

SECTION 01100

SUMMARY

PART 1 GENERAL

1.01 PROJECT

- A. Project Name: PHRC Laboratory 305 Renovation
- B. Owner's Name: University of South Carolina
- C. Architect's Name: JHS-Architecture: Integrated Design
- D. Project Description: This project consists of the partial demolition of existing walls, mechanical, electrical, and plumbing systems, the addition of new partitions, mechanical, electrical, and plumbing systems, and the addition of new lab casework. The scope of this casework includes a new fume hood that will be vented through the existing roof. This will require a new shaft to be built, also including demolition and renovation work.

1.02 CONTRACT DESCRIPTION

- A. Contract Type: A single prime contract based on a Stipulated Price as described in Document 00500 - Agreement.

1.03 DESCRIPTION OF ALTERATIONS WORK

- A. Scope of demolition and removal work is shown on drawings.
- B. Scope of alterations work is shown on drawings.
- C. New Finishes: as specified.
- D. Electrical Power and Lighting: as specified.

1.04 WORK BY OWNER

- A. Owner will supply and install the following:
 - 1. NA
- B. Owner will supply the following for installation by Contractor:
 - 1. NA.

1.05 OWNER OCCUPANCY

- A. This building is fully occupied. All work must be coordinated with owner so as not to disrupt building operations. This may require work outside of normal working hours.
- B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
- C. 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. 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.
- C. Existing building spaces may not be used for storage unless approved by owner.
- D. Utility Outages and Shutdown:
 - 1. Limit disruption of utility services to hours the building is unoccupied.

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

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01200

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

- A. Document 00500 - Agreement: Contract Sum, retainages, payment period, monetary values of unit prices.
- B. Document 00700 - General Conditions and Document 00800 - Supplementary Conditions: Additional requirements for progress payments, final payment, changes in the Work.

1.03 SCHEDULE OF VALUES

- A. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample 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 bonds and insurance.

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. Present required information in typewritten form.
- E. Form: AIA G702 Application and Certificate for Payment and AIA G703 - Continuation Sheet including continuation sheets when required.
- F. 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.
- G. Execute certification by signature of authorized officer.
- H. 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.
- I. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of Work.
- J. Submit three copies of each Application for Payment.
- K. Include the following with the application:
1. Transmittal letter as specified for Submittals in Section 01300.
 2. Construction progress schedule, revised and current as specified in Section 01300.
 3. Partial release of liens from major Subcontractors and vendors.
 4. Project record documents as specified in Section 01780, for review by Owner which will be returned to the Contractor.
 5. Affidavits attesting to off-site stored products.
- L. 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 Price or Contract Time, Architect will issue instructions directly to Contractor.
- C. 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.
- D. 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 with a stipulation of any overtime work required and the period of time during which the requested price will be considered valid. Contractor shall prepare and submit a fixed price quotation within 5 days.
- E. 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 01600.
- F. 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.

- G. Substantiation of Costs: Provide full information required for evaluation.
 - 1. Provide 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. Time records and wage rates paid.
 - c. 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.
- H. Execution of Change Orders: Architect will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.
- I. 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.
- J. 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.
- K. 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. Record Change Orders on Project Record Drawings maintained at the site, these will be the basis of "As Built" documents.
- C. Application for Final Payment will not be considered until the following have been accomplished:
 - 1. All closeout procedures specified in Section 01700.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

ECTION 01300

ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preconstruction meeting.
- B. Progress meetings.
- C. Construction progress schedule.
- D. Coordination drawings.
- E. Submittals for review, information, and project closeout.
- F. Number of copies of submittals.
- G. Submittal procedures.

1.02 RELATED REQUIREMENTS

- A. Document 00700 - General Conditions: Dates for applications for payment.
- B. Section 01100 - Summary:
- C. Section 01700 - Execution Requirements: Additional coordination requirements.
- D. Section 01780 - Closeout Submittals: Project record documents.

1.03 PROJECT COORDINATION

- A. Project Coordinator: Contact Doug Fraser - Administrator for the owner from JHS-Architecture:. Integrated Design.
- B. During construction, coordinate use of site and facilities through the Project Coordinator.
- C. Comply with Project Coordinator's procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.
- D. Comply with instructions of the Project Coordinator for use of temporary utilities and construction facilities.
- E. Coordinate field Architecting and layout work under instructions of the Project Coordinator.
- F. Make the following types of submittals to Architect through the Project Coordinator:
 - 1. Requests for interpretation.
 - 2. Requests for substitution.
 - 3. Shop drawings, product data, and samples.
 - 4. Test and inspection reports.
 - 5. Design data.
 - 6. Manufacturer's instructions and field reports.
 - 7. Applications for payment and change order requests.
 - 8. Progress schedules.
 - 9. Coordination drawings.
 - 10. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRECONSTRUCTION MEETING

- A. Architect will schedule a meeting after Notice of Award.
- B. Attendance Required:
 - 1. Owner's Representative(s).
 - 2. Architect and/or Contract Administrator.
 - 3. Contractor.
 - 4. Major Subcontractors.
- C. Agenda:
 - 1. Submission of list of Subcontractors, list of Products, schedule of values, and progress schedule.
 - 2. Procedures and processing of field decisions, submittals, and substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 - 3. Scheduling.
- D. Record minutes and distribute copies within two days after meeting to participants, with copies to Architect, Owner, participants, and those affected by decisions made.

3.02 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the Work at maximum weekly intervals.
- B. Make arrangements for meetings, prepare agenda with copies for participants and preside at meetings.
- C. Attendance Required: Job superintendent, major Subcontractors and suppliers, Owner, Architect, as appropriate to agenda topics for each meeting.
- D. Agenda:
 - 1. Review minutes of previous meetings.
 - 2. Review of Work progress.
 - 3. Field observations, problems, and decisions.
 - 4. Identification of problems that impede, or will impede, planned progress.
 - 5. Review of submittals schedule and status of submittals.
 - 6. Review of off-site fabrication and delivery schedules.
 - 7. Maintenance of progress schedule.
 - 8. Corrective measures to regain projected schedules.
 - 9. Planned progress during succeeding work period.
 - 10. Coordination of projected progress.
 - 11. Maintenance of quality and work standards.
 - 12. Effect of proposed changes on progress schedule and coordination.
 - 13. Change Orders and RFI status.
 - 14. Infection Control reports and issues.
 - 15. Other business relating to Work.
- E. Record minutes and distribute copies within two days after meeting to participants, with copies to Architect, Owner, participants, and those affected by decisions made.

3.03 CONSTRUCTION PROGRESS SCHEDULE

- 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.
- B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.

- C. Within 5 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
 - 1. Include written certification that major contractors have reviewed and accepted proposed schedule.
- D. Within 5 days after joint review, submit complete schedule.
- E. Submit updated schedule with each Application for Payment.

3.04 COORDINATION DRAWINGS

- A. Provide information required by Project Coordinator for preparation of coordination drawings.
- B. Review drawings prior to submission to Architect.

3.05 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 01780 - CLOSEOUT SUBMITTALS.

3.06 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.

3.07 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.
- B. Submit for Owner's benefit during and after project completion.

3.08 NUMBER OF COPIES OF SUBMITTALS

- A. Documents for Review:
 - 1. See Specification Section 16050 1.05A for requirements by Architect. Coordinate with Specification Section 16010.

3.09 SUBMITTAL PROCEDURES

- A. See Specification Section 16010 for requirements.

END OF SECTION

SECTION 01400

QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. References and standards.
- B. Quality assurance submittals.
- C. Control of installation.
- D. Tolerances.
- E. Testing and inspection services.
- F. Manufacturers' field services.

1.02 RELATED REQUIREMENTS

- A. Section 01300 - Administrative Requirements: (Paragraph 3.09) Submittal procedures.

1.03 SUBMITTALS

- A. 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.
- B. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, 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.
- C. Manufacturer's Field Reports: Submit reports for Architect's benefit as Contract Administrator or for Owner.
 - 1. Submit report in duplicate within 15 days of observation to Architect for information.
 - 2. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.

1.04 REFERENCES AND STANDARDS

- A. For products and 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 current on date of Contract Documents, except where a specific date is established by applicable code.
- C. Obtain copies of standards where required by product specification sections.
- D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.
- E. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.

- F. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Architect shall be altered from the Contract Documents by mention or inference otherwise in any reference document.

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 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.

3.03 MANUFACTURERS' FIELD SERVICES

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment as applicable, and to initiate instructions when necessary.
- B. Submit qualifications of observer to Architect 15 days in advance of required observations.
 - 1. Observer subject to approval of Architect.
- C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.04 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 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Security requirements.
- B. Waste removal facilities and services.

1.02 TEMPORARY UTILITIES

- A. Contractor shall provide Port-a-john, storage container and/or office

1.03 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

1.04 INTERIOR ENCLOSURES

- A. Provide means to isolate construction 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 E 90.
 - 2. Maximum flame spread rating of 75 in accordance with ASTM E 84.
- C. Paint surfaces exposed to view from Owner-occupied areas.

1.05 SECURITY

- 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.

1.06 WASTE REMOVAL

- A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition. Provide containers with lids. Remove trash from site daily.
- B. 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.

1.07 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials and prior to Substantial Completion inspection.
- B. Clean and repair damage caused by installation or use of temporary work.
- C. Restore existing facilities used during construction to original condition.
- D. Restore new permanent facilities used during construction to specified condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01600

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. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 RELATED REQUIREMENTS

- A. Document 00200 - Instructions to Bidders: Product options and substitution procedures prior to bid date.

1.03 REFERENCE STANDARDS

- A. 16 CFR 260 - Guides for the Use of Environmental Marketing Claims; Federal Trade Commission; current edition.
- B. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

1.04 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 5 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.

PART 2 PRODUCTS

2.01 EXISTING PRODUCTS

- A. Do not use materials and equipment removed from existing premises unless specifically required or permitted by the Contract Documents.
- B. Unforeseen historic items encountered remain the property of the Owner; notify Owner promptly upon discovery; protect, remove, handle, and store as directed by Owner.
- C. Existing materials and equipment indicated to be removed, but not to be re-used, relocated, reinstalled, delivered to the Owner, or otherwise indicated as to remain the property of the Owner, become the property of the Contractor; remove from site.

2.02 NEW PRODUCTS

- A. Provide new products unless specifically required or permitted by the Contract Documents.

2.03 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.

2.04 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. Substitutions will not be considered when a product becomes unavailable through no fault of the Contractor.
- C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
- D. 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. Will provide the same warranty for the substitution as for the specified product.
 - 3. Will 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.
- E. 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.
- F. Substitution Submittal Procedure:
 - 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 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.
- F. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.03 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. Provide bonded off-site storage and protection when site does not permit on-site storage or protection.
- G. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- H. Prevent contact with material that may cause corrosion, discoloration, or staining.
- I. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- J. 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 01700

EXECUTION REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Examination, preparation, and general installation procedures.
- B. Pre-installation meetings.
- C. Cutting and patching.
- D. Cleaning and protection.
- E. Starting of systems and equipment.
- F. Demonstration and instruction of Owner personnel.
- G. Closeout procedures, except payment procedures.
- H. General requirements for maintenance service.

1.02 RELATED REQUIREMENTS

- A. Section 01100 - Summary: Limitations on working in existing building; continued occupancy; work sequence; identification of salvaged and relocated materials.
- B. Section 01300 - Administrative Requirements: (Paragraph 3.09) Submittals procedures.
- C. Section 01400 - Quality Requirements: (Paragraph 3.03) Testing and inspection procedures.
- D. Section 01780 - Closeout Submittals: (Paragraph 3.01) Project record documents, (Paragraph 3.02-3.05) operation and maintenance data, (Paragraph 3.06) warranties and bonds.
- E. Section 16010 – Electrical General Requirements.
- F. Individual Product Specification Sections:
 - 1. Advance notification to other sections of openings required in work of those sections.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. 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. 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. Date and time work will be executed.
- C. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.04 QUALIFICATIONS

- A. For demolition work, employ a firm specializing in the type of work required.
 - 1. Minimum of 3 years of documented experience.

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.
- C. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.
- D. Pollution Control: Provide methods, means, and facilities to prevent contamination of water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.

1.06 COORDINATION

- A. See Section 01100 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.
- C. 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.
- D. 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.
- E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- F. Coordinate completion and clean-up of work of separate sections.
- G. 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 01600.

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. Examine and verify specific conditions described in individual specification sections.

- C. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or miss-fabrication.
- D. Verify that utility services are available, of the correct characteristics, and in the correct locations.
- E. 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 pre-installation 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. Hold a round table meeting with Client's Representatives to review schedules and phasing of installation.
- F. Record minutes and distribute copies within two days after meeting to participants, with one copy to Architect, Owner, participants, and those affected by decisions made.

3.04 GENERAL INSTALLATION REQUIREMENTS

- A. 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.
- B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- E. 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 01500.
 - 2. Provide sound retardant partitions of construction indicated on drawings 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. 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.
 - 3. 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 Electrical): 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 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 01100 for other limitations on outages and required notifications.
 - c. Provide temporary connections as required to maintain existing systems in service.
 - 3. Verify that abandoned services serve only abandoned facilities.
 - 4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification; 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.
 - 1. 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.
 - 2. 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.
- G. 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.
- H. Refinish existing surfaces as indicated:
 - 1. 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.
 - 2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.
 - 3. Patch as specified for patching new work.

- I. Clean existing systems and equipment.
- J. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.
- K. Do not begin new construction in alterations areas before demolition is complete.
- L. 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 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 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. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- G. Restore work with new products in accordance with requirements of Contract Documents.
- H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07840, to full thickness of the penetrated element.
- J. 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.
- K. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
- L. Make neat transitions. Patch work to match adjacent work in texture and appearance. Where new work abuts or aligns with existing, perform a smooth and even transition.

- M. Patch or replace surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. Repair substrate prior to patching finish. Finish patches to produce uniform finish and texture over entire area. When finish cannot be matched, refinish entire surface to nearest intersections.

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 daily 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. 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 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.
 - G. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

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,
- D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- E. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.
- F. Space shall be clean to a level of occupancy by the client at substantial completion.

3.13 CLOSEOUT PROCEDURES

- A. Make submittals that are required by governing or other authorities.
 - 1. Provide copies to Architect.
 - 2. Provide copies to Owner.
- B. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in Contractor's Notice of Substantial Completion.
- C. Notify Architect when work and documentation is considered ready for Substantial Completion.
- D. Submit written certification that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's review.
- E. Owner will occupy all of the building as specified in Section 01100.
- F. Correct items of work listed in executed Certificates of Substantial Completion and comply with requirements for access to Owner-occupied areas.
- G. Accompany Project Coordinator on preliminary final inspection.

- H. Notify Architect when work is considered finally complete.
- I. Complete items of work determined by Architect's final inspection.

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

END OF SECTION

SECTION 01780

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 00700 - General Conditions: Performance bond and labor and material payment bonds, warranty, and correction of work.
- B. Section 01300 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- C. Section 01700 - Execution Requirements: Contract closeout procedures.
- D. Individual Product Sections: Specific requirements for operation and maintenance data.
- E. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

- A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
- B. Operation and Maintenance Data:
 - 1. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
 - 2. 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.
 - 3. 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 horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 2. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 3. Field changes of dimension and detail.
 4. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

- A. 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.
 2. Information for re-ordering custom manufactured products.
- 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. Additional information as specified in individual product specification sections.
- D. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

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 Architecting data and tests.
 4. Complete nomenclature and model number of replaceable parts.
- B. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and

communications; typed.

- C. Include color coded wiring diagrams as installed.
- D. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- E. 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.
- F. Provide servicing and lubrication schedule, and list of lubricants required.
- G. Include manufacturer's printed operation and maintenance instructions.
- H. Include sequence of operation by controls manufacturer.
- I. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- J. Additional Requirements: As specified in individual product specification sections.

3.05 OPERATION AND MAINTENANCE MANUALS

- A. Prepare instructions and data by personnel experienced in maintenance and operation of described products.
- B. Prepare data in the form of an instructional manual.
- 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. Provide tabbed dividers for each separate product and system, with typed description of product and major component parts of equipment.
- F. Text: Manufacturer's printed data, or typewritten data on 24 pound paper.
- G. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- H. Arrange content by systems under section numbers and sequence of Table of Contents of this Project Manual.
- I. Contents: Prepare a Table of Contents for each volume, with each product or system description identified, in three parts as follows:
 - 1. Part 1: Directory, listing names, addresses, and telephone numbers of Architect, Contractor, Subcontractors, and major equipment suppliers.
 - 2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - a. Significant design criteria.
 - b. List of equipment.
 - c. Parts list for each component.
 - d. Operating instructions.
 - e. Maintenance instructions for equipment and systems.
 - f. Maintenance instructions for special finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.

3. Part 3: Project documents and certificates, including the following:
 - a. Shop drawings and product data.
 - b. Certificates.
 - c. Photocopies of warranties and bonds.
- J. Provide a listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.
- K. Table of Contents: Provide title of Project; names, addresses, and telephone numbers of Architect, Consultants, and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.

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 the 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.
- E. Manual: Bind in commercial quality 8-1/2 by 11 inch three D side ring binders with durable plastic covers.
- F. Cover: Identify each binder with typed or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible company principal.
- G. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.
- H. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

END OF SECTION

SECTION 02225

DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Building demolition excluding removal of hazardous materials and toxic substances.
- B. Selective demolition of building elements for alteration purposes.

1.02 RELATED REQUIREMENTS

- A. Section 00300 - Information Available to Bidders: Existing building survey conducted by Owner; information about known hazardous materials.
- B. Section 01100 - Summary: Limitations on Contractor's use of site and premises.
- C. Section 01500 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- D. Section 01700 - Execution Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.

1.03 PROJECT CONDITIONS

- A. 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.
- B. Comply with other requirements specified in Section 01700.

PART 3 EXECUTION

2.01 GENERAL PROCEDURES AND PROJECT CONDITIONS

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

2.02 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 01500 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, Telecommunications, and _____): Remove existing systems and equipment as indicated.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 - 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - 3. Verify that abandoned services serve only abandoned facilities before removal.
 - 4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.
- 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.

2.03 DEBRIS AND WASTE REMOVAL

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

END OF SECTION

SECTION 05400

COLD FORMED METAL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formed steel stud interior wall framing.
- B. Formed steel joist and purlin framing and bridging.

1.02 RELATED REQUIREMENTS

- A. Section 05310 - Steel Deck.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with work of other sections that is to be installed in or adjacent to the metal framing system, including but not limited to structural anchors, cladding anchors, utilities, insulation, and firestopping.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on standard framing members; describe materials and finish, product criteria, limitations.
- C. Shop Drawings: Indicate component details, framed openings, bearing, anchorage, loading, welds, and type and location of fasteners, and accessories or items required of related work.
 - 1. Provide design engineer's stamp on shop drawings.
- D. Manufacturer's Installation Instructions: Indicate special procedures, conditions requiring special attention, and _____.

1.05 QUALITY ASSURANCE

- A. Designer Qualifications: Design framing system under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.

PART 2 PRODUCTS

2.01 FRAMING SYSTEM

- A. Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.

2.02 FRAMING MATERIALS

- A. Studs and Track: ASTM C955; studs formed to channel, "C", or "Sigma" shape with punched web; U-shaped track in matching nominal width and compatible height.

2.03 FASTENERS

- A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A153/A153M.
- B. Anchorage Devices: Power actuated.

2.04 MANUFACTURING

- A. All products to be manufactured in the United States of America.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Verify field measurements and adjust installation as required.

3.02 INSTALLATION OF STUDS

- A. Install components in accordance with manufacturers' instructions and ASTM C1007 requirements.
- B. Align floor and ceiling tracks; locate to wall layout. Secure in place with fasteners at maximum 24 inches on center. Coordinate installation of sealant with floor and ceiling tracks.
- C. Install load bearing studs full length in one piece. Splicing of studs is not permitted.
- D. Install load bearing studs, brace, and reinforce to develop full strength and achieve design requirements.
- E. Touch-up field welds and damaged galvanized surfaces with primer.

END OF SECTION

SECTION 06100

ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concealed wood blocking, nailers, and supports.
- B. Miscellaneous wood nailers, furring, and grounds.

1.02 RELATED REQUIREMENTS

- A. Section 05500 - Metal Fabrications: Miscellaneous steel connectors and support angles for wood framing.
- B. Section 09260 - Gypsum Board Assemblies: Gypsum-based sheathing.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. If no species is specified, provide any species graded by the agency specified; if no grading agency is specified, provide lumber graded by any grading agency meeting the specified requirements.
 - 2. Grading Agency: Any grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
- B. Lumber fabricated from old growth timber is not permitted.

2.02 DIMENSION LUMBER

- A. Sizes: Nominal sizes as indicated on drawings, S4S.
- B. Moisture Content: S-dry or MC19.
- C. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S, No. 2 or Standard Grade.
 - 2. Boards: Standard or No. 3.

2.03 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel per ASTM A 153/A 153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.

2.04 MANUFACTURING

3.01 All products shall be manufactured in the United States of America.

PART 3 EXECUTION

4.01 PREPARATION

- A. Coordinate installation of rough carpentry members specified in other sections.

4.02 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.

4.03 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.

4.04 CLEANING

- A. Waste Disposal: Comply with the requirements of Section 01732.
 - 1. Comply with applicable regulations.
 - 2. Do not burn scrap on project site.
 - 3. Do not burn scraps that have been pressure treated.
 - 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- B. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.
- C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION

SECTION 07840

FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Firestopping systems.
- B. Firestopping of all joints and penetrations in fire-resistance rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2011.
- B. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops; 2011a.
- C. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
- D. FM 4991 - Approval of Firestop Contractors; Factory Mutual Research Corporation; 2001.
- E. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.
- F. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.
- G. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on product characteristics.
- C. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.05 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements.

1. Fire Ratings: Use any system listed by UL or tested in accordance with ASTM E814 that has F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and that meets all other specified requirements.

2.02 MATERIALS

- A. Firestopping Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
- B. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.
- C. All products shall be manufactured in the United States of America.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Install backing materials to arrest liquid material leakage.

3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by authority having jurisdiction.
- C. Install labelling required by code.

3.04 PROTECTION

- A. Clean adjacent surfaces of firestopping materials.
- B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 07900

JOINT SEALERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sealants and joint backing.
- B. Precompressed foam sealers.
- C. Hollow gaskets.

1.02 RELATED REQUIREMENTS

- A. Section 07260 - Weather Barriers: Sealants required in conjunction with air barriers and vapor retarders:
- B. Section 07840 - Firestopping: Firestopping sealants.
- C. Section 09300 - Tile: Sealant used as tile grout.

1.03 REFERENCE STANDARDS

- A. ASTM C834 - Standard Specification for Latex Sealants; 2010.
- B. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2008.
- C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2011.
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2009.
- E. ASTM D1667 - Standard Specification for Flexible Cellular Materials--Poly(Vinyl Chloride) Foam (Closed-Cell); 2005 (Reapproved 2011).
- F. BAAQMD 8-51 - Bay Area Air Quality Management District Regulation 8, Rule 51, Adhesive and Sealant Products; www.baaqmd.gov; current edition.
- G. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating sealant chemical characteristics.

1.05 QUALITY ASSURANCE

- A. Maintain one copy of each referenced document covering installation requirements on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
- C. Applicator Qualifications: Company specializing in performing the work of this section with minimum five years experience.

1.06 FIELD CONDITIONS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.07 COORDINATION

- A. Coordinate the work with all sections referencing this section.

1.08 WARRANTY

- A. See Section 01780 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective work within a two year period after Date of Substantial Completion.
- C. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal and watertight seal, exhibit loss of adhesion or cohesion, or do not cure, leak, harden, crack, crumble, melt, shrink, run or stain adjacent work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Silicone Sealants:
 - 1. Bostik Inc: www.bostik-us.com.
 - 2. GE Plastics: www.geplastics.com.
 - 3. Pecora Corporation: www.pecora.com.
 - 4. Tremco Incorporated.
 - 5. Substitutions: See Section 01600 - Product Requirements.
- B. Polyurethane Sealants:
 - 1. Bostik Inc: www.bostik-us.com.
 - 2. Pecora Corporation: www.pecora.com.
 - 3. Tremco Incorporated.
 - 4. Sonneborne Building Products Div.
 - 5. Substitutions: See Section 01600 - Product Requirements.
- C. Preformed Compressible Foam Sealers:
 - 1. EMSEAL Joint Systems, Ltd: www.emseal.com.
 - 2. Substitutions: See Section 01600 - Product Requirements.

2.02 SEALANTS

- A. Sealants and Primers - General: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
- B. Type 1 - General Purpose Exterior Sealant: Polyurethane; ASTM C920, Grade NS, Class 25, Uses M, G, and A; single component.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Product: Dymeric 511 manufactured by Tremco Inc..
 - 3. Applications: Use for:
 - a. Control, expansion, and soft joints in masonry.
 - b. Joints between concrete and other materials.
 - c. Joints between metal frames and other materials.
 - d. Other exterior joints for which no other sealant is indicated.
- C. Type 2 - Exterior Metal Lap Joint Sealant: Butyl or polyisobutylene, nondrying, nonskinning, noncuring.
 - 1. Product: Tremco Butyl Sealant manufactured by Tremco Inc.
 - 2. Applications: Use for:
 - a. Concealed sealant bead in sheet metal work.
 - b. Concealed sealant bead in siding overlaps.
- D. Type 3 - General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C834, Type OP, Grade NF single component, paintable.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Product: Tremco Acrylic Latex 834 manufactured by Tremco Inc..
 - 3. Applications: Use for:

- a. Interior wall and ceiling control joints.
 - b. Joints between door and window frames and wall surfaces.
 - c. Other interior joints for which no other type of sealant is indicated.
- E. Type 4 - Bathtub/Tile Sealant: White silicone; ASTM C920, Uses I, M and A; single component, mildew resistant.
1. Product: Proglaz White manufactured by Tremco Inc.
 2. Applications: Use for:
 - a. Joints between plumbing fixtures and floor and wall surfaces.
 - b. Joints between kitchen and bath countertops and wall surfaces.
- F. Type 5 - Acoustical Sealant for Concealed Locations: Permanently tacky non-hardening butyl sealant.
1. Product: Tremco Acoustical Sealant manufactured by Tremco Inc.
 2. Applications: Use for concealed locations only:
 - a. Sealant bead between top stud runner and structure and between bottom stud track and floor.

2.03 ACCESSORIES

- A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
- B. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.
- C. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Verify that joint backing and release tapes are compatible with sealant.

3.02 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean and prime joints in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Protect elements surrounding the work of this section from damage or disfigurement.

3.03 INSTALLATION

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform installation in accordance with ASTM C1193.
- C. Perform acoustical sealant application work in accordance with ASTM C919.
- D. Measure joint dimensions and size joint backers to achieve the following, unless otherwise indicated:
 1. Width/depth ratio of 2:1.
 2. Neck dimension no greater than 1/3 of the joint width.
 3. Surface bond area on each side not less than 75 percent of joint width.
- E. Install bond breaker where joint backing is not used.

- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
- G. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- H. Tool joints concave.
- I. Precompressed Foam Sealant: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 1/8 to 1/4 inch below adjoining surface.
- J. Compression Gaskets: Avoid joints except at ends, corners, and intersections; seal all joints with adhesive; install with face 1/8 to 1/4 inch below adjoining surface.

3.04 CLEANING

- A. Clean adjacent soiled surfaces.

3.05 PROTECTION

- A. Protect sealants until cured.

3.06 SCHEDULE

- A. Exterior Joints for Which No Other Sealant Type is Indicated: Type 1; colors as selected.
- B. Interior Joints for Which No Other Sealant is Indicated: Type 3; colors as shown on the drawings.
- C. Joints Between Plumbing Fixtures and Walls and Floors, and Between Countertops and Walls: Type 4.
- D. In STC-Rated Walls, Between Metal Stud Track/Runner and Adjacent Construction: Type 5.

END OF SECTION

SECTION 09260

GYPSUM 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. Gypsum wallboard.
- E. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 05400 - Cold Formed Metal Framing: Exterior wind-load-bearing metal stud framing.
- B. Section 06100 - Rough Carpentry: Wood blocking product and execution requirements.
- C. Section 07840 - Firestopping: Top-of-wall assemblies at fire rated walls.
- D. Section 07900 - Joint Sealers: Acoustic sealant.

1.03 REFERENCE STANDARDS

- A. ANSI A108.11 - American National Standard for Interior Installation of Cementitious Backer Units; 1999 (R2005).
- B. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units; 1999 (R2005).
- C. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2002 (Reapproved 2007).
- D. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2009a.
- E. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2006.
- F. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2009a.
- G. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2008.
- 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; 2010.
- I. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2007.
- J. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2010a.
- K. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2009a.
- L. ASTM E72 - Standard Test Methods of Conducting Strength Tests of Panels for Building Construction; 2010.

- M. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009.
- N. ASTM E413 - Classification for Rating Sound Insulation; 2010.
- O. GA-216 - Application and Finishing of Gypsum Board; Gypsum Association; 2010.
- P. GA-600 - Fire Resistance Design Manual; Gypsum Association; 2009.
- Q. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.
- C. Test Reports: For all stud framing products that do not comply with ASTM C645 or C 754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.

1.05 QUALITY ASSURANCE

- A. Perform in accordance with ASTM C 840. Comply with requirements of GA-600 for fire-rated assemblies.
- B. Installer Qualifications: Company specializing in performing gypsum board application and finishing, with minimum 5 years of documented experience.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
- B. Interior Partitions: Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC of 55-59 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

2.02 METAL FRAMING MATERIALS

- A. Manufacturers - Metal Framing, Connectors, and Accessories:
 - 1. Clarkwestern Dietrich Building Systems LLC: www.clarkdietrich.com.
 - 2. Dietrich Metal Framing: www.dietrichindustries.com.
 - 3. MarinoWare: www.marinoware.com.
 - 4. Telling Industries: www.tellingindustries.com.
 - 5. Substitutions: See Section 01600 - Product Requirements.
- B. Metal Framing Connectors and Accessories:
 - 1. Same manufacturer as framing.
- C. 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. Exception: The minimum metal thickness and section properties requirements of ASTM C 645 are waived provided steel of 40 ksi minimum yield strength is used, the metal is continuously dimpled, the effective thickness is at least twice the base metal thickness, and maximum stud heights are determined by testing in accordance with ASTM E 72 using assemblies specified by ASTM C 754.
 - 2. Studs: "C" shaped with flat or formed webs with knurled faces.

3. Runners: U shaped, sized to match studs.
 4. Ceiling Channels: C shaped.
 5. Furring: Hat-shaped sections, minimum depth of 7/8 inch.
- D. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
- E. Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and braced with continuous bridging both sides.

2.03 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
1. Georgia-Pacific Gypsum LLC: www.gp.com/gypsum.
 2. National Gypsum Company: www.nationalgypsum.com.
 3. USG Corporation: www.usg.com.
 4. Substitutions: See Section 01600 - 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. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
 - b. Ceilings: 5/8 inch.
- C. Gypsum Wallboard: ASTM C 1396/C 1396M. Sizes to minimize joints in place; ends square cut.
1. Regular Type:
 - a. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 - b. Thickness: 5/8 inch.
 - c. Edges: Tapered.
 2. Ceiling Board: Special sag-resistant type.
 - a. Application: Ceilings, unless otherwise indicated.
 - b. Thickness: 1/2 inch.
 - c. Edges: Tapered.

2.04 ACCESSORIES

- A. Acoustic Sealant: Non-hardening, non-skinning, for use in conjunction with gypsum board.
- B. Finishing Accessories: ASTM C1047, galvanized steel, unless otherwise indicated.
1. Types: As detailed or required for finished appearance.
 2. Special Shapes: In addition to conventional cornerbead and control joints, provide U-bead at exposed panel edges.
- C. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.
1. Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.
 2. Ready-mixed vinyl-based joint compound.
- D. 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.
- E. Screws for Attachment to Steel Members Less Than 0.03 inch In Thickness, to Wood Members, and to Gypsum Board: ASTM C1002; self-piercing tapping type; cadmium-plated for exterior locations.
- F. Screws for Attachment to Steel Members From 0.033 to 0.112 Inch in Thickness: ASTM C954; steel drill screws for application of gypsum board to loadbearing steel studs.
- G. Screws: ASTM C 1002; self-piercing tapping type.

- H. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

2.05 MANUFACTURING

- A. All products shall be manufactured in the United States of America.

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 at 12 inches on center.
 - 1. Level ceiling system to a tolerance of 1/1200.
 - 2. Laterally brace entire suspension system.
 - 3. Install bracing as required at exterior locations to resist wind uplift.
- C. Studs: Space studs at 16 inches on center.
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
- D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- E. Acoustic Furring: Install resilient channels at maximum 24 inches on center. Locate joints over framing members.
- F. Blocking: Install blocking for support of plumbing fixtures, toilet partitions, toilet accessories, and hardware. Comply with Section 06114 for wood blocking.

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. In non-fire-rated construction, seal around all penetrations by conduit, pipe, ducts, and rough-in boxes.

3.04 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as follows:
 - 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 and as indicated.

3.05 JOINT TREATMENT

- A. Paper Faced Gypsum Board: Use paper joint tape, bedded with ready-mixed vinyl-based joint compound and finished with ready-mixed vinyl-based joint compound.

- B. 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.
- C. Finish all gypsum board in accordance with ASTM C 840 Level 4.
- 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 surfaces behind adhesive applied ceramic tile.
 - 3. 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.
- F. Spray apply high build drywall surfacer over entire surface after joints have been properly treated to achieve Level 5 finish in areas indicated.
- G. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

3.06 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 09300

TILE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tile for floor applications.
- B. Tile for wall applications.
- C. Cementitious backer board as tile substrate.
- D. Stone thresholds.
- E. Ceramic accessories.
- F. Ceramic trim.

1.02 RELATED REQUIREMENTS

- A. Section 07900 - Joint Sealers.

1.03 REFERENCE STANDARDS

- A. ANSI A108 Series/A118 Series/A136.1 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2009.
 - 1. ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar; 2005.
 - 2. ANSI A108.1b - American National Standard Specifications for Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex Portland Cement Mortar; 1999 (R2005).
 - 3. ANSI A108.1c - Specifications for Contractors Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Bed with Dry-Set or Latex Portland Cement Mortar; 1999 (R2005).
 - 4. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile-Setting Epoxy Adhesive; 1999 (R2005).
 - 5. ANSI A108.5 - American National Standard Specifications for Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar; 1999 (R2005).
 - 6. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy; 1999 (R2005).
 - 7. ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout; 1999 (R2005).
 - 8. ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout; 1999 (R2005).
 - 9. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework; 1999 (R2005).
- B. TCNA (HB) - Handbook for Ceramic Tile Installation; 2011.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- C. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.
- D. Maintenance Data: Include recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.

1.06 QUALITY ASSURANCE

- A. Maintain one copy of The Tile Council of North America Handbook and ANSI A108 Series/A118 Series on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum 5 years of documented experience.
- C. Installer Qualifications: Company specializing in performing tile installation, with minimum of 5 years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Do not install adhesives in an unventilated environment.
- B. Maintain ambient and substrate temperature of 50 degrees F during installation of mortar materials.

PART 2 PRODUCTS

2.01 TILE

- A. Manufacturers: All products by the same manufacturer.
 - 1. Dal-Tile Corporation: www.daltile.com.
 - 2. Substitutions: See Section 01600 - Product Requirements.

2.02 TRIM AND ACCESSORIES

- A. Ceramic Accessories: Glazed finish, same color and finish as adjacent field tile; same manufacturer as tile.
- B. Ceramic Trim: Matching bullnose, double bullnose, cove base, and cove ceramic shapes in sizes coordinated with field tile.
 - 1. Manufacturer: Same as for tile.
- C. Thresholds: Marble, white or gray, honed finish; 2 inches wide by full width of wall or frame opening; 1/2 inch thick; beveled one long edge with radiused corners on top side; without holes, cracks, or open seams.
 - 1. Applications: Provide at the following locations:
 - a. At doorways where tile terminates.
 - b. At open edges of floor tile where adjacent finish is a different height.

2.03 ADHESIVE MATERIALS

- A. Manufacturers:
 - 1. Bonsal American, Inc; B-4050 Multi-Purpose Adhesive: www.prospec.com.
 - 2. Bonsal American, Inc; StayFlex 590: www.prospec.com

3. Bonsal; Product ____: www.bonsal.com.
4. Bostik Inc; Product ____: www.bostik-us.com.
5. Custom Building Products; OmniGrip: www.custombuildingproducts.com.
6. LATICRETE International, Inc; LATICRETE 254 Platinum: www.laticrete.com.
7. Mapei Corporation; Product ____: www.mapei.com.
8. Substitutions: See Section 01600 - Product Requirements.

2.04 MORTAR MATERIALS

A. Manufacturers:

1. Bonsal American, Inc; Permalastic System: www.prospec.com.
2. Bonsal American, Inc; Permalastic System: www.prospec.com.
3. Bonsal; Product ____: www.bonsal.com.
4. Bostik Inc; Product ____: www.bostik-us.com.
5. Custom Building Products; MegaLite: www.custombuildingproducts.com.
6. LATICRETE International, Inc; LATICRETE 3701 Fortified Mortar Bed: www.laticrete.com.
7. Substitutions: See Section 01600 - Product Requirements.

B. Mortar Bond Coat Materials:

2.05 GROUT MATERIALS

A. Manufacturers:

1. Bonsal American, Inc; ProSpec Sanded Tile Grout 700: www.prospec.com.
2. Bonsal American, Inc; ProSpec Sanded Tile Grout 700: www.prospec.com.
3. Bonsal; Product ____: www.bonsal.com.
4. Bostik Inc; Product ____: www.bostik-us.com.
5. Custom Building Products; Prism SureColor Grout: www.custombuildingproducts.com.
6. LATICRETE International, Inc; LATICRETE SpectraLOCK PRO Grout: www.laticrete.com.
7. Substitutions: See Section 01600 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. 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 tile.

3.02 PREPARATION

- A. Protect surrounding work from damage.
- B. Vacuum clean surfaces and damp clean.
- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.

3.03 INSTALLATION - GENERAL

- A. Install tile, thresholds, and stair treads and grout in accordance with applicable requirements of ANSI A108.1 through A108.13, manufacturer's instructions, and The Tile Council of North America Handbook recommendations.
- B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar, or excess grout.

- E. Form internal angles square and external angles bullnosed.
- F. Install ceramic accessories rigidly in prepared openings.
- G. Install thresholds where indicated.
- H. Sound tile after setting. Replace hollow sounding units.
- I. Keep expansion joints free of adhesive or grout. Apply sealant to joints.
- J. Allow tile to set for a minimum of 48 hours prior to grouting.
- K. Grout tile joints. Use standard grout unless otherwise indicated.
- L. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes.

3.04 INSTALLATION - WALL TILE

- A. Over gypsum wallboard on wood or metal studs install in accordance with The Tile Council of North America Handbook Method W243, thin-set with dry-set or latex-Portland cement bond coat, unless otherwise indicated.

3.05 CLEANING

- A. Clean tile and grout surfaces.

3.06 PROTECTION

- A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION

SECTION 09511

SUSPENDED ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.

1.02 REFERENCE STANDARDS

- A. ASTM C635 - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2007.
- B. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels; 2008.
- 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; 2011.
- D. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2008e1.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on suspension system components.
- C. Samples: Submit two samples 4 x 4 inch in size illustrating material and finish of acoustical units.
- D. Manufacturer's Installation Instructions: Indicate special procedures.

1.04 QUALITY ASSURANCE

- A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.05 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.

1.06 PROJECT CONDITIONS

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

PART 2 PRODUCTS

2.01 ACOUSTICAL UNITS

- A. Manufacturers:
 - 1. Match building standard.
 - 2. USG; Product Radar #2110: www.usg.com.

- B. Acoustical Units - General: ASTM E1264, Class A.
- C. Acoustical Tile Type ACP-1: Plastic faced mineral fiber, with the following characteristics:
 - 1. Size: 24 x 24 inches.
 - 2. Thickness: 5/8 inches.
 - 3. Edge: Square.
 - 4. Surface Color: White.
 - 5. Suspension System: Donna DX - Exposed Tee System.

2.02 SUSPENSION SYSTEM(S)

- A. Manufacturers:
 - 1. Match building standard.
 - 2. Donn DX Exposed Tee System.
- B. Suspension Systems - General: ASTM C635; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required.
- C. Exposed Steel Suspension System: Formed steel, commercial quality cold rolled; intermediate-duty.
 - 1. Finish: White painted.

2.03 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Perimeter Moldings: Same material and finish as grid.
 - 1. At Exposed Grid: Provide L-shaped molding for mounting at same elevation as face of grid.
- C. Acoustical Sealant For Perimeter Moldings: Specified in Section 07900.
- D. Gasket For Perimeter Moldings: Closed cell rubber sponge tape.
- E. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.02 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.
- D. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.
- E. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

- G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- H. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- I. Do not eccentrically load system or induce rotation of runners.
- J. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Use longest practical lengths.
 - 2. Overlap and rivet corners.

3.03 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Fit border trim neatly against abutting surfaces.
- D. Install units after above-ceiling work is complete.
- E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- F. Cutting Acoustical Units:
 - 1. Make field cut edges of same profile as factory edges.

3.04 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

END OF SECTION

SECTION 09650

RESILIENT FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Resilient sheet flooring.
- B. Resilient base.
- C. Installation accessories.

1.02 REFERENCE STANDARDS

- A. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2010e1.
- B. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2008.
- C. ASTM F1066 - Standard Specification for Vinyl Composition Floor Tile; 2004 (Reapproved 2010)e1.
- D. ASTM F1303 - Standard Specification for Sheet Vinyl Floor Covering with Backing; 2004 (Reapproved 2009).
- E. ASTM F1861 - Standard Specification for Resilient Wall Base; 2008.
- F. ASTM F1913 - Standard Specification for Vinyl Sheet Floor Covering Without Backing; 2004 (Reapproved 2010).
- G. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; National Fire Protection Association; 2011.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Verification Samples: Submit two samples, 4x4 inch in size illustrating color and pattern for each resilient flooring product specified.
- D. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect roll materials from damage by storing on end.

1.05 FIELD CONDITIONS

- A. Maintain temperature in storage area between 65 degrees F and 100 degrees F.
- B. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS

2.01 SHEET FLOORING

- A. Vinyl Sheet Flooring: Homogeneous without backing, with color and pattern throughout full thickness, and:
 - 1. Minimum Requirements: Comply with ASTM F1303, Type II, without backing, or ASTM F1913.
 - 2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E 648 or NFPA 253.
 - 3. Total Thickness and Wear Layer Thickness: 0.080 inch nominal.
 - 4. Sheet Width: 72 inch minimum.
 - 5. Static Load Resistance: 125 psi minimum, when tested as specified in ASTM F1303.
 - 6. Heat welded seams.
 - 7. Integral coved base with cap strip.
 - 8. Pattern: As indicated in Finish Schedule Legend.
 - 9. Manufacturers:
 - a. Mannington; Product Assurance II.
 - b. Substitutions: See Section 01600 - Product Requirements.
- B. Vinyl Welding Rod: Solid vinyl bead produced by manufacturer of vinyl flooring for heat welding seams, in color matching field color.

2.02 RESILIENT BASE

- A. Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; top set Style B, Cove, and as follows:
 - 1. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E 648 or NFPA 253.
 - 2. Height: 4 inch.
 - 3. Thickness: 0.125 inch thick.
 - 4. Finish: Satin.
 - 5. Length: Roll.
 - 6. Color: Color as selected from manufacturer's standards.
 - 7. Manufacturers:
 - a. Johnsonite, Inc: www.johnsonite.com.
 - b. Substitutions: See Section 01600 - Product Requirements.

2.03 ACCESSORIES

- A. Primers, Adhesives, and Seaming Materials: Waterproof; types recommended by flooring manufacturer.
- B. Moldings, Transition and Edge Strips: Metal.
- C. Filler for Coved Base: Plastic.

2.04 MANUFACTURING

- A. All products shall be manufactured in the United States of America.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive resilient flooring.
- C. 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 resilient base.

- D. Verify that sub-floor surfaces are dust-free and free of substances which would impair bonding of adhesive materials to sub-floor surfaces.
- E. Verify that concrete sub-floor surfaces are dry enough and ready for resilient flooring installation by testing for moisture emission rate and alkalinity in accordance with ASTM F710; obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
- F. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Remove sub-floor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with sub-floor filler to achieve smooth, flat, hard surface.
- B. Prohibit traffic until filler is cured.
- C. Clean substrate.
- D. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed.

3.03 INSTALLATION

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install in accordance with manufacturer's instructions.
- C. Spread only enough adhesive to permit installation of materials before initial set.
- D. Fit joints tightly.
- E. Set flooring in place, press with heavy roller to attain full adhesion.
- F. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
- G. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
- H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.04 SHEET FLOORING

- A. Install in accordance with manufacturer's instructions.
- B. Spread only enough adhesive to permit installation of materials before initial set.
- C. Set flooring in place, press with heavy roller to attain full adhesion.
- D. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns carefully at seams.
- E. Double cut sheet at seams.
- F. Lay flooring with tightly butted seams, without any seam sealer unless otherwise indicated.
- G. Finish seams in sheet vinyl by heat welding.
- H. Double cut sheet; provide heat welded seams.
- I. Where floor finishes are different on opposite sides of door, terminate flooring under centerline of door.

- J. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated. After installation of flooring, secure metal strips with stainless steel screws. Secure resilient strips by adhesive.
- K. Coved Base: Install as detailed on drawings, using coved base filler as backing at floor to wall junction. Extend sheet flooring vertically to height indicated, and cover top edge with metal cap strip.
- L. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.
- M. Install flooring in recessed floor access covers. Maintain floor pattern.
- N. Caulk at all door frames and unsealed joints that abutt a different material.

3.05 RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.
- B. Miter internal corners. At external corners, "V" cut back of base strip to 2/3 of its thickness and fold. At exposed ends, use premolded units.
- C. Install base on solid backing. Bond tightly to wall and floor surfaces. If base is not attached tightly to the wall during installation- the perimeter will be caulked.
- D. Scribe and fit to door frames and other interruptions. Caulk at door frame.

3.06 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's instructions.
- C. Clean, seal, and wax resilient flooring products in accordance with manufacturer's instructions.

3.07 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION

SECTION 09680

CARPET

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Carpet, direct-glued.
- B. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 03300 - Cast-in-Place Concrete: Restrictions on curing compounds for concrete slabs and floors to receive adhesive-applied carpet.

1.03 SUBMITTALS

- A. See Section 01300 - 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 samples 6x6 inch in size illustrating color and pattern for each carpet material specified.
- D. Manufacturer's Installation Instructions: Indicate special procedures.
- E. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.

1.04 QUALITY ASSURANCE

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

1.05 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.
- B. Maintain minimum 70 degrees F ambient temperature 24 hours prior to, during and 24 hours after installation.
- C. Ventilate installation area during installation and for 72 hours after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Carpet:
 - 1. To be selected from the building standard.
 - 2. Substitutions: See Section 01600 - Product Requirements.

2.02 ACCESSORIES

- A. Sub-Floor Filler: Type recommended by carpet manufacturer.
- B. Tackless Strip: Carpet gripper, of type recommended by carpet manufacturer to suit application, with attachment devices.
- C. Moldings and Edge Strips: Embossed aluminum, color as selected.

- D. Adhesives - General: Compatible with materials being adhered; maximum VOC content of 50 g/L; CRI Green Label certified; in lieu of labeled product, independent test report showing compliance is acceptable.
- E. Seam Adhesive: Recommended by manufacturer.
- F. Contact Adhesive: Compatible with carpet material; releasable type.

2.03 2.03 MANUFACTURING

ALL PRODUCTS SHALL BE MANUFACTURED IN THE UNITED STATES OF AMERICA.

PART 3 EXECUTION

4.01 EXAMINATION

- A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive carpet.
- 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.
- C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesives to sub floor surfaces.
- D. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for resilient flooring installation by testing for moisture and pH.
 - 1. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
- E. Verify that concrete sub-floor surfaces are ready for carpet installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within limits recommended by carpet manufacturer and adhesive materials manufacturer.
- F. Verify that required floor-mounted utilities are in correct location.

4.02 PREPARATION

- A. Remove existing carpet and carpet cushion.
- B. Remove sub-floor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with sub-floor filler.
- C. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.
- D. Clean substrate.

4.03 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install carpet and cushion in accordance with manufacturer's instructions and CRI Carpet Installation Standard.
- C. Verify carpet match before cutting to ensure minimal variation between dye lots.
- D. Lay out carpet:
 - 1. Locate seams in area of least traffic, out of areas of pivoting traffic, and parallel to main traffic.
 - 2. Do not locate seams perpendicular through door openings.
 - 3. Align run of pile in same direction as anticipated traffic and in same direction on adjacent pieces.

4. Locate change of color or pattern between rooms under door centerline.
 5. Provide monolithic color, pattern, and texture match within any one area.
- E. Install carpet tight and flat on subfloor, well fastened at edges, with a uniform appearance.

4.04 DIRECT-GLUED CARPET

- A. Double cut carpet seams, with accurate pattern match. Make cuts straight, true, and unfrayed. Apply seam adhesive to cut edges of woven carpet immediately.
- B. Apply contact adhesive to floor uniformly at rate recommended by manufacturer. After sufficient open time, press carpet into adhesive.
- C. Apply seam adhesive to the base of the edge glued down. Lay adjoining piece with seam straight, not overlapped or peaked, and free of gaps.
- D. Roll with appropriate roller for complete contact of adhesive to carpet backing.
- E. Trim carpet neatly at walls and around interruptions.
- F. Complete installation of edge strips, concealing exposed edges. Bind cut edges where not concealed by edge strips.

4.05 CLEANING

- A. Remove excess adhesive from floor and wall surfaces without damage.
- B. Clean and vacuum carpet surfaces.

END OF SECTION

SECTION 09900

PAINTS AND COATINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints.
- 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 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; 2011.

1.03 DEFINITIONS

- A. Conform to ASTM D 16 for interpretation of terms used in this section.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on all finishing products, including VOC content.
- C. Samples: Submit two paper chip samples, 6x6 inch in size illustrating range of colors and textures available for each surface finishing product scheduled.
- D. Certification: By manufacturer that all paints and coatings comply with VOC limits specified.
- E. Manufacturer's Instructions: Indicate special surface preparation procedures.
- F. Maintenance Data: Submit data on cleaning, touch-up, 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 3 years experience.

1.06 REGULATORY REQUIREMENTS

- A. Conform to applicable code for flame and smoke rating requirements for products and finishes.

1.07 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.

1.08 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. Paints:
 - 1. Sherwin Williams Paints
- C. Primer Sealers:
- D. Substitutions: See Section 01600 - Product Requirements.

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: 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.
- D. Chemical Content: The following compounds are prohibited:
 - 1. Aromatic Compounds: In excess of 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).

2. Acrolein, acrylonitrile, antimony, benzene, butyl benzyl phthalate, cadmium, di (2-ethylhexyl) phthalate, di-n-butyl phthalate, di-n-octyl phthalate, 1,2-dichlorobenzene, diethyl phthalate, dimethyl phthalate, ethylbenzene, formaldehyde, hexavalent chromium, isophorone, lead, mercury, methyl ethyl ketone, methyl isobutyl ketone, methylene chloride, naphthalene, toluene (methylbenzene), 1,1,1-trichloroethane, vinyl chloride.

2.03 PAINT SYSTEMS - INTERIOR

- A. Paint CI-OP-3L - Concrete/Masonry, Opaque, Latex, 3 Coat:
 1. One coat of block filler.
 2. Flat: Two coats of latex enamel; as scheduled.
- B. Paint GI-OP-3L - Gypsum Board/Plaster, Latex, 3 Coat:
 1. See finish schedule in drawings for requirements.
 2. One coat of alkyd primer sealer.
 3. Eggshell: Two coats of latex enamel.

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.
 2. Plaster and Stucco: 12 percent.
 3. Masonry, Concrete, and Concrete Unit Masonry: 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 mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Surfaces: Correct defects and clean surfaces which affect work of this section. Remove or repair existing coatings that exhibit surface defects.
- 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.
- H. Plaster Surfaces to be Painted: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
- I. Galvanized Surfaces to be Painted: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.
- J. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.

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. Sand wood and metal surfaces lightly between coats to achieve required finish.
- F. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- G. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Refer to Section 15075 and Section 16075 for schedule of color coding of equipment, duct work, piping, and conduit.
- B. Paint shop-primed equipment, where indicated.
- C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- D. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.05 FIELD QUALITY CONTROL

- A. See Section 01400 - Quality Requirements, for general requirements for field inspection.

3.06 CLEANING

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

3.07 PROTECTION

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

3.08 SCHEDULE - SURFACES TO BE FINISHED

- A. Do Not Paint or Finish the Following Items:

1. Items fully factory-finished unless specifically noted.
 2. Fire rating labels, equipment serial number and capacity labels.
 3. Stainless steel items.
- B. Paint the surfaces described below under Schedule - Paint Systems.
- C. Mechanical and Electrical: Use paint systems defined for the substrates to be finished.
1. Paint all insulated and exposed pipes occurring in finished areas to match background surfaces, unless otherwise indicated.
 2. Paint shop-primed items occurring in finished areas.
 3. Paint interior surfaces of air ducts and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
 4. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.

END OF SECTION

SECTION 10260

WALL AND CORNER GUARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Corner guards.

1.02 REFERENCE STANDARDS

- A. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 2003.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate physical dimensions, features, anchorage details, and rough-in measurements.
- C. Samples: Submit two sections of bumper rail, 24 inch long, illustrating component design, configuration, color and finish.
- D. Manufacturer's Instructions: Indicate special procedures, perimeter conditions requiring special attention.

1.04 PROJECT CONDITIONS

- A. Coordinate the work with wall or partition sections for installation of concealed blocking or anchor devices.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Wall and Corner Guards:
 - 1. Acrovyn; Product Surface Mounted www.c-sgroup.com.
 - 2. Substitutions: See Section 01600 - Product Requirements.

2.02 COMPONENTS

- A. Corner Guards - Surface Mounted: High impact vinyl with extruded aluminum full height retainer and integral impact absorbing device.
 - 1. Performance: Resist lateral impact force of 100 lbs at any point without damage or permanent set.
 - 2. Size: 2 inches.
 - 3. Corner: Square.
 - 4. Color: As selected from manufacturer's standard colors.
 - 5. Length: One piece.
 - 6. Preformed end caps.

2.03 FABRICATION

- A. Fabricate components with tight joints, corners and seams.
- B. Pre-drill holes for attachment.
- C. Form end trim closure by capping and finishing smooth.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
- B. Verify that field measurements are as instructed by the manufacturer.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to wall framing members only.
- B. Position top of corridor hand rail 33 to 36 inches from finished floor. Match existing rail height in corridor.
- C. Position corner guard _____ inches above finished floor to _____ inches high.
- D. Terminate rails 6 inches short of door opening.

3.03 TOLERANCES

- A. Maximum Variation From Required Height: 1/4 inch.
- B. Maximum Variation From Level or Plane For Visible Length: 1/4 inch.

3.04 SCHEDULE

- A. See Finish Schedule & Floor Pattern Plan for manufacturer, product number and color.

END OF SECTION

SECTION 10523

FIRE EXTINGUISHERS, CABINETS AND ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.
- C. Accessories.

1.02 REFERENCE STANDARDS

- A. NFPA 10 - Standard for Portable Fire Extinguishers; 2010.
- B. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide extinguisher operational features.
- C. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.04 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire Extinguisher Cabinets and Accessories:
 - 1. JL Industries, Inc: www.jlindustries.com.
 - 2. Substitutions: See Section 01600 - Product Requirements.

2.02 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
- B. Dry Chemical Type Fire Extinguishers: Stainless steel tank, with pressure gage.
 - 1. Finish: Baked enamel, red color.

2.03 FIRE EXTINGUISHER CABINETS

- A. Metal: Formed primed steel sheet; 0.036 inch thick base metal.
- B. Cabinet Configuration: Recessed type.
 - 1. Sized to accommodate accessories.
 - 2. Form cabinet enclosure with right angle inside corners and seams. Form perimeter trim and door stiles.
- C. Door: 0.036 inch thick, reinforced for flatness and rigidity; latch. Hinge doors for 180 degree opening with two butt hinge. Provide nylon catch.

- D. Door Glazing: Plastic, clear, 1/8 inch thick acrylic. Set in resilient channel gasket glazing.
- E. Cabinet Mounting Hardware: Appropriate to cabinet. Pre-drill for anchors.
- F. Weld, fill, and grind components smooth.
- G. Finish of Cabinet Exterior Trim and Door: Primed for field paint finish.
- H. Finish of Cabinet Interior: White enamel.

2.04 MANUFACTURING

- A. All products shall be manufactured in the United States of America.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure rigidly in place.
- C. Place extinguishers and accessories in cabinets.

END OF SECTION

SECTION 11600

LABORATORY EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fume hoods.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.03 SUMMARY

- A. This section includes the following:
 - 1. Bench-top laboratory fume hoods.
 - 2. Laminar Hoods/Biological Safety Cabinets
 - 3. Laboratory sinks and sup sinks in fume hoods.
 - 4. Water, laboratory gas, and electrical service fittings in fume hoods.
 - 5. Piping and wiring within fume hoods for service fittings, light fixtures, blower switches, and other electrical devices.
- B. Related Sections include the following:
 - 1. Division 6 Section "Rough Carpentry" for wood blocking for anchoring fume hoods.
 - 2. Division 9 Section "Gypsum Board Assemblies" for reinforcements in metal-framed gypsum board partitions for anchoring fume hoods.
 - 3. Division 15 Section "Testing, Adjusting, and Balancing" for field quality-control testing of fume hoods.
 - 4. Division 15 Sections for fume hood duct connections, including ducts.
 - 5. Division 15 and 16 Sections for connecting service utilities at back of fume hoods. Piping and wiring within fume hoods are specified in this Section.

1.04 PERFORMANCE REQUIREMENTS

- A. Containment: Provide fume hoods that comply with the following when tested according to ASHRAE 110-1995 at a release rate of 4.0L/min.
 - 1. Average Face Velocity: 100 fpm (0.51 m/s) plus or minus 10 percent with sashes open 18 inches.
 - 2. Face Velocity Variation: Not more than 10 percent of average face velocity.
 - 3. Sash Position: Open to 18 inches.
 - 4. As-Manufactured (AM) Rating: AM 0.05 (0.05 ppm).
 - 5. Test Setup Modifications: Conduct tests with a minimum of 3 and a maximum of 5 people in the test room and with two 1-gal.(3.8-L) round paint cans, one 12-by-12-by-12-inch (300-by-300-by-300-mm) cardboard box, and three 6-by-6-by-12-inch (150-by-150-by-300-mm) cardboard boxes in the fume hood during the test. Position items from 6 to 10 inches (150 to 250mm) behind the sash, randomly distributed, and supported off the work surface by 2-by-2-inch (50-by-50-mm) blocks.
 - 6. Walk-by Test: At the conclusion of containment test, execute 3 rapid walk-bys at 30-second intervals, 12 inches (300 mm) behind the manikin. Test-gas concentration during each walk-by shall not exceed 0.1 ppm and shall return to specified containment value within 15 seconds.
- B. Static-Pressure Loss: Not more than 3/8-inch wg(93 Pa) at 100-fpm((0.51-m/s)) face velocity when tested according to Paragraph 6.4.2.4 in SEFA 1.2, "Laboratory Fume Hoods-Recommended Practices."

- C. Structural Performance: Provide fume hood components capable of withstanding the following loads without permanent deformation, excessive deflection, or binding of cabinet drawers and doors:
1. Fume Hood Countertops: 200lb/ft.(297 kg/m).
 2. Base Cabinets of Fume Hoods: 75 lb/ft.(112 kg/m) within cabinets, 50-lb/ft.(74-kg/m) countertop, 200lb/ft.(297 kg/m) on countertop, plus weight of hood.
 3. Fume Hood Base Stands: 50-lb/ft(74-kg/m) countertop, 75 lb/ft.(112 kg/m) on countertop, plus weight of hood.
 4. Fume Hood Base Stands for Hoods: 50-lb/ft.(74-kg/m) countertop, 200 lb/ft.(297 kg/m) on countertop, plus weight of hood.

1.05 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide equipment dimensions and construction, equipment capacities, physical dimensions, utility and service requirements and locations, and point loads for each type of product indicated.
1. Indicate details for anchoring fume hoods to permanent building construction including locations of blocking and other supports.
 2. Indicate locations and types of service fittings together with associated service supply connection required.
 3. Indicate duct connections, electrical connections, and locations of access panels.
 4. Include roughing-in information for mechanical, plumbing, and electrical connections.
 5. Show adjacent walls, doors, windows, other building components, laboratory casework, and other laboratory equipment. Indicate clearances from above items.
 6. Include layout of fume hoods in relation to lighting fixtures and air conditioning registers and grilles.
 7. Include coordinated dimensions for laboratory equipment specified in other Sections.
- C. Samples for Verification: For factory-applied finishes interior lining, in manufacturer's standard sizes. All finishes are to match existing.
- D. Product Test Reports: Based on evaluation of comprehensive tests according to SEFA 1.2, "Laboratory Fume Hoods--Recommended Practices" and ASHRAE 110 performed by manufacturer and witnessed by a qualified independent testing agency, for fume hoods.

1.06 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the types of products specified in this section, with minimum three years of documented experience.
- B. Product Standard: Comply with SEFA 1.2, "Laboratory Fume Hoods--Recommended Practices."
- C. Safety Glass: Products complying with testing requirements in 16 CFR 1201 for Category II materials.
1. Subject to compliance with requirements, permanently mark safety glass with certification label of Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.08 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install fume hoods until building is enclosed, wet work and utility roughing-in are complete, and HVAC system is operation and maintaining temperature and relative humidity at occupancy levels during remainder of the construction period.

1.09 COORDINATION

- A. Coordinate installation of fume hoods with laboratory casework, fume hood exhaust ducts, and plumbing and electrical work.

1.10 EXTRA MATERIALS

- A. Furnish complete touchup fit for each type and color of fume hood finish provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged fume hood finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Baker Company (The).
 - 2. Fisher Hamilton L.L.C.
 - 3. Kewanee Scientific Corporation; Laboratory Division
 - 4. Labconco Corporation
 - 5. Mott Manufacturing Ltd.

2.02 MATERIALS

- A. Finishes and general appearance to match existing fume hoods in existing building.
- B. Steel Sheet: Cold-rolled commercial steel sheet, complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.
- C. Glass-Fiber-Reinforced Polyester: Polyester laminate complying with ASTM D 4357, with a chemical-resistant gel coat on the exposed face, and having a flame-spread index of 25 or less per ASTM E 84.
- D. Epoxy: Factory molded of modified epoxy-resin formulation complying with Division 12 Section "Wood Laboratory Casework" and having a flame-spread index of 25 or less per ASTM E 84.
- E. Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality q3.
- F. Laminated Safety Glass: ASTM C 1172, Kind LT, Condition A, Type I Class I Quality q3 with clear, polyvinyl butryal interlayer.
- G. Polycarbonate Glazing: Clear, uncoated polycarbonate sheet manufactured by extrusion process and complying with the following requirements:
 - 1. Impact Resistance: 12 to 16 ft-lbf/in.(640 to 850 J/m) per ASTM D 256, Method A.
 - 2. Elongation and Modulus of Elasticity: 110 percent maximum and 340,000 psi (2345 MPa), respectively, per ASTM D 638.
 - 3. Heat Deflection: 270 deg F(132 deg C) at 264 psi(1820 kPa) per ASTM D 638.
 - 4. Flame-Spread Index: 25 or less per ASTM E 84.

2.03 BYPASS FUME HOODS

- A. Provide fume hoods with compensating bypass above sash, which opens as sash is closed. Provide sufficient bypass capacity so that face velocity with sash opening of 6 inches (150 mm) does not exceed 3 times the face velocity with sash fully open.

2.04 FABRICATION

- A. General: Preassemble fume hoods in factory to greatest extent possible. Disassemble fume hoods as necessary for shipping and handling limitations. Fume hoods shall be capable of being partly disassembled as necessary to permit movement through a 35-by-79-inch(889-by-2007-mm) door opening.
- B. Steel Exterior: Fabricate from steel sheet, not less than 0.0478 inch(1.2mm) thick, with component parts screwed together to allow removal of end panels, front fascia, and airfoil and to allow access to plumbing lines and service fitting. Apply chemical-resistant finish to interior and exterior surfaces of component parts before assembly.
- C. Ends: Fabricate with double-wall end panels without projecting corner posts or other obstructions to interfere with smooth, even airflow. Close area between double walls at front of fume hood and as needed to house sash counterbase weights, utility lines, and remote-control valves.
- D. Splay top and sides of face opening to provide an aerodynamic shape to ensure smooth, even flow of air into fume hood.
- E. Interior Lining: Provide linings of types indicated for each product designation on Fume Hood Schedule.
- F. Rear Baffle: Provide baffle, of same material as fume hood lining, at rear of hood with openings at top and bottom for airflow through hood. Secure baffle to cleats at rear of hood with stainless-steel screws. Fabricate baffle for easy removal for cleaning behind baffle.
- G. Exhaust Plenum: Full width of fume hood and with adequate volume to provide uniform airflow from hood, of same material as hood lining, and with duct stub for exhaust connection.
- H. Bypass Grilles: Provide grilles at bypass openings and restricted bypass fume hoods.
- I. Sashes: Provide operable sashes of type indicated by product designation on Fume Hood Schedule.
- J. Provide airfoil at bottom of sash opening to direct airflow across countertop from 1-inch(25-mm) space between airfoil and countertop.
 - 1. Fabricate airfoil from stainless steel.
- K. Light Fixtures: Provide vaporproof, two-tube, rapid-start, fluorescent light fixtures, of longest practicable length; complete with tubes at each fume hood. Shield tubes from hood interior with 1/4-inch-(6.35-mm-) thick laminated glass or 3-mm-thick tempered glass, sealed into hood with chemical resistant rubber gaskets. Provide units with fluorescent tubes easily replaceable from outside of fume hood.
 - 1. Provide fluorescent tubes with color temperatures of 3500 K and minimum color-rendering index of 85.
 - 2. Provide vaporproof, acid-resistant, incandescent light fixtures complete with 100-W, Type A, long life bulbs instead of fluorescent fixtures at radioisotope fume hoods. Provide 2 fixtures for hoods up to 60 inches(1524 mm) long and 1 fixture for each 24 inches(610 mm) of length for longer hoods.
- L. Base Cabinets: Comply with Division 12 Section "Wood Laboratory Casework."

- M. Fume Hood Base Stands: Fabricated from not less than 2-inch-(50-mm-) square, electrically welded steel tubing. Provide leg stretchers, cross stretchers, and countertop support rails to legs, and finish entire assembly with chemical-resistant finish. Provide leveling device at each corner of base stand at floor.
 - 1. Provide clear floor space not less than 36 inches(915 mm) wide by 25 inches(635 mm) deep by 27 inches(685 mm) high within fume hood base stands.

2.05 CHEMICAL-RESISTANT FINISH

- A. Preparation: Clean steel surfaces, other than stainless steel, of mill scale, rust, oil, and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
- B. Chemical-Resistant Finish: Immediately after cleaning and pretreating, apply fume hood manufacturer's standard two-coat, chemical resistant, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils(0.05 mm).
 - 1. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface tests in SEFA 8. Acceptance level for chemical spot test shall be no more than four Level 3 conditions.
 - 2. Colors for Fume Hood Finish: To match existing fume hoods in existing building and to be verified by architect from manufacturer's full range.

2.06 ACCESSORIES

- A. Service Fittings: Comply with requirements in Division 12 Section "Wood Laboratory Casework."
 - 1. Provide service fittings with exposed surfaces, including fittings, escutcheons, and trim, finished with acid- and solvent-resistant, baked-on plastic coating in manufacturer's standard color as approved by Architect.
 - 2. Provide service fittings with parts exposed within fume hoods from PVDF.
 - 3. Provide service fittings complying with either of the above.
- B. Airflow Indicator: Provide fume hoods with airflow indicator of the following type:
 - 1. Indicator Type: Thermal anemometer that measures fume hood face velocity and displays data as digital readout.
- C. Airflow Alarm: Provide fume hoods with audible and visual alarm that activates when airflow sensor reading is outside of preset range.
 - 1. Provide with either thermal-anemometer or aneroid (Magnehelic-type) gage airflow sensor.
 - 2. Provide with reset and test switches.
 - 3. Provide with switch that silences audible alarm and automatically resets when airflow returns to within preset range.
- D. Sash Alarm: Provide fume hoods with audible and visual alarm that activates when sash is opened beyond preset position.
 - 1. Provide with silence and test switches.
- E. Sash Stops: Provide fume hoods with sash stops to limit hood opening to 50 percent of sash height. Sash stops can be manually released to open sash fully for cleaning fume hood and for placing large apparatus within fume hood.
- F. Bypass Grille Blank-off Panel: Provide fume hoods with blank-off panel on bypass grille designed for use with sash stops to reduce exhaust air volume and provide design face velocity with sash at 50 percent open position.
- G. Face Velocity Labels: Provide minimum 6 inch by 8 inch permanent sign attached to the front of each hood indicating design face velocity with sash open 18 inches.

- H. Alarm Signs: Provide minimum 6 inch by 8 inch permanent sign attached to the front of each hood indicating procedures at alarm mode.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fume hoods.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Verify that rough-in frames, anchors and supports are accurately placed.

3.02 INSTALLATION

- A. General: Install fume hood according to Shop Drawings and manufacturer's written instructions. Install level, plumb, and true; shim as required, using concealed shims, and securely anchor to building and adjacent laboratory casework. Securely attach access panels, but provide for easy-removal and secure reattachment. Where fume hoods abut other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- B. Comply with requirements in Division 12 Section "Wood Laboratory Casework" for installing fume hood base cabinets, countertops, and sinks.
- C. Comply with requirements in Division 15 and 16 Sections for installing water and laboratory gas service fittings, piping, electrical devices, and wiring. Install according to Shop Drawings and manufacturer's written instructions. Securely anchor fittings, piping, and conduit to fume hoods, unless otherwise indicated.

3.03 FIELD QUALITY CONTROL

- A. Field test installed fume hood according to ASHRAE 110 to verify compliance with performance requirements.
 - 1. Adjust fume hood, hood exhaust fan, and building's HVAC system, or replace hood and make other corrections until tested hoods perform as specified.
 - 2. After making corrections, retest fume hood that failed to perform as specified.

3.04 ADJUSTING AND CLEANING

- A. Adjust moving parts for smooth, near silent, accurate sash operation with one hand. Adjust sashes for uniform contact of rubber bumpers. Verify that counterbalances operate without interference.
- B. Clean finished surfaces, including both sides of glass; touch up as required; and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

3.05 FUME HOOD SCHEDULE

- A. Basis-of-Design Product: The design of the laboratory fume hood is based on the product listed below. subject to compliance with requirements, provide the named product or a comparable product by another listed manufacturer.
- B. Provide hoods in sizes indicated on Drawings.
- C. Chemical Hood
 - 1. Fisher Hamilton SafeAire Restricted Bypass Hood with Vertical Sash and Polyresin Liner. (Airmastersystems "The Eliminator 100 SERIES: Airfoil Fume Hood")

END OF SECTION

SECTION 12352

WOOD LABORATORY CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wood laboratory casework.
- B. Laboratory countertops.
- C. Utility-space framing at backs of base cabinets and between backs of base cabinets.
- D. Utility-space closure panels between base cabinets and at exposed ends of utility spaces.
- E. Shelves.
- F. Laboratory sinks and troughs.
- G. Accessories
- H. Water, laboratory gas, and electrical service fittings.

1.02 RELATED REQUIREMENTS

- A. Division 6 Section "Rough Carpentry" for wood blocking and anchoring laboratory casework.
- B. Division 9 Section "Gypsum Board Assemblies" for reinforcements in metal-framed gypsum board partitions for anchoring laboratory casework.
- C. Division 9 Section "Resilient Wall Base and Accessories" for resilient base applied to wood laboratory casework.
- D. Division 11 Section "Laboratory Fume Hoods" for fume hoods, including base cabinets and countertops under fume hoods.
- E. Division 15 and 16 Sections for installing service fittings specified in this Section.

1.03 DEFINITIONS

- A. Exposed Portions of Casework: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than 48 inches (1200mm) above floor, and visible surfaces in open cabinets or behind glass doors.
 - 1. Ends of cabinets indicated to be installed directly against and completely concealed by walls of other cabinets after installation shall not be considered exposed.
- B. Semiexposed Portions of casework: Surfaces behind opaque doors, such as interiors of cabinets, shelves, dividers, interiors and sides of drawers, and interior faces of doors. Tops of cases 78 inches (1980mm) or more above floor are defined as semiexposed.
- C. Concealed Portions of Casework: Include sleepers, web frames, dust panels, and other surfaces not usually visible after installation.

1.04 REFERENCE STANDARDS

- A. NFPA 30 - Flammable and Combustible Liquids Code; 2008.
- B. SEFA 8 - Laboratory Casework; 2006.

1.05 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.

- B. Product Data (for each type of product indicated): Component dimensions, configurations, construction details, joint details, attachments; manufacturer's catalog literature on hardware, accessories, and service fittings, if any.
- C. Shop Drawings: Casework locations, large scale plans, elevations, cross sections, rough-in and anchor placement dimensions and tolerances, clearances required, and utility locations, if any.
 - 1. Indicate locations of blocking and reinforcements required for installing laboratory casework.
 - 2. Indicate locations and types of service fittings, together with associated service supply connection required.
 - 3. Include details of utility spaces showing supports for conduits and piping.
 - 4. Include details of exposed conduits, if required, for service fittings.
 - 5. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and other laboratory equipment.
 - 6. Include coordinated dimensions of laboratory equipment specified in other sections.
- D. Samples For Initial Selection: For factory-applied finishes, epoxy sinks, epoxy countertops and troughs. All finishes are to match existing.
- E. Samples for Verification: For each type of finish, including countertop material, in manufacturer's standard sizes.

1.06 QUALITY ASSURANCE

- A. All new casework is to match existing lab casework. All manufacturers submitting bids on this scope of work are required to perform a site visit and provide written documentation acknowledging the existing conditions and their ability to match them.
- B. Source Limitations: Obtain laboratory casework, including countertops, sinks, service fittings, and accessories, through one source from a single manufacturer.
- C. Product Designations: Drawings indicate sizes and configurations of laboratory casework by referencing designated manufacturer's catalog numbers. Other manufacturers' laboratory casework of similar sizes, similar door and drawer configurations, and complying with the Specifications may be considered. Refer to Division 1 Section "Product Requirements."
- D. Product Standard: Comply with SEFA 8, "Laboratory Furniture--Casework, Shelving and Tables--Recommended Practices."
- E. Flammable Liquid Storage: Where cabinets are indicated for solvent or flammable liquid storage, provide units that are listed and labeled as complying with requirements of NFPA 30 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."
- H. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.08 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install wood laboratory casework until wet work and utility roughing in are complete and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.09 COORDINATION

- A. Coordinate layout and installation of framing and reinforcements for support of wood laboratory casework.
- B. Coordinate installation of wood laboratory casework with installation of fume hoods and other laboratory equipment.

1.10 EXTRA MATERIALS

- A. Furnish complete touchup kit for each type and color of wood laboratory casework provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged laboratory casework finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. New casework is to match existing lab casework. The selected manufacturer shall provide matching construction, material finishes, and detailing so that all new casework matches the existing lab casework found throughout the existing building. If a product is no longer available or there is any other reason for any variation from the existing casework, the manufacturer must make the Architect aware of these variations. No variations are acceptable without the approval of the Architect.
- B. Existing lab casework was provided by Advance Lab Concepts, Inc. and was selected as listed below:
 - 1. VM Plain Sliced Maple Laboratory Casework
 - a. Flush Overlay,
 - b. Running Book matched veneer,
 - c. 3/4 extension drawer slides and plywood drawer bottoms,
 - d. 4 inch chrome plated wire pulls,
 - e. 5 knuckle chrome plated hinges,
 - f. 5 disc tumbler locks and label holders
 - 2. 60 inch Bench top fume hood
 - a. Services as shown in drawings,
 - b. Ceiling enclosure,
 - c. Bases as shown in drawings.
 - d. Black epoxy resin work top dished,
 - 3. 1 inch black epoxy resin tops and sink
 - 4. Chrome plated brass laboratory grade fixtures as shown,
 - a. Valves on peninsulas, fixtures at sink
- C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include but are not limited to, the following:
 - 1. Wood Laboratory Casework:
 - a. Advance Lab Concepts, Inc.
 - b. Fisher Hamilton L.L.C.
 - c. Kewaunee Scientific Corporation; Laboratory Division.
 - d. Sheldon Laboratory Systems
 - 2. Epoxy Countertops, Sinks, and Troughs:
 - a. Dureon Company, Inc. (The).

- b. Epoxyn Products
- c. Laboratory Tops, Inc.
- d. Prime Industries, Inc.

2.02 WOOD LABORATORY CASEWORK

- A. General:
 - 1. Adhesives: Do not use adhesives that contain urea formaldehyde.
 - 2. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.
 - 3. Hardwood Plywood: IIPVAHP-1, either veneer core or particle core, unless otherwise indicated, made without urea formaldehyde.
 - 4. Particore: Straw-based particore complying with requirements of ANSI A208.1, Grade M-2, except for density.
 - 5. Edgebanding for Wood-Veneered Construction: Minimum 1/8-inch-(3-mm-) thick, solid wood of same species as face veneer.
 - a. Colors: As selected by Architect from manufacturer's full range.
- B. Exposed Materials:
 - 1. General: Provide materials that are selected and arranged for compatible grain and color. Do not use materials adjacent to one another that are noticeably dissimilar in color, grain, figure, or natural character markings.
 - 2. Wood Species and Veneer Cut: Plain sliced select White Hard Maple, no heartwood allowed.
 - 3. Stains Colors and Finishes: As selected by Architect from manufacturer's full range.
 - 4. Solid Wood: Clear hardwood lumber.
 - 5. Plywood: Hardwood plywood: Grade A exposed faces at least 1/50 inch (0.5mm) thick, Grade J crossbands, and backs of same species as faces.
- C. Semiexposed Materials:
 - 1. Solid Wood: Sound hardwood lumber, selected to eliminate appearance defects, of same species as exposed solid wood.
 - 2. Plywood: Hardwood plywood of same species as exposed plywood. Grade B faces, Grade J crossbands, and backs of same species as faces. Semiexposed backs of plywood with exposed faces shall be same species as faces.
- D. Concealed Materials:
 - 1. Solid Wood: Any hardwood species, with no defects affecting strength or utility.
 - 2. Plywood: Hardwood plywood. Concealed backs of plywood with exposed or semiexposed faces shall be same species as faces.
 - 3. Particleboard: ANSI A208.1, Grade M-2.
 - 4. Medium-Density Fiberboard: ANSI A208.2, Grade MD.
 - 5. Hardboard: AIIA A135.4 Class 1 tempered.
- E. Acid Storage-Cabinet Lining: 1/4-inch-(6-mm-) thick, polyethylene or polypropylene.
- F. Glass for Glazed Doors: Clear float glass complying with ASTM C 1036, Type I, Class I, Quality q³; not less than 3.0mm thick.

2.03 CABINET DESIGN

- A. Match existing.
- B. Flush overlay.
- C. Grain Direction: Continuous vertical grain match on door and drawer fronts of individual cabinets.

2.04 CABINET FABRICATION

- A. Match existing.
- B. Construction: Provide wood-faced laboratory casework of the following minimum construction:
 - 1. Bottoms and Ends of Cabinets, Shelves, and Tops of Wall Cabinets and Tall Cabinets: 3/4-inch-(19mm-) thick plywood.
 - 2. Base Cabinet Top Frames: 3/4-by-2-inch(19-b-50-mm) solid wood with mortise and tenon or doweled connections, glued and pinned or screwed.
 - 3. Backs of Cabinets: 3/4-inch-(19-mm-) thick plywood where exposed, 1/4-inch(6.4-mm-) thick hardboard dadoed into sides, bottoms, and tops where not exposed. Provide access panels at back-to-back base cabinets, removable from the inside of the cabinet without special tools, to allow access to utilities.
 - 4. Drawer Fronts: 3/4-inch-(19-mm-) thick plywood or solid hardwood.
 - 5. Drawer Sides and Backs: 1/2-inch-(12.7-mm-) thick solid wood or plywood, with glued dovetail or multiple-dowel joints.
 - 6. Drawer Bottoms: 1/4-inch-(6.4-mm-) thick plywood glued and dadoed into front, back, and sides of drawers. Use 1/2-inch-(12.7mm-) thick material for drawers more than 24 inches(600mm) wide.
 - 7. Doors 48 inches(1200mm) or Less in Height: 3/4 inch(19mm) thick, with particleboard or medium-density fiberboard cores, and hardwood face veneers and crossbands.
 - 8. Doors More Than 48 Inches(1200 mm) in Height: 1-1/8 inches(29mm) thick, with particleboard cores and hardwood face veneers and crossbands.
 - 9. Stiles and Rails of Glazed Doors: 3/4-inch-(19-mm-) thick solid hardwood.
- C. Leg Shoes: Vinyl or rubber, black, open-bottom type.
- D. Utility-Space Framing: Laboratory casework manufacturer's standard steel framing units consisting of 2 steel slotted channels complying with MFMA-2, not less than 1-5/8 inches(41 mm) square by 0.0966 inch(2.5 mm) thick, and connected together at top and bottom by U-shaped brackets made from 1-1/4-by-1/4-inch(32-by-6-mm) steel flat bars. framing units may be made by welding specified channel material into rectangular frames instead of using U-shaped brackets.
- E. Filler Strips and Utility-Space Closure Panels: Provide as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from the same material and with same finish as cabinet fronts.

2.05 WOOD FINISH

- A. Match existing.
- B. Preparation: Sand lumber and plywood for laboratory casework construction before assembling. Sand edges of doors, drawer fronts, and molded shapes with profile-edge sander. Sand casework after assembling for uniform smoothness at least equivalent to that produced by 220 grit sanding and without machine marks, cross sanding, or other surface blemishes.
- C. Staining: Remove fibers and dust and apply stain to exposed and semiexposed surfaces as necessary to match approved samples. Apply stain in a manner that will produce a consistent appearance. Apply wash-coat sealer before applying stain to closed-grain wood species.
- D. Chemical-Resistant Finish: Apply laboratory casework manufacturer's standard three-coat;chemical-resistant, transparent finish consisting of sealer and catalyzed topcoat(s). Sand and wipe clean between coats. Topcoat(s) may be omitted on concealed surfaces.
 - 1. Chemical and Physical Resistance of Finish System: Finish complies with acceptable levels of cabinet finish tests in SEFA 8. Acceptance level for chemical spot test shall be no more than four Level 3 conditions.

2.06 CABINET HARDWARE

- A. Match existing.
- B. General: Provide laboratory casework manufacturer's standard satin-finish, commercial quality, heavy-duty hardware complying with requirements indicated for each type.
- C. Hinges: Stainless-steel, 5-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide 2 for doors 48 inches(1219 mm) or less in height, 3 for doors more than 48 inches(1219 mm) in height.
- D. Pulls: Solid aluminum, stainless steel, or chrome-plated brass; fastened from back with two screws. For sliding doors, provide stainless-steel or chrome-plated recessed flush pulls. Provide 2 pulls for drawers more than 24 inches (600 mm) in width.
- E. Door Catches: Nylon-roller spring catch or dual, self-aligning, permanent magnet catch. Provide 2 catches on doors more than 48 inches(1200 mm) in width.
- F. Drawer Slides: Powder-coated, full-extension, self-closing, heavy-duty drawer slides; designed to prevent rebound when drawers are closed; with nylon-tired, ball-bearing rollers; and complying with BHMA A156.9, Type B05091, and rated for 100lbf(440 N).
- G. Label Holders: Stainless steel, aluminum, or chrome plated; sized to receive standard label cards approximately 1 by 2 inches(25 by 50mm), attached with screws or rivets. Provide on all drawers.
- H. Lockes: Cam type with 5-pin tumbler, brass with chrome-plated finish; complying with BHMA A156.11, Type E07281.
 - 1. Provide minimum of two keys per lock and two master keys.
 - 2. Provide on all drawers and doors.
- I. Adjustable Shelf Supports: Powder-coated steel shelf rests complying with BHMA A156.9, Type B04013.

2.07 COUNTERTOPS, SHELVES, TROUGHS, AND SINKS

- A. Match existing.
- B. Countertops, General: Provide units with smooth surfaces in uniform plane free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of 1 inch(25 mm), with continuous drip groove on underside 1/2 inch(13 mm) from edge.
- C. Sinks, General: Provide sizes indicated or laboratory casework manufacturer's closest standard size of equal or greater volume, as approved by Architect.
 - 1. Outlets: Provide with strainers and tailpieces, NPS 1-1/2(DN 40), unless otherwise indicated.
 - 2. Overflows: For each sink except cup sinks, provide overflow of standard beehive or open-top design with separate strainer. Height 2 inches(50 mm) less than sink depth. Provide in same material as strainer.
- D. Epoxy Countertops, Troughs, and Sinks: Factory molded of molded epoxy-resin formulation with smooth, nonspecular finish.
 - 1. Physical Properties:
 - a. Flexural Strength: Not less than 10,000 psi(70 MPa).
 - b. Modulus of Elasticity: Not less than 2,000,000 psi(1400 MPa)
 - c. Hardness (Rockwell M): Not less than 100.
 - d. Water Absorption (24 hours): Not more than 0.02 percent.
 - e. Heat Distortion Point: Not less than 260 deg F(127 deg C).
 - 2. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated agents according to NEMA LD 3, Test Procedure 3.4.5:

- a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.
 - b. Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).
3. Color: Black
4. Countertop Fabrication: Fabricate with factory cutouts for sinks and with butt joints assembled with epoxy adhesive.
 - a. Countertop Configuration: Flat, 1 inch(25 mm) thick, with beveled or rounded edge and corners, and with drip groove and applied backsplash.
 - b. Countertop Construction: Uniform throughout full thickness.
5. Sink Fabrication: Molded in 1 piece with smooth surfaces, covered corners, and bottom sloped to outlet, 1/2-inch(13-mm) uniform thickness.
 - a. Provide with polypropylene strainers and tailpieces.
 - b. Provide integral sinks in epoxy countertops, bonded to countertops with invisible joint line.
- E. Cup Sinks: Material and sizes as indicated.
 1. Provide epoxy cup sinks with polypropylene strainers and integral tailpieces.
- F. Troughs: Epoxy. Comply with requirements for materials and construction as specified for countertops and sinks. Pitch to drains not less than 1/8 inch/foot(10mm/m).
 1. Outlets: Except where troughs empty into sinks, provide NPS 1-1/1(DN 40) outlets with strainers and tailpieces.
 2. Provide epoxy troughs with polypropylene strainers and tailpieces.

2.08 ACCESSORIES

- A. Match existing.
- B. Adjustable Wall Shelf Supports: Surface-type steel standards and steel shelf brackets, with epoxy powder-coated finish, complying with BHMA A156.9, Types b04102 and B04112.
- C. Pegboards: Polypropylene, epoxy, or phenolic-composite pegboards with removable polypropylene pegs and stainless steel drip troughs with drain outlet.

2.09 WATER AND LABORATORY GAS SERVICE FITTINGS

- A. Match existing.
- B. Service Fittings: Provide units that comply with SEFA 7, "Laboratory and Hospital fixtures-Recommended PRactices." Provide fittings complete with washers, locknuts, nipples, and other installation accessories. Include wall and deck flanges, escutcheons, handle extensions rods, and similar items.
- C. Materials: Fabricated from cast or forged red brass, unless otherwise indicated.
- D. Finish: Corrosion resistant.
 1. Provide corrosion-resistant finish in laboratory casework manufacturer's standard metallic brown, aluminum, or other color as approved by Architect.
- E. Water Valves and Faucets: Provide units complying with ASME A112.18.1, with renewable seats, designed for working pressure up to 80 psig (550 kPa).
 1. Vacuum Breakers: Provide ASSE 1035 vacuum breakers on water fittings with sorrated outlets.
 2. Aerators: Provide aerators on water fittings that do not have sorrated outlets.

- F. Needle Valves: Provide units with renewable, self-centering, floating cones and renewable seats of stainless steel or Monel metal, with removable serrated outlets.
 - 1. Provide units designed for working pressure 100 psig (690 kPa).
- G. Hand of Fittings: Furnish right-hand fittings unless fitting designation is followed by "L."
- H. Remote-Control Valves: Provide needle valves, straight-through or angle type as indicated for fume hoods and where indicated.
- I. Handles: Provide three or four-arm, forged-brass handles for valves, unless otherwise indicated.
- J. Service-Outlet Identification: Provide color-coded plastic discs with embossed identification, secured to each service-fitting handle to be tamper resistant.

2.10 ELECTRICAL SERVICE FITTINGS

- A. Match existing.
- B. Service Fittings General: Provide units complete with metal housings, receptacles, terminals, switches, pilot lights, device plates, accessories, and gaskets required for mounting on laboratory fume hoods.
- C. Receptacles: Comply with NEMA WD 1, NEMA WD 6, FS W-C-596, and UL 498. Duplex type, Configuration 5 20R.
 - 1. Receptacle Grade: General grade, unless otherwise indicated.
 - 2. GFCI Receptacles: Comply with UL 943, General grade.
- D. Switches: Comply with FS W-C-896 and UL 20. Provide single-pole, double-pole, or 3-way switches as required, rated 120 to 227-V ac; and in amperage capacities to suit units served.
- E. Cover Plates: Provide satin finish, Type 304, stainless steel cover plates with formed, beveled edges.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas, with installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of wood laboratory casework.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Verify adequacy of support framing and anchors.
- C. Verify that service connections are correctly located and of proper characteristics.

3.02 INSTALLATION OF CABINETS

- A. Install level, plumb, and true; shim as required, using concealed shims. Where laboratory casework abuts finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- B. Utility-Space Framing: Secure to floor with two fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.
- C. Base Cabinets: Adjust top rails and subtops within 1/16 inch (1.5 mm) of a single plane. Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions with fasteners spaced not more than 24 inches (600 mm) o.c. Fasten adjacent cabinets together with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch (1.5 mm).

1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than 24 inches(600 mm) o.c. and at sides of cabinets with not less than 2 fasteners per side.
- D. Wall Cabinets: Adjust fronts and bottoms within 1/16 inch(1.5mm) of a single plane. Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 24 inches(600 mm) o.c. Align similar doors to a tolerance of 1/16 inch (1.5 mm).
- E. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.
- F. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.03 INSTALLATION OF COUNTERTOPS

- A. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where shown on Shop Drawings.
- B. Field Jointing: Where possible, make in the same manner as shop jointing using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop.
 1. Use concentrated clamping devices for field joints in plastic-laminate countertops. Locate clamping devices within 6 inches(150 mm) of front and back edges and at intervals not exceeding 24 inches (600 mm). Tighten according to manufacturer's written instructions to exert a uniform heavy pressure at joints.
- C. Fastening:
 1. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at no more than 48 inches(1200 mm) o.c.
 2. Where necessary to penetrate countertops with fasteners, countersink heads approximately 1/8 inch(3 mm) and plug hole flush with material equal to countertops in chemical resistance, hardness, and appearance.
- D. Provide required holes and cutouts for service fittings.
- E. Seal unfinished edges and cutouts in plastic-laminate countertops with heavy coat of polyurethane varnish.
- F. Provide scribe moldings for closures at junctions of countertop, curb, and splash, with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.
- G. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

3.04 INSTALLATION OF SINKS

- A. Drop-in Installation of Epoxy Sinks: Rout groove in countertop to receive sink rim if not prepared in shop. Set sink in adhesive and fill remainder of groove with sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess adhesive and sealant while still wet and finish joint for neat appearance.
- B. Drop-in Installation of Epoxy Cup Sinks: Rout groove in countertop to receive sink rim if not prepared in shop. Set sink in adhesive and fill remainder of groove with sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess adhesives and sealant while still wet and finish joint for neat appearance.

3.05 INSTALLATION OF ACCESSORIES

- A. Install accessories according to Shop Drawings and manufacturer's written instructions.
- B. Securely fasten adjustable shelving supports, stainless-steel shelves, and pegboards to partition framing, wood blocking, or reinforcements in partitions.
- C. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.

3.06 INSTALLATION OF SERVICE FITTINGS

- A. Comply with requirements in Division 15 and 16 Sections for installing water and laboratory gas service fittings, piping, electrical devices, and wiring.
- B. Install fittings according to Shop Drawings and manufacturer's written instructions. Set bases and flanges of sink and countertop-mounted fittings in sealant recommended by manufacturer of sink or countertop material. Securely anchor fittings, piping, and conduit to laboratory casework unless otherwise indicated.

3.07 CLEANING AND PROTECTING

- A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- B. Protect countertop surfaces during construction with 6-mil(0.15-mm) plastic or other suitable water -resistant covering. Tape to underside of countertop at minimum of 48 inches(1200 mm) o.c.

3.08 SERVICE-FITTING-SCHEDULE

- A. Laboratory Gas Service-Fittings:
 - 1. Service: Air, Gas (fuel gas, Vacuum).
 - 2. Type of Fitting: Turret.
 - 3. Outlets: Two, at 90 degrees.
 - 4. Outlet Type: Straight.
 - 5. Valve Type: Needle Valve.
- B. Electrical Service-Fitting:
 - 1. Type of Fitting: Recessed.
 - 2. Device: One duplex receptacle.

END OF SECTION

SECTION 13851
FIRE ALARM SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. System smoke detectors.
 - 2. Heat detectors.
 - 3. Notification appliances.
 - 4. Addressable interface device.

1.03 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

1.04 SYSTEM DESCRIPTION

- A. Noncoded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.
- B. Fire alarm system is existing and is manufactured by EST.

1.05 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Raceways shall withstand the effects of earthquake motions determined according to IBC.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.06 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
 - 2. Include voltage drop calculations for notification appliance circuits.
 - 3. Include battery-size calculations.
 - 4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

1.07 GENERAL SUBMITTAL REQUIREMENTS:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified fire-alarm technician, Level III minimum.
- B. Delegated-Design Submittal: For smoke and heat detectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
 2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.

1.08 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
- C. Field quality-control reports.

1.09 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," deliver copies to authorities having jurisdiction and include the following:
 1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
 3. Record copy of site-specific software.
 4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
 5. Manufacturer's required maintenance related to system warranty requirements.

1.10 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of

units required for this Project.

- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II (minimum) technician.
- C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Edward Systems Technology, EST.

2.02 SYSTEMS OPERATIONAL DESCRIPTION

- A. System operation shall match existing.

2.03 FIRE-ALARM CONTROL UNIT

- A. Fire alarm control unit is existing; expand as needed to accommodate new devices.

2.04 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - 1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.

2.05 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
 - 1. Comply with UL 268; operating at 24-V dc, nominal.
 - 2. Detectors shall be two-wire type.
 - 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 - 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 6. Integral Visual-Indicating Light: LED type indicating detector has operated.

- B. Photoelectric Smoke Detectors:
 - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
- C. Ionization Smoke Detector:
 - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
- D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
 - 3. Each sensor shall have multiple levels of detection sensitivity.
 - 4. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - 5. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.06 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
 - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
- B. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.
- C. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.
- D. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
 - 1. Rated Light Output:

2. 15/30/75/110 cd, selectable in the field.
3. Mounting: Wall mounted unless otherwise indicated.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, white.

2.07 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

PART 3 - EXECUTION

3.01 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
1. Connect new equipment to existing control panel in existing part of the building.
 2. Connect new equipment to existing monitoring equipment at the supervising station.
 3. Expand, modify, and supplement existing monitoring equipment as necessary to extend existing monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
- C. Smoke- or Heat-Detector Spacing:
1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
 2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
 3. Smooth ceiling spacing shall not exceed 30 feet.
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
 5. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.
- D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
- E. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- F. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

3.02 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

3.03 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals.

3.04 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100.

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- D. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION

SECTION 15000
MECHANICAL AND ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, General Requirements and all other Specification Sections apply to the work specified in this section.

1.02 SCOPE

- A. This Section describes the general provisions for the mechanical and electrical work included in Divisions 15 and 16 respectively. This section applies to all sections of Divisions 15 and 16. Refer to Division 16 for additional General Provisions related to electrical work.
- B. The General Contractor shall be responsible for all work included in the Mechanical and Electrical Divisions. The delegation of work to Subcontractors shall not relieve him of this responsibility. Subcontractors who perform work under these Sections shall be responsible to the General Contractor. The term "Contractor" is used throughout this Division and shall mean the General Contractor, although the actual performance of the work may be by a Subcontractor.
- C. Within thirty (30) days after award of the contract, the Contractor shall submit to the Architect, for approval a list of all subcontractors' names he proposes to use.
- D. The Contractor shall carefully review all divisions of the project specifications. Where conflicts exist between divisions and/or sections of the specifications the most stringent requirement as determined by the Architect shall apply.

1.03 REFERENCES AND DEFINITIONS

Following are definitions of terms and expressions used in the Mechanical and Electrical Sections:

- | | |
|-------------|--|
| Provide | - furnish and install |
| Directed | - directed by the Architect |
| Indicated | - indicated in Contract Documents |
| Concealed | - hidden from normal sight; includes items within furred spaces, pipe and duct shafts, above suspended ceilings and within return air plenums. |
| Exposed | - non concealed - Work within Equipment Rooms shall be considered exposed. |
| Exterior | - items being or situated outside. Items located within a crawl space shall be considered exterior. |
| Conditioned | - a heated or cooled space, or both, within a building and, where required, provided with humidification or dehumidification means, so as to be capable of maintaining a space condition falling within the comfort envelope set forth in ASHRAE 55. |
| Piping | - includes pipes, fittings, valves, hangers, and accessories comprising a system |

- Ductwork - includes ducts, fittings, housings, dampers, hangers, air devices, and accessories comprising a system.

1.04 STANDARD SPECIFICATIONS

- A. See Division 1 - General Requirements.
- B. References to catalogs, standards, codes, specifications, and regulations apply to the latest edition in effect at the date of the invitation to bid.

1.05 CODES, REGULATIONS, AND PERMITS:

- A. Give all necessary notices, obtain all permits, and pay all fees and other costs, including those for utility connections or extensions in connection with the work. File all necessary plans, prepare all documents, and obtain all necessary approvals of all governmental departments having jurisdiction. Obtain all required certificates of inspection and deliver same to the Architect before request for acceptance and final payment for the work.
- B. All materials furnished and all work installed shall comply with the latest rules, regulations, and recommendations of the following bodies:

2009 International Building Code

2009 International Existing Building Code

2009 International Mechanical Code

2009 International Plumbing Code

2009 International Fire Code

2009 International Energy Code

National Electric Code, 2007 Edition

National Fire Protection Association Standards (Latest Editions)

State Fire Marshal Regulations

Fire Prevention Bureaus of the City of Columbia, University of South Carolina and the State of South Carolina

ASHRAE Handbooks (Latest Editions)

ASHRAE 55-2007

ASHRAE 62.1-2007

ASHRAE 90.1-2007

Local and State Health Departments

Local Utility Companies

Underwriters Laboratories

Owner's Insurance Underwriter Standards

Environmental Protection Agency

1.06 SHOP DRAWINGS

- A. See Division 1, GENERAL REQUIREMENTS for Additional Requirements related to submittals and shop drawings.
- B. After receiving approval of equipment manufacturers and prior to delivery of any material or equipment to the job site; submit for approval, dimensioned drawings or cuts showing

construction size, arrangement, operating clearances, performance characteristics, and capacity of material or equipment. Each item of equipment proposed shall be a standard catalog product of the approved manufacturer. Submittals shall be received early in the construction period to allow the Architect ample time for review and checking for compliance with the contract documents. The Architect will be expected to process a maximum of ten (10) submittals in a five (5) day working period. The Contractor shall carefully schedule the submission time of all submittals to insure that approvals will be received to meet the critical path of the construction project.

- C. If the Contractor's submittals, upon review by the Architect, do not conform to the requirements of the contract documents, the contractor shall be required to resubmit with modification, within fifteen (15) working days of receipt of the Architect's notification and comments to the Contractor. The Contractor shall be responsible for the extra expenses for subsequent review of rejected or revised submittals necessitated by the Contractor's failure to provide a complete and accurate submittal meeting the requirements of the contract documents. Such extra fees shall be deducted by the Owner from payments to the Contractor.
- D. Samples, drawings, specifications, catalogs, etc., submitted for approval shall be properly labeled indicating specific item, model number, and service for which material or equipment shall be used. Section and article number of specifications governing, Contractor's name, name of job, and date and also be clearly indicated on all submittals. Submittals that are not properly labeled or identified will be returned marked "Not Reviewed".
- E. Catalogs, pamphlets, or other documents submitted to describe items on which approval is being requested shall be specific. Identification in catalog, pamphlet, etc., of item submitted shall be clearly made in ink. Data of a general nature will not be accepted.
- F. If material or equipment is installed prior to receipt by the Contractor of pertinent shop drawings marked "No Exceptions Taken" or "Comments Noted", the Contractor shall be liable for its removable replacement at no extra charge to the Owner.
- G. Prepare and submit shop drawings for all specifically fabricated items, modifications to standards items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on contract drawings.
- H. Submit data and shop drawings as listed below, in addition to provisions of paragraphs above. Identify all shop drawings by the name of the item and system and applicable specification paragraph number.

Shop Drawings:

Section 15000 – Mechanical and Electrical General Provisions

Record Drawings
Installation and Coordination Drawings
Pipe and Conduit Hangers and Supports
Access Doors
Sleeves and Penetrations Drawings
Operation and Maintenance Manuals
List of Manufacturers' Material and Equipment

Section 15100 – Basic Materials and Methods

- Hangers and Pipe Shields
- Identification Items
- Pipe, Fittings, and Joints
- Balancing Valves
- Ball Valves
- Drain Valves
- Gas Valves
- Gate and Globe Valves
- Check Valves
- Manual and Automatic Air Vents
- Pressure Regulating and Relief Valves
- Backflow Preventers and Vacuum Breakers
- Strainers
- Temperature Wells
- Pressure Gauges
- Thermometers
- Test Plugs
- Dielectric Fittings
- Unions
- Test Reports
- Sterilization Report

Section 15200 – Mechanical Systems Insulation

- All Insulation Types
- Adhesives, Sealers, and Coatings
- Fabric Jackets
- Fitting and Valve Covers
- Metallic Components

Section 15300 – Plumbing

- Cleanouts
- Drains
- Plumbing Fixtures
- Tempering Valve
- Shock Absorbers
- Laboratory Gas Outlets

Section 15400 – Fire Protection

- Contractor Qualifications
- AutoCAD Shop Drawings
- Sprinkler Head Samples
- Record Drawings

- Site and Final Inspection Forms
- Hydraulic Calculations
- Piping
- Drain Valves
- Automatic Sprinklers
- Pipes and Fittings
- Hangers
- Valves
- Sprinkler System Drawings and Calculations
- Sprinkler System Acceptance Test Statement

Section 15800 – Air Distribution

- Air Terminal Units
- Air Devices
- Sound Attenuators and Certified Test Data
- Volume Dampers
- Ductwork
- Medium Pressure Ductwork Samples
- Air Measuring Devices
- Fans

Section 15850 – Building Automation and Temperature Control System

- Central Equipment and Operating System
- Data Transmission System
- User Software
- Data Gathering Panels
- Sensors
- Control Dampers:
 - Motor Operated
- Thermostats
- Transmitters
- Gauges and Thermometers
- Control Valves
- Operators
- Control Panels
- Receiver Controllers
- Fire and Smoke Control Devices
- Electronic Components
- Software
- Field Hardware
- Automatic Temperature Control System

Section 15900 – Testing and Balancing

- Test Reports

- I. Contractor, additionally, shall submit for approval any other shop drawings as requested by the Architect. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Architect.

1.07 EQUIPMENT START-UP AND INITIAL OPERATION

- A. No equipment shall be operated, for testing or trial use, before full compliance with the equipment manufacturers' specifications and instructions for the lubrication, alignment, direction of rotation, balance, and other applicable considerations.
- B. Particular care shall be taken to see that all equipment is completely assembled, properly lubricated, and all grease and oil cases and reservoirs have been filled to the correct level with the recommended lubricants.
- C. It is the Contractor's responsibility to place each item of equipment, installed by him, in operating condition. This responsibility includes all auxiliaries, piping, wiring, etc., the start up of each unit, and a check of its performance.

1.08 GUARANTEE

- A. The Contractor guarantees, by his acceptance of the Contract, that all work installed, by him or his subcontractors, will be free from defects, in workmanship and materials, for a period of one (1) year after the date of certification of completion and acceptance of work. Any defects in workmanship, materials or performance which appear within the guarantee period shall be corrected by the Contractor, without cost to the Owner, within a reasonable time to be specified in notice from the Architect. In default thereof, Owner may have such work done and charge the cost of same to the Contractor.

1.09 SITE VISIT

- A. Prior to preparing the bid, the Contractor and subcontractors shall visit the site and familiarize themselves with all existing conditions, make all necessary investigations as to locations of utilities, and all other matters which can affect the work. No additional compensation will be made to the Contractor as a result of his failure to familiarize himself with the existing conditions under which the work must be performed.

1.10 DRAWINGS

- A. The Contract Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Any offsets, rises, or transitions not shown on the drawings and required to provide a complete system shall be provided at no additional contract cost. Do not scale the drawings. Consult the Architectural and Structural drawings and details for exact location of structure and equipment; where same are not definitely located, obtain this information from the Architect.

1.11 RECORD DRAWINGS

- A. Contractor shall keep accurate records of all deviations in work, as actually installed, from work indicated.

- B. When work is complete, make two (2) complete "Record" sets of marked-up prints, certify the accuracy of each print by endorsement and signature thereon. Deliver same to the Architect who will, after approval, deliver these two (2) sets to the Owner.

1.12 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the systems and equipment for a minimum period of four (4) days of eight (8) hours each, or as otherwise specified. During this period, Contractor shall instruct the Owner's representative fully in the operation, adjustment, and maintenance of all equipment furnished. At least forty-eight (48) hours in advance written notice shall be given to the Owner.
- B. Contractor shall furnish to the Architect four (4) complete bound sets of typewritten or blueprinted instructions for operating and maintaining all systems and equipment included in this Contract. Operating and maintenance manuals shall include all construction test reports, final balancing reports, valve tag schedule, final inspection certificates, and occupancy permits. Also provide two (2) complete bound sets of approved shop drawings for all items of equipment utilized on the project. All instructions shall be submitted in draft for approval prior to final issue. Manufacturers' advertising literature or catalogs will not be acceptable for operating and maintenance instructions.
- C. Instructions shall include a general description of each system and specific instructions describing routine and emergency procedures required of the building personnel for operating and maintaining each system. The instructions shall include the name or label, location, and function of all operating equipment and controls, such as start-stop switches, time clocks, and safety and temperature controllers. Operating modes and the procedures for indexing each mode shall be clearly described. A listing of names, addresses, and phone numbers of the service organizations for each item of equipment and a typewritten maintenance schedule for same shall be included.
- D. The instructor shall be thoroughly familiar with all parts of the installation on which he is to give instruction. The instructor shall be trained in operating theory as well as practical operation and maintenance work. Employ factory trained instructors for automatic temperature control systems and wherever else necessary, as determined by the Architect.
- E. During the guarantee period, the Contractor shall service and maintain all equipment, excluding filter replacement, provided under this contract. Prior to the start of guarantee period, the Contractor shall provide the Owner with a schedule of required maintenance operations for each system and items of equipment. Contractor shall submit schedule to the Architect for approval. Thereafter, monthly reports shall be submitted to the Owner describing actual service provided. Forty-eight (48) hours advance notice shall be given to the Owner, prior to work required under this Section.
- F. Contractor shall provide the Owner with all tools required to service and maintain all equipment.

1.13 ELECTRICAL WORK

- A. Under Division 15 MECHANICAL, provide the following items of electrical work which shall conform with the applicable requirements of the Electrical Division:
 - 1. Low voltage temperature control wiring.

2. Interlock wiring for mechanical equipment and devices.
- B. Under Division 16 ELECTRICAL, provide:
1. Power wiring, complete from power source to motor or equipment junction box, including power wiring through motor starters, power factor correction devices, and line reactors. Power factor correction devices shall be provided under Division 15 and installed under Division 16.
 2. Motor control centers or motor starter, panelboards.
 3. All miscellaneous individual motor starters, unless noted or specified otherwise.

1.14 SINGULAR NUMBER

- A. Where any device or part of equipment is herein referred to in the singular number (such as "valve"), such reference applies to as many such devices as are required to complete the installation as shown on the drawings.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials shall be new, the best of their respective kinds, suitable for the conditions and duties imposed on them at the building, and shall be of reputable manufacturers'. The description, characteristics, and requirements of materials to be used shall be in accordance with qualifying conditions established in the sections following.
- B. See Division 1 - General Requirements. All component parts of each items of equipment or device shall bear the manufacturers' name plate; giving name of manufacturer, description, size, type, serial or model number, electrical characteristics, etc., in order to facilitate the maintenance or replacement. The name plate of a subcontractor or distributor will not be acceptable. Where Underwriters' Laboratories standards apply, material and equipment shall be approved by them and shall bear the UL Label.
- C. In specifying materials, three (3) general procedures are used. The three (3) classifications are as follows:

GROUP 1: When a material or equipment is specified by brand name or other identifying information and three (3) or more brands are named it is considered that any one (1) of the brands so named will perform as desired, and the Contractor shall base his proposal on one (1) of the named brands. The first brand named or identified basis of design shall be used as a standard. The other brands named shall be equal to the specified brand in all respects. If one (1) of the other brands named is used it shall be the Contractor's responsibility to verify proper clearances and fit of the substituted equipment.

GROUP 2: When the material or equipment is specified with the phrase "...or approved equal..." after a brand name and other identifying information, it is intended that the brand name is used for the purpose of establishing a minimum acceptable standard of quality and performance and Contractor may base his bid proposal on any item which is in all respects equal to that specified and presents essentially the same appearance. It shall be the Contractor's responsibility to ensure proper fit and clearances of all substituted equipment.

GROUP 3: When material is specified as complying with the requirements of published "Standard Specification" of trade associations, American Society of Testing and

Materials, government specifications, etc. the Contractor shall base his proposal on any item which can be shown to comply in all respects to the referred "Standard Specification".

1. It is distinctly understood: (1) that the Architect will use his own judgment in determining whether or not any materials, equipment or methods offered in substitution are equal to those specified; (2) that the decision of the Architect on all such questions of equality is final; and (3) that all substitutions will be made at no increase in cost to the Owner.
2. Upon receipt of written approval from Architect, Contractor may proceed with substitution providing Contractor assumes full responsibility for, and makes, at his own expense, any changes or adjustments in construction or connection with other work that may be required by the substitution of such materials, equipment or methods. In the event of any adverse decisions by the Architect no claim of any sort shall be made or allowed against the Owner.

2.02 INSTALLATION AND COORDINATION DRAWINGS

- A. Prepare, submit and use composite installation and coordination drawings to assure proper coordination and installation of work in all buildings. No installation or construction work shall begin until the coordination drawings are completed, submitted, and approved. Drawings shall include, but not be limited to, the following:
 1. Complete floor and roof plans
 2. Pipe sleeves, equipment pads, etc.
- B. Show relationship and integration of different construction elements that require coordination during fabrication or installation to fit in space provided and function as intended.
- C. Prior to fabricating or installing work, prepare composite coordination drawings at appropriate scale; detail major elements, components, and systems of architectural, structural, mechanical, and electrical such as equipment, components, and materials in relationship with each other, installations, and building components. Include dimensions. Composite coordination drawings shall include all new building elements, components, and systems.
- D. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important to efficient flow of Work.
- E. Indicate scheduling, sequencing, movement, and positioning of large equipment into building during construction.
- F. Assembly Penetrations: Prepare drawings as required to indicate penetrations in floors, walls, and ceilings and their relationship to assembly construction, other penetrations and installations. Identify where additional bracing and offsets are required to comply with Contract Documents.
- G. Prepare drawings as required to coordinate and integrate ceiling installations, air outlets and inlets, light fixtures, communications systems components, sprinklers, other ceiling-mounted devices, components located above suspended ceilings, and suspended ceiling support components.
- H. Show interrelationship of components indicated on separate Shop Drawings.

- I. Indicate required installation sequences to minimize cutting and patching.
- J. Include, but do not necessarily limit to, the following:
 - 1. Proposed locations of piping, ductwork, equipment, and materials.
 - 2. Proposed locations for access panels and doors. All equipment which must be serviced, operated, or maintained (valves, clean-outs, motors, controllers, dampers, drain points, etc) shall be located in accessible locations to eliminate or minimize the need for access panels and doors.
 - 3. Clearances for installing and maintaining insulation.
 - 4. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance. Show access locations.
 - 5. Equipment connections and support details, including vibration isolation, seismic and sway bracing.
 - 6. Exterior wall, roof and foundation penetrations.
 - 7. Fire-rated wall and floor penetrations.
 - 8. Sizes and location of required concrete pads and bases.
 - 9. Valve stem movement.
- K. Draw plans to a scale not less than 1/4 inch equals one (1) foot. Include plans, sections, and elevations of proposed work, showing all equipment, piping and ductwork in areas involved. Fully dimension all work horizontally and vertically. Show coordination with other work including sprinklers, lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.
- L. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to be factory-wired terminals include manufacturer's literature showing internal wiring.
- M. Installation and coordination drawings shall be produced on an AutoCad format. Reproduction of any portion of the mechanical and electrical contract drawings for re-submittal as a shop drawing is strictly prohibited. Shop drawings produced in such a manner will be rejected and returned not reviewed. Installation and coordination drawings shall be to scale reflecting actual equipment sizes purchased for the project.
- N. The "Base" architectural and structural background drawings shall be provided on Autocad format by the Construction Manager/General Contractor. These "Base" background documents are to be provided to each Contractor in the coordination process to establish a common platform for each Contractor to use for their design drawings. This same information will be used to communicate their respective coordination with the other Contractors. Coordination will be accomplished by each Contractor superimposing his work on drawings in the following sequence:
 - 1. Construction Manager/General Contractor - Base Drawings indicating structural steel with elevations for bottom of beams & finish floor. The general contractor shall include a layout of ceiling tiles (where applicable).
 - 2. HVAC Contractor - Ductwork layout drawings & piping with elevations to bottom of ductwork & piping. HVAC contractor shall indicate location of all registers, diffusers and grilles.
 - 3. Plumbing Contractor - Layout of all piping with elevations.
 - 4. Sprinkler Contractor - Layout of all piping & heads with elevations.
 - 5. Electrical Contractor - Conduit layout with junction boxes and location of all electrical fixtures.

- O. If necessary, Contractor coordination meetings shall be held continuously until the coordination drawings are complete and approved by all parties. Any conflicts, etc., discovered in the coordination stages prior to Contractor(s) sign-off which cannot be resolved by the Contractor(s) shall be brought to the Architect's attention for resolution.
- P. Any conflicts, etc., discovered after the created and submission of the coordination and installation drawings and during the installation of the Work will be the responsibility of the Contractor(s) to resolve with the approval of Architect. Any and all costs for these resolutions shall be solely the responsibility of the Contractor(s).
- Q. Work fabricated/installed prior to the completion of the coordination and installation drawings is performed at the Contractors own risk, and compensation of time/costs for corrections will not be awarded. Any work installed that is not in conformance with final approved coordination and installation drawings shall be required to be removed and relocated, and compensation of time/costs for corrections will not be awarded.
- R. Each Contractor is responsible for timely updates to the coordination drawings to indicate as-built conditions for their own work. Updates are required to include all changes regardless of the source or reason for the change, including changes initiated by the Owner, Architects or Engineers.

2.03 PIPING, CONDUITS, AND SUPPORTS, GENERALLY

- A. Piping and conduits, except electrical conduits run in floor construction, shall be run parallel with the lines of the building, unless otherwise shown or noted on the drawings. Electrical conduits shall not be hung on hangers with any other service pipes. The different service pipes, valves, and fittings shall be so installed that after the covering is applied there will not be less than 1/2 inch clear space between the finished covering and other work and between the finished covering and parallel adjacent pipes. Hangers on different service lines, running parallel with each other and nearly together, shall be in line with each other and parallel to the lines of the building. Exact location of sprinklers, electrical outlets, piping, ducts, and conduits shall be coordinated among the trades so that there will be no interference between lighting fixtures, piping, ducts, and conduits. Where conflicts between the trades result, they shall be resolved by the Contractor to the Architect's satisfaction and at no expense to the Owner.
- B. Hangers shall be spaced to prevent sag and permit proper drainage. Refer to Division 15, Section "Basic Materials and Methods" for hanger spacing. A hanger shall be placed within one (1) foot of each horizontal elbow. See drawings for any additional hanger requirements.
- C. Vertical runs of pipe and conduit less than fifteen (15) feet long shall be supported by hangers placed one (1) foot or less from the elbows on the connecting horizontal runs. Vertical runs of pipe and conduit over fifteen (15) feet long, but not over sixty (60) feet long, and not over six (6) inches in size, shall be supported by heavy steel clamps. Clamps shall be bolted tightly around the pipes and conduits and shall rest securely on the building structure without blocking. Clamps may be welded to the pipes or placed below coupling.
- D. Hangers shall be of manufacturers hereinafter specified in Division 15, Section "Basic Materials and Methods". Unless otherwise specified, or indicated on the drawings, pipe and conduit hangers and hanger supports shall conform with the following Anvil International figures.

1. Hangers generally shall be Figs. 65, 104, 212, 260 and 295.
 2. Hanger Figs. 212 and 295 shall be provided with turnbuckles and eye rods or rods with eye nuts.
 3. Turnbuckles shall be Figs. 114 or 230, shall have not less than 1-1/2 inches of adjustment, and shall be provided with locknuts.
 4. Brackets Figs. 194, 195, and 199 shall be used for support of pipe hangers on lines larger than four (4) inches run along walls near floors.
 5. Riser clamps shall be Figs. 261 (steel and cast iron piping) or CT-121 (copper piping).
 6. Roller supports shall be adjustable, Anvil International Fig. 274 for installation of hot service piping over two (2) inches in size and installed in racks or on trapeze hangers.
 7. Concrete inserts shall be Figs. 281 or 282.
 8. On copper pipes, hangers in contact with pipe shall be copper plated.
- E. In lieu of individual hangers, multiple (trapeze) hangers may be used for water pipes having same elevation and slope and for electrical conduits as specified hereinafter:
1. Horizontal members shall consist of 1-1/2 inch by 1-1/2 inch twelve (12) gauge, cold formed, lipped channels designed to accept special, springheld, hardened steel nuts for securing hanger rods and other attachments. Two (2) or more such channels may be welded together forming horizontal members of greater strength than single channels. Members shall be Kindorf, Unistrut, or equal. Horizontal members made of Kindorf, Unistrut, or similar products shall be limited to a maximum length of eight (8) feet. Structural steel members shall be used for horizontal members exceeding eight (8) feet in length.
 2. Each multiple hanger shall be designed to support a load equal to the sum of the weights of the pipes, conduits, wire, and water, the weight of the hanger itself, and 200 pounds. The size of the hanger rods shall be such that the stress at the roof of the thread will not be over 10,000 pounds per square inch at the design load. No rod shall be smaller than 3/8 inch. The size of the horizontal members shall be such that the maximum stress will not be over 15,000 pounds per square inch at design load.
 3. Horizontal runs of piping and conduits along walls, four (4) inches and smaller, exposed or concealed, shall be secured to Kindorf or Unistrut support members as specified hereinbefore. Provide appropriate clamps, brackets and similar attachments to secure piping and conduits to vertical members in accordance with applicable sections of the specification.
 4. Refer to architectural drawings and specifications for additional requirements related to supports using Kindorf or Unistrut type systems.
- F. Hanger attachments shall be suitable for each type of hanger and shall be compatible with the building materials to which it is secured. The types of attachments which shall be used for the various types of building construction encountered shall conform to the following Anvil International figures:
1. Concrete (new) - Inserts Figs. 281 or 282. Power driven fasteners may be used for light loading as hereinafter specified.
 2. Concrete (existing) - Figs. 47, 49 or 52 attachments. Refer to drawings for specific application of individual types.
 3. Steel beams - Figs. 66, 92, and 93 attachments. Refer to drawings for specific application of individual types.
 4. Bar joists - Figs. 60 or 225.
 5. Brick or block walls - Figs. 194, 195, 199, or 202 fastened as follows: For light duty, self-drilling anchors in brick and toggle bolts in block; for heavy duty, through bolts with backing plates.

- G. Welded attachments for securing hangers to piping or to structural steel may be provided in lieu of other attachments specified. Welded attachments shall be designed so that the fiber stress at any point in the weld or attachment will not exceed the fiber stress in the hanger rod.
- H. Refer to Division 15, Section "Mechanical Vibration, Sound and Seismic Controls", for vibration hanger requirements.
- I. In no case shall wire or perforated strap be used for pipe or conduit support.
- J. All piping, ductwork, and equipment shall be suspended from the structure above unless otherwise indicated or noted on the drawings. The Contractor shall obtain prior approval from the Architect for floor supports of piping, ductwork, and equipment. Provide structural steel members consisting of angles, channels, and beams as required to hang piping, ductwork, and equipment.

2.04 SLEEVES AND PLATES

- A. All pipe sleeves shall be constructed of one (1) piece Schedule 40 steel pipe, unless otherwise indicated on the drawings.
- B. Where watertight sleeves are indicated, provide Link Seal rubber seals, as manufactured by Thunderline Corporation, between pipes and sleeves.
- C. Escutcheon plates shall be provided for all exposed pipes passing through walls, floors, and ceilings in finished areas. Plates shall be chrome plated brass, split ring type, and sized to match the pipe or insulation where installed. Where plates are provided for pipes passing through sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.
- D. Provide twenty-four (24) gauge galvanized sheet metal sleeves for all exposed ductwork passing through floors, walls, or ceilings and all ductwork passing through fire-rated or smoke partitions. Duct sleeves shall be large enough to pass duct with insulation and shall have 2 (two) inch flanges returned against floor, wall, partition, or ceiling. Where fire dampers are required, provide sleeves as detailed on the drawings and as required by the damper manufacturer.
- E. At all sleeves, where noise can be transmitted and at fire rated separations, seal all openings between pipes and ducts and corresponding sleeve to prevent sound transmission and maintain fire rating of the wall, floor or ceiling. Submit method of sealing sleeves for approval. U.L. assembly rating of fire walls and floors shall be maintained at all times. All sleeves installed in masonry or concrete construction shall be grouted in place.

2.05 FIRE RATED PENETRATION SYSTEMS

- A. Provide UL Listed fire penetration systems in openings in rated floors, walls, and other elements of construction. Provide UL listed fire penetration systems at all new and existing pipe penetrations of new and existing rated construction within the area of work. Coordinate work of this section with all other trades necessary for the proper installation of the fire rated penetration systems.

- B. Submit shop drawings showing each condition requiring penetration seals in dictating proposed UL systems materials, anchorage, methods of installation, and actual adjacent construction. Submit a copy of UL illustration of each proposed system indicating manufacturer approved modifications. Submit copies of manufacturer's specifications, recommendations, inspection requirements, installation instructions, and maintenance data for each type of material required. Include letter indicating that each material complies with the requirements and is recommended for the applications shown.
- C. All fire penetration systems shall reference ASTM E814/UL 1479 - Fire Test of Through - Penetration Fire Stops.
- D. All systems shall be UL tested and listed in the UL Fire Resistance Directory.
- E. Submit copies of written guarantee agreeing to repair or replace joint sealers which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated. The guarantee period shall be one (1) year from date of substantial completion.
- F. 3M products have been specified as the penetration fire stop basis of design. Other manufacturer's systems are acceptable providing they meet the requirements set forth in this specification. The fire rated penetration systems shall be the products of one manufacturer to the maximum extent possible. The products of more than one manufacturer shall not be used as a combined seal.
- G. Provide materials classified by UL to provide fire stopping equal to time rating, both "F" and "T" ratings, of construction being penetrated. Provide asbestos free materials that comply with applicable codes and have been tested under positive pressure in accordance with UL 1479 or ASTM E814. Systems shall be smoke and air tight.
- H. Deliver material undamaged in manufacturer's clearly labeled, unopened containers identified with brand, type, grade, and UL label where applicable. Coordinate delivery with scheduled installation date to allow minimum storage time at site. Store material in clean, dry ventilated location. Protect from soiling, abuse, and moisture. Follow manufacturer's instruction.
- I. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.
- J. Furnish adequate ventilation if using solvent. Furnish forced air ventilation during installation if required by manufacturer. Keep flammable materials away from sparks or flame. Provide masking and drop cloths to prevent contamination of adjacent surfaces by fire stopping resistance.
- K. Clean surfaces to be in contact with penetration seal materials, of dirt, grease, oil, loose, materials, rust, or other substances that may affect proper fitting, adhesion of the required fire resistance.
- L. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instructions. Seal holes or voids made by penetrations to ensure an effective smoke barrier. Where floor openings

without penetrating items are more than four (4) inches in width and subject to traffic or loading, install fire stopping materials capable of supporting same loading as floor. Protect materials from damages on surfaces subject to traffic.

- M. Clean up spills of liquid components. Neatly cut and trim materials as required. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.
- N. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas. Keep areas of work accessible until inspection by applicable code authorities. Perform under this section patching and repairing of fire stopping caused by cutting or penetration by local inspectors and other trades.

PART 3 - EXECUTION

3.01 WORKMANSHIP

- A. Each Subcontractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work.
- B. The quality of workmanship required, for each trade, in the execution of work shall be the finest and highest obtainable in that trade working with the materials specified. Workmanship shall be satisfactