND ALTERATION PLANS GROUND FLOOR EAST, etc.



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Issue / Revision table header

Table with 3 columns: No., Date, Description. Row 1: 1, 03/31/2016, Issue for Construction

Project

UT Health MSB 1st Floor Infill LRC 3 & 4



The University of Texas Health Science Center at Houston

Issued Date

MECHANICAL/ELECTRICAL/PLUMBING SYMBOLS/ABBREVIATIONS/GENERAL NOTES

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SECTION 15900

BUILDING CONTROLS AND AUTOMATION (BAS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15002, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: This Section require the furnishing and installing of an expansion of the existing JCI MetaSys Building Control and Automation System (BAS) to control new mechanical equipment being provided under the project scope, complete including all items specified herein, indicated on the Drawings or reasonably inferred as necessary for safe and proper operation, monitoring and control; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, programming supervision, supplies, equipment, transportation, storage, utilities and all required permits and licenses. All work performed under this Section shall be in accordance with the Drawings and Specifications and subject to the terms and conditions of the Contract. For purposes of these Specifications, "provide" and "furnish and install" shall be synonymous. Owner's Representative (OR) shall refer to the individual designated by the owner to receive and distribute correspondence with the contractor.
- B. Drawings: Refer to the Mechanical, Plumbing and Electrical Drawings for graphic representations, schedules, and notations showing building control and automation work.
- C. Work Included: This Work includes the furnishing of all labor, materials, equipment, fixtures, apparatus, and appurtenances required for complete installation of operating Building Control and Automation System expansion as specified, in place and ready for service. Provide labor, materials, tools, machinery, equipment, appliances, and services necessary to complete the specified building control and automation work of this Division. Coordinate Work with other trades to prevent conflicts without impeding job progress. The Work includes, but is not limited to, the following systems, equipment and services:
 - 1. An expansion of the existing Johnson Controls, Inc. (JCI) Metasys Building Control and Automation System (BAS), furnished and installed by the JCI Houston office, as specified and required to provide controls and monitoring for new Building and M/E/P systems being installed under the project as specified and shown on the drawings.
 - 2. All the necessary controls, wiring and installation shall be provided under this Division. System to be installed shall be as specified in this Division providing a complete system of electronic and computer devices to perform the sequences and programs outline herein, including, but not limited to:
 - a. Electric and electronic control and operation for items shown on the Drawings, to provide the specified Sequence of Controls, and as specified hereinafter including sensors, relays and motors. Electric damper operators and control valves furnished to the appropriate trade as specified under the Work of other Sections.
 - b. Control panels as specified hereinafter and as shown on the Drawings.
 - c. The existing PC based central computer and associated peripherals and software shall be reused with additional components and programming as required.
 - 3. Other miscellaneous control system and components as shown on the Drawings and/or specified herein.

4. Testing, balancing, and adjusting of building automation and control systems as specified.
 5. Additional items as shown on the Drawings or specified.
- D. Work of Other Sections: Requirements given within this Section apply to the Work of all Sections of this Division. The actual performance of the Work stays within the Section in which it occurs; but subject to the requirements of this Section to the extent applicable.
1. Owner's Representative (OR) shall refer to the individual designated by the owner to receive and distribute correspondence with the contractor. Finish painting of mechanical systems in areas exposed to the view of building occupants is specified in other Divisions. All prime and protective painting for all areas and finished painting of mechanical systems in areas not exposed to the view of building occupants shall be provided under this Division.
 2. Installation of electrical control power which is not specified as an integral part of equipment specified under this Division is specified under Division 16 and where shown on the Electrical Drawings. Necessary conduit, wiring, boxes, and fittings are specified under Division 16.
 3. Finish painting of BAS systems in areas exposed to the view of building occupants is specified in other Divisions. All prime, finished and protective painting and finished painting of BAS systems in areas not exposed to the view of building occupants shall be provided under this Division.
 4. Access doors in finished surfaces are provided under this Division and installed by the Contractor installing the finished surface. Locations are as shown on the Drawings and as required for proper equipment access.
 5. Owner and General Contractor-furnished equipment is furnished and installed under other Divisions. Proper BAS provisions, including rough-in and final equipment connections, are included in the Work of this Division.
 6. The following work shall be provided by the Division 15 Contractor under other sections of this Specification:
 - a. Install immersion wells, pressure taps and any associated shut-off cocks.
 - b. Install flow switches.
 - c. Install automatic control valves.
 - d. Install level switches.
 - e. Furnish and install venturi flanges.
 - f. Install venturis and flow sensors.
 - g. Furnish automatic valve flanges and flange gaskets, increasers, reducers, nuts and bolts as required.
 - h. Furnish flare nuts for unitary valves.
 - i. Furnish union fittings where required in unitary equipment for service of automatic valves, including necessary transitions.
 - j. Install automatic control dampers.
 - k. Provide necessary transitions and blank-off plates required to install dampers that are different than duct size.
 - l. Assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper motors.
 - m. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation and affix and seal permanently in place only after stratification problem has been eliminated.

- n. Provide access doors or other approved means of access through ducts for service to control equipment.
 - o. Include necessary duct transitions to provide velocities as recommended by airflow station manufacturers.
7. The Division 16 Contractor shall:
- a. Provide control power to all BAS control panel locations as shown on the Electrical Drawings and the power supply to the temperature control air compressors. All BAS control wiring and other required control power shall be included in the work of Division 15.
 - b. Fire alarm interface relays and addressable input devices shall be provided by Division 16. Control wiring to these relays shall be by Division 15.
8. Refer to Section 15950 "Sequence of Operation" for BCAS sequences of operation and device naming requirements.
- E. Drawings: Refer to the Mechanical and Plumbing Drawings for graphic representations, schedules, and notations showing mechanical and plumbing work.
- F. Specifications: Refer to this Division for the primary technical specifications of mechanical and plumbing work.
- G. Workmanship: All mechanical and plumbing work shall be constructed and finished in every respect in a workmanlike and substantial manner. Furnish and install all work as may be necessary to complete systems in accordance with the best trade practice and to the satisfaction of the OR and Engineer. The entire installation shall be ready in every respect for satisfactory and efficient operation when completed. The OR and Engineer will interpret the meaning of the drawings and specifications and will reject all work and materials which, in their judgment, is not in full accordance therewith.
- H. Certification: Submit a single certification stating that all portions of the work are in accordance with contract requirements. Warranty all work against faulty and improper material and workmanship for a period of one year from date of final acceptance by the OR, except that where guarantees or warranties for longer terms are specified by contract, such longer term shall apply. At no additional cost to Owner, within 24 hours after notification, correct any deficiencies which occur during the warranty period, to the satisfaction of the Owner.
- I. Safe Work Place: The Contractor covenants and agrees that he and his Subcontractors and his and their agents and employees will provide and maintain a safe place to work and will comply with all laws and regulations of any governmental authorities having jurisdiction thereof, and the contractor agrees to indemnify, defend and hold harmless, the Engineer and Owner from and against any liability, loss, damage or expense, including attorneys' fees, arising from a failure or alleged failure on the part of the contractor, his subcontractors and his and their agents and employees to provide and maintain a safe place to work or to comply with laws and regulations of governmental authorities having jurisdiction thereof.
- J. Indemnification: The Contractor and each Subcontractor covenants and agrees to indemnify, defend and hold harmless the Engineer and Owner against any liability, loss, damage or expenses, including attorneys' fees, arising from a failure or alleged failure on the part of the contractor, his subcontractor or his or their agents and employees properly to discharge the obligations assumed by him or them in the performance of the work, including any act or omission allegedly resulting in death or personal injury or property damage on improper construction, construction techniques, or the use of improper or inappropriate material or tools.
- K. System Down Time: This building is a 24 hour research/classroom/office facility and any shutdown of the supply and exhaust systems or interruption of utility service will be strictly enforced and number of shutdowns must be minimized. Any required shutdowns must be scheduled during weekday evening hours of a duration no longer than 10 consecutive hours, during weekends from 6 PM Friday till 5 AM Monday morning, or as agreed in writing with the OR. Only one power system may be shut down at a time unless required by work on a common item of service and specifically scheduled with the OR.

Shutdown of power systems is extremely critical and must be coordinated with the OR before any scheduled shutdown. A detailed schedule of activities and system shutdowns is critical and must be submitted to and coordinated with the OR within two weeks of the award of contract. Primary system shutdowns shall be scheduled a minimum of two weeks in advance and reconfirmed 72 hours prior to shutdown. The agreed schedule shall be posted in the penthouse and the scheduled shutdown date shall be posted on each piece of equipment and in the affected laboratories. Refer to phasing notes on drawings for additional requirements.

1. Noise and vibrations within the work space must be minimized since it is likely that research will continue in all surrounding spaces. Work that requires loud noise or noticeable vibration must be scheduled with the RCM.
 2. Dust and dirt are extremely detrimental to research in adjacent spaces. All duct removal process shall minimize the spread of dirt and dust from the materials removed.
 3. A schedule will be submitted by the contractor and subsequently reviewed by the building users to determine acceptance or alternative scheduling. All cleaning, treating and coating work shall be undertaken by this contractor using means and methods that minimize odors during working hours
- L. Project Completion: All bid submissions, coordination schedules and project staffing shall be based on the critical project completion time.

1.3 MANUFACTURERS

- A. Products and installation by Johnson Controls, Inc is acceptable contingent upon compliance with the Specifications:
- B. All of the following Quality Assurance requirements shall be met.
1. All BAS work shall be furnished and installed by the temperature control system Contractor. The work shall be performed by skilled mechanics under the direction of experienced engineers, all of whom shall be properly trained and qualified for this work.
 2. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems, and not custom designed for this project. All systems and components shall have been thoroughly tested and proven in actual use.
 3. Single source responsibility of supplier shall be the complete installation and proper operation of the BAS and control system, and shall include debugging and proper calibration of each component in the entire system.
 4. Supplier shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory, and all necessary test and diagnostic equipment.
 5. All electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.
 6. BAS shall comply with UL 864 UDTZ and UUKL and UL 1076 as applicable to the project.
- C. Electrical Standards: Provide electrical products which have been tested, listed and labeled by Underwriters' Laboratories, Inc. (UL) and which comply with National Electrical Manufacturers' Association (NEMA) standards.
- D. Accuracy Standards:
1. Sensing elements and associated controllers or readout devices shall be field-adjusted to provide the minimum operating throttling range possible without control loop hunting. Variation from control point setting through the full control range shall be no more than 1/2 the throttling range.
 2. Accuracy standards for individual sensors, transducers, devices, and systems shall be as specified for the individual components and systems.

- E. Equipment and materials shall be catalogued products of manufacturers regularly engaged in production and installation of HVAC control products. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.
- F. Complete installation and proper operation of the DDC control system shall include debugging and calibration of the entire control system shall be the single source responsibility of the BAS supplier.
- G. Maintenance service contract by supplier using an established program shall be available to the Owner following the warranty period.
- H. The specification covers minimum requirements and is not intended to preclude provisions of equipment or methods that exceed the requirements.
- I. The supplier shall have established office within 100 mile radius of the job site staffed with factory trained engineers fully capable of providing instruction, routine maintenance, and emergency maintenance service on all system components.
- J. Prepare test procedure and perform, calibration, performance testing, and adjusting of entire system. Submit written report documenting procedures and results. Demonstrate satisfactory operation of points randomly selected by the Engineer. If more than 10% of the selected points fail to perform as expected, repeat entire testing procedure.
- K. Provide skilled technicians, properly trained and qualified for the work, and directed by experienced engineers.
- L. Electrical work and safety requirements shall comply with NFPA 70 and all applicable local and State codes.
- M. Environmental Conditions of Operation:
 - 1. DDC controller and I/O equipment shall be designed to operate in ambient temperatures from 32°F to 122°F and relative humidity from 10% to 95% non-condensing.
 - 2. Sensors and Operating Devices: The environment which they are sensing or controlling but not less severe than for controller and I/O devices.
- N. Ratings: All equipment shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered at the installed location.

1.4 SYSTEM ACCEPTANCE:

- A. The BAS manufacturer shall issue a report upon project completion stating that the system is complete, has been adjusted, has had all hardware and software functions verified, and is operating in accordance with the specifications. Any deviations from specified setting or operations necessitated during system adjustment shall be specifically noted. A demonstration of complete system operation shall be made to the Engineer and Owner's Representative.
- B. Upon receipt of a detailed punch list from the Engineer or Owner's Representative an installation inspection report shall be prepared by the BAS contractor showing, by system, each outstanding item on the punch list. After all items appearing on the installation inspection report are completed, a second written request for system approval shall be made to the Owner's Representative. As each or all items are approved, an appropriate notation shall be entered at the time of joint inspection on the system report, with counter signature of the Owner's Representative and date. A copy of this report shall be made to the Owner's Representative.
- C. Where it is required for the BAS contractor to modify, alter, add or remove hardware or software programs of the building automation system or related accessories for the purpose of eliminating punch list items, off-line operation and testing to implement them shall be done as required by the BAS contractor until such time acceptance performance of the building automation system has been established.

- D. Problems which occur within approved hardware or software, shall be corrected in an appropriate fashion under guarantee. Any such occurrence shall not void previous approval; however, the BAS contractor shall be responsible to attend to and remedy such items within a reasonable amount of time. Appropriate logs, schedules, and reports shall be maintained to reflect these items and their redress.

1.5 OWNER INSTRUCTION:

- A. General: This Contractor and appropriate factory-trained representatives shall instruct the Owner's representative in the proper operation and maintenance of all systems and equipment and shall explain all warranties.
- B. Outline: Prior to instruction of Owner Personnel, prepare a typed outline, listing the subjects that will be included in this instruction, and submit the outline for review by the Engineer.
- C. Certification: At the conclusion of the instruction period obtain the signature of each person being instructed on each copy of the approved outline to signify that he has a proper understanding of the operation and maintenance of the systems and resubmit the signed outlines.
- D. Other Requirements: Refer to other Division 15 Sections for additional operator training requirements.
- E. Operator Training: Provide training encompassing:
 - 1. Creating and modifying color graphics.
- F. Programmer Training: Provide training encompassing:
 - 1. Use of portable programmer's terminal.
- G. Operator and Supervisor training shall be in a classroom format at the project site and shall be scheduled at the Owners convenience. Class size shall be approximately eight per session.
- H. Programmer training shall be for two Owner personnel and shall be scheduled by the Owner with two week notice anytime during the warranty period.
- I. Other Requirements: Refer to other Division 17 Sections for additional Operator Training requirements.

1.6 CONTRACTOR WARRANTIES AND GUARANTEES:

- A. General: Contractor shall guarantee all material and equipment installed by him against defects in workmanship and material and provide service for a period of 24 months after final acceptance of the work by the Owner and he shall repair or replace any materials or equipment developing such defects within that time, promptly on due notice given him by the Owner and at Contractor's sole cost and expense.
- B. After completion of the installation, control manufacturer shall completely adjust all control equipment provided under this Contract; place the system in operation, subject to the Engineer and Owner's Representative approval, and instruct the operating personnel in the operation of the control system.
- C. Local service shall be available within 50 miles of the project.
- D. Service shall be accomplished and guarantee fulfilled by qualified employees of the BAS contractor. The contractor shall have a quality history of at least 5 years in the project area.
- E. Indirect temperature control service by independent contractors, distributors and franchised installers will not be acceptable.
- F. Warranty servicing shall include, but not be limited to, the following:
 - 1. Replacing defective parts and components are required.
 - 2. Servicing by factory-trained and locally employed service representative of system contractor.
 - 3. Maintaining of system programming.

- G. The BAS contractor shall have an in-place service facility within 50 miles of project site with technical staff, complete spare parts inventory, and all necessary test and diagnostic equipment to keep system operating.

1.7 SUBMITTALS:

- A. Shop drawing submittals shall include, but not be limited to, the following:
1. Control one-line diagrams for this specific project with accompanying description of the sequence control.
 2. Provide a flow diagram depicting the program control algorithms and how they are implemented on this project with specific input and output points shown.
 3. Scope and details of field tests that supplier shall perform to demonstrate that the system meets these specifications.
 4. One-line diagrams from sensor and control points to I/O boards and controllers, including all components, signal values and cables.
 5. Terminal cabinets, including terminal blocks.
 6. Communication links between distributed controllers and central controller complete with communications systems and one-line diagrams, including all components, elements and cables.
 7. Communication terminal cabinets including terminal blocks.
 8. Control panels.
 9. Test Reports: Description of test exercise events and results of measurements and observations.
 10. Provide complete manuals which include the following documentation:
 - a. General description and specifications for all components.
 - b. Principles and theory of operation.
 - c. Detailed schematics and assembly drawings and complete alignment and calibration procedures for all components.
 - d. Complete trouble-shooting procedures, diagrams and guidelines.
 - e. Operators Manual: Complete instruction with keyboard pictures and step-by-step procedures annotated to properly describe the system and its operation as installed. Provide index and tabbed sections for each operator function.
 - f. Complete description of all keyboard programming functions with sample written programs.
 - g. Two sets of manuals for each application package and each utility package.
 - h. Provide one copy of the final version of all software on CD-Rom.
 - i. Document all user-performed maintenance, including inspection, preventive maintenance, fault diagnosis and repair/replacement of defective components. Provide properly identified ordering number for each system components and source of supply. Provide a list of recommended spare parts needed to minimize downtime of the DDC control system.
 - j. Interconnection wiring diagrams and wire lists of the complete field installed system with ordering number for each component.
 - k. Test reports.
 11. Certified drawings showing overall dimensions of completed assemblies only with weights, mounting requirements and parts lists.
 12. Cut sheets on all equipment showing adjustment capabilities, performance criteria and accuracy limits for each specific application.
 13. Pressure ratings, leakage ratings, and dead end isolation pressure ratings for all valves.
 14. Sizing calculation for all control valves and dampers.

15. Floor plan drawings showing proposed locations of all wall mounted and return air path space temperature sensors.
16. Additional information as specified in Section 15002.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver materials and components in fabricated water-resistant wrapping.
- B. Handle materials and components carefully to avoid damage to material component, enclosure and finish.
- C. Store materials and components in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. General: Provide new components as required to provide the monitoring and controls shown on the drawings. In general new BAS components shall match the types and applications used in other buildings on the UTHSC-H campus.

2.2 MATERIALS AND EQUIPMENT:

- A. General: Provide electronic temperature control products in the size, capacities, and quality indicated by these Specifications and required, conforming to manufacturer's standard materials and components as published in their product information, designed and constructed as recommended by the manufacturer, and as required for the application indicated or required. These Specifications shall be considered minimum standards in all situations.

2.3 APPLICATION SPECIFIC CONTROLLERS - HVAC APPLICATIONS:

- A. HVAC Terminal Unit Controllers/Actuators: HVAC terminal unit controllers for Double Duct applications shall be JCI FEC VMA controllers ~~to~~ matching existing controllers in the building, no exception. Damper ~~per~~ operators for double duct terminal units shall be JCI FEC VMA actuators ~~to~~ matching existing actuators in the building, no exception.

2.4 ELECTRONIC ACTUATORS:

- A. General: Provide fully proportioning electronic actuators of either the push-pull or rotary type, as required. Actuator motor shall be of the low voltage synchronous type and shall be non-overloading at a continuous stall. Provide each motor with corrosion protection. Actuators for outside air and exhaust applications shall have nonferrous motor housings and stainless steel shaft and linkage. Actuator control signal shall be 0-10 VDC or 4-20 mA as required. Provide spring return for normally open/closed positioning.
- B. Selection: Size electronic actuators to operate their appropriate dampers and valves with sufficient reserve power to provide smooth modulating or two position action as specified.

2.5 TEMPERATURE SENSORS:

- A. Space Temperature Sensors: Wall mounted DDC space temperature sensors shall be JCI FEC type compatible with the specified FEC VMA controller and ~~to~~ matching existing sensors in the building, no exception.

2.6 POSITION/STATUS INDICATORS:

- A. End (Limit) Switches: Limit switches shall be of the sealed or enclosed type as required for the application. Contacts shall be snap-action SPDT rated for the application. Damper end switches shall be industrial quality, shaft-mounted, enclosed switches set to sense open or closed position of damper

blades. Switches shall be arranged to prevent "oven-center" operation and for mounting as required. Switch enclosures shall be waterproof with a conduit entry seal where subject to moisture or water.

- B. Key-operated Switches: Hand-off-automatic (H-O-A), off-automatic, and all similar use switches shall be key-operated with all switches keyed alike where switches are not located in access limited locations. All switches shall be rated for a minimum of 600 volt ac, 5-A, and shall be mounted in an enclosure as specified or shown.

2.7 OUTPUT DEVICES:

- A. Control Relays: Control relay contacts shall be rated for the application, with a minimum of two sets of SPDT contacts, enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage.
- B. Time Delay Relays: Time delay relay contacts shall be rated for the application with a minimum of two sets of SPDT contacts, enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Relays shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage. Delayed contact opening or closing shall be adjustable from one (1) to 60 seconds with a minimum accuracy of $\pm 2\%$ of setting.
- C. Latching Relays: Latching relay contacts shall be rated for the application with a minimum of two sets of SPDT contacts, enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage.
- D. Reed Relays: Reed relays shall be encapsulated in a container housed in a plastic, epoxy, or metal case. Contacts shall be rated for the application. Operating and release times shall be 1 millisecond or less. Relays shall be rated for a minimum life of 10 million operations and shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage.
- E. Contactors: Contactors shall be of the single coil, electrically operated, mechanically or electrically held type. Positive locking shall be obtained without the use of hooks, latches, or semi-permanent magnets. Contacts shall be double break silver-to-silver type protected by arcing contacts where necessary. Number of contacts and ratings 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 to limit transients to 150% of rated coil voltage.
- F. Solid State Relays: Input-output isolation shall be greater than 1000 megohms with a breakdown voltage of 1500 volt root mean square or greater at 60 Hz. Relays shall be rated for a minimum life of 10 million operations. The ambient temperature range shall be at least -20°F to +140°F. Input impedance shall not be less than 500 ohms. Relays shall be rated for the application in accordance with NEMA ICS 1. Operating and release times shall be one millisecond or less. Transients shall be limited to 150% of control voltage.

PART 3 - EXECUTION

3.1 EXECUTION:

- A. The BAS contractor shall enter all computer programs and data files into the related computers including all control programs, initial approved parameters and settings, English descriptors, and color graphics complete with dynamic dispersed data. In addition, the following, to be user implemented, shall have samples installed for training and validation.
 - 1. Bar chart (four different bars on one chart).
 - 2. Curve plot (five curves on one plot).
 - 3. Trend log.

4. Alarm message (action taking message).
 5. Run time maintenance message.
 6. Trouble action message.
- B. The BAS contractor shall maintain CD-ROM copies of all data file and application software for reload use in the event of a system crash or memory failure, including DDC panel programs. One copy shall be delivered to the Owner during training session, and one copy shall be archived in the BAS manufacturer's local software vault.
- C. The BAS contractor shall completely check out, calibrate and test all connected hardware and software to ensure that the system performs in accordance with the approved specifications and sequences of operation submitted.
1. Running each specified control sequence.
 2. Display and demonstrate such data entry template and show site specific customizing capability. Demonstrate parameter changes.
 3. Execute menu tree.
 4. Display graphics, demo update.
 5. Execute digital and analog commands in English and graphic mode.
 6. Demonstrate freeform address assignment and commands.
 7. Demonstrates all specified diagnostics.
 8. Demonstrate DDC loop precision and stability via trend logs of inputs and outputs (six loops minimum).
 9. Demonstrate BAS performance via trend logs and command printouts.
 10. Demonstrate scan, update, and alarm responsiveness.

3.2 **MANUALS:**

- A. Operators Manual shall be provided with graphic explanations of keyboard use for all operator functions specified under Operator Training, including graphic mode. Although operator functions are to be self-instructional, and menu-interactive from the keyboard terminal, this manual shall be of off-line study and refresher use.
- B. A Programmer's Manual shall be provided with graphic descriptions of all keyboard functions required for software modifications and development specified under Programmer Training. Although high level languages may be required to be usable on the system, full manuals and training are not required. The use and installation of high level type programs shall be included in this manual.
- C. A manual shall be provided including revised As-build Documents.
- D. A minimum of three operator manuals, two programmers, and two As-built manuals shall be provided to the Owner.

3.3 **PANEL LOCATIONS:**

- A. General: Direct Digital Control (DDC) Panels, status/monitoring panels and other control panels shall be located where shown on the Drawings or as close to the controlled equipment as is feasible.
- B. Location: Panels shall be located so as to provide adequate clearance for maintenance and shall not interfere with maintenance or code clearances for other equipment. Floor plan drawings showing the proposed locations of all control panels shall be submitted for approval.
- C. Mounting: Wall mounted panels shall be adequately supported from the wall which they are attached to. Floor mounted panels shall be mounted on housekeeping pads.

- D. Coordination: Panel locations shall be coordinated with the Division 16 Contractor so that there is adequate lighting and convenience outlets at the panel location for panel use and maintenance.

3.4 CONTROL POWER:

- A. General: Control power for the BAS is provided by Division 16 at each BAS panel location and at other locations where shown on the Electrical Drawings. Control power transformers are typically provided in motor starters on the project. All other required control power shall be provided by Division 16 at the expense of this Division.
- B. Coordination: Control power requirements and locations shall be coordinated with the Division 16 Contractor and be responsible for any additional costs incurred to provide the required control power. Input to the Division 16 Contractor shall include, but not be limited to:
 - 1. Locations requiring control power.
 - 2. Voltage, phase and ampacity.
 - 3. Power type, normal or emergency.
 - 4. Type of connection.

3.5 BAS WIRING:

- A. General: All wiring required for a complete and operational building control and automation system shall be provided by this Division.
- B. Wiring shall be jacketed cables installed with or without conduit as specified herein or single conductors installed in conduit. Control wiring shall have minimum 600 volt insulation for low voltage wiring and 600 volt insulation for line voltage wiring.
- C. All line voltage control wiring and all low voltage control wiring and the main data communications loop shall be installed in conduit.
- D. Minimum requirements for control wiring shall be as follows:
 - 1. Control wiring for digital functions shall be No. 18 AWG copper minimum, with 600 volt insulation. Multi-conductor wire shall have an outer jacket of polyvinyl chloride (PVC) or UL listed plenum rated jacket.
 - 2. Control wiring for analog functions shall be No. 18 AWG copper minimum, with 600 volt insulation, twisted and shielded, 2-, 3- or 4-wire to match analog function hardware. Multi-conductor wire shall have an outer jacket of PVC or UL listed plenum rated jacket.
 - 3. Sensor wiring shall be No. 18 AWG copper minimum, twisted and shielded, 2-, 3- or 4-wire to match analog function hardware. Multi-conductor wire shall have an outer jacket of PVC or UL listed plenum rated jacket.
 - 4. Class 2 low energy conductor sizes specified for digital and analog functions shall take precedence over any requirements for Class2 low energy remote control and signal circuit conductors specified elsewhere, unless a larger conductor size is required by the NEC.
- E. Line and low voltage control wiring shall not be installed in the same conduit and control wiring shall not be installed in the same conduit with power wiring.
- F. BAS conduit shall be EMT sized for wire fill per the NEC, minimum 3/4". BAS boxes shall be 1900 boxes with coverplates. All BAS conduit and boxes shall be painted blue.
- G. BAS main communications loop conduits shall be routed above corridor ceilings. Where terminal units are located above offices, install a box in the main communications loop raceway and stub BAS conduit above ceiling into office space as close to terminal unit as possible.
- H. All conduit in exposed locations shall be run in a neat manner and shall be perpendicular and parallel to building lines. Coordinate conduit routing with field conditions so as not to interfere with code clearances, maintenance access and walkways.

- I. All conduit and control wiring in concealed locations shall be installed in an orderly manner, generally perpendicular and parallel to building lines.
- J. Permanently mark terminal blocks for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions. Line-protect all wiring that comes from external sources to the site from lightning and static electricity.
- K. Label or code each field wire at each end. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color-coded cable with cable diagrams may be used to accomplish cable identification.
- L. Signal Transmission System wiring shall be installed as follows:
 - 1. Splices in shielded and coaxial cables shall consist of terminations and the use of shielded cable couplers. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties.
 - 2. Fit all equipment contained in cabinets or panels with service loops, each loop being at least 12" long. Equipment for fiber optics system shall be rack-mounted, as applicable, in ventilated, self-supporting, code gauge steel enclosure. Cables shall be supported for minimum sag.
 - 3. Keep cable runs as short as possible. Allow extra length for connecting to the terminal board.
 - 4. Use vinyl tape, sleeves, or grommets to protect cables from vibration at points where they pass around sharp corners, through walls, panel cabinets, etc.
 - 5. Grounding shall be in accordance with NFPA 70. All ground wire shall be insulated conductors.
 - 6. Ground wire shall be run to service entrance ground.
 - 7. Conduit grounds shall be isolated from BAS panels by PVC couplings to prevent ground loops.
- M. Refer to applicable Division 16 Sections for additional requirements for conduit and wiring materials and installation. All conduit and wiring shall be installed in accordance with all requirements of applicable codes.

3.6 COMPONENT INSTALLATION:

- A. General: Install system and materials in accordance with manufacturer's instructions, roughing-in drawings and details on the Drawings. All components and appurtenances shall be installed in accordance with the manufacturer's instructions and as shown or specified. All necessary interconnections, services, and adjustments required to prepare the building for interface to the BAS shall be furnished. All electrical work shall be in accordance with Division 16. Instrumentation grounding as necessary to preclude ground loops and noise from adversely affecting equipment operations shall be installed. Final adjustment shall be performed by specially trained personnel in the direct employ of the manufacturer of the BAS.
- B. Electrical Wiring: Refer to the applicable Sections of Division 16 for electrical wiring and raceway installation requirements.
- C. Mechanical Work: Refer to the applicable Sections of Division 15 for the installation of wells, valve bodies, and dampers in mechanical systems.
- D. I/O Summary Tables shall be used in conjunction with the Drawings to identify the hardware required for each building control and automation system.
- E. All temperature control and automation materials shall be applied and installed per the manufacturers' recommendations.
- F. Remote bulbs shall be flange mounted in ductwork and casing and mounted with separable sockets in pipes and tanks. Where installed through insulation, flanges and sockets shall have extension necks to finish flush with the insulation surface.

- G. All sensing elements for supply air temperature in ductwork or casing shall be of averaging type with sensing length of number of elements to measure air temperature through the entire cross section of the duct or casing.

3.7 EQUIPMENT INSTALLATION:

A. Temperature Instruments:

- 1. Temperature Sensor/Transducers: When a temperature sensor/transducer is installed in pipes or is susceptible to corrosion and vibration, the sensor shall be installed in a thermowell. Temperature sensors/transducers used for space temperature sensing shall include a housing suitable for wall-mounting. Temperature sensors/transducers used for outside air sensing shall have an instrument shelter to minimize solar effects, and shall be mounted to minimize building effects. Assemblies shall be readily accessible and installed in a manner as to allow easy replacement without special tools. Mount duct sensors/transducers in locations to sense the correct temperature of the air only, within the vibration and velocity limits of the sensing element. Mount extended surface element, when used, securely within the duct and position to measure the average temperature. Thermally isolate elements from brackets and supports to respond to air temperature only. Securely seal duct penetrations.
- 2. Sensor Locations: Sensors shall be wall mounted in office areas, approximate locations are shown on the Drawings and shall typically be located 6" from the room light switch as the same vertical centerline height as the switches. Sensors shall be mounted in the space return air space for public areas, corridors and similar areas, unless shown otherwise on the drawings. Locate sensors to sense average return air temperature in the space monitored. Submit Drawings showing proposed locations of space and return air temperature sensors to the Engineer for review.

B. Output Devices:

- 1. Controllers, Relays and Contactors: Install controllers, relays and contactors in control cabinets or as required.

C. Position Sensors:

- 1. End (Limit) Switches: Limit switch type and mounting shall be properly suited for the application to provide reliable switch operation.
- 2. Potentiometers: Potentiometer type and mounting shall be properly suited for the application to provide reliable operation.
- 3. Instrument shelters shall be installed with the bottom 4' above the supporting surface using legs and secured rigidly to minimize vibrations from winds. Instrument shelters shall be oriented facing north.

3.8 FINAL ADJUSTMENT OF EQUIPMENT:

- A. General: After completion of the installation, adjust thermostats, control valves, motors, and similar equipment provided as work of this Section. Final adjustment shall be performed by specially trained personnel in the direct employ of the manufacturer of the primary temperature control system.

END OF SECTION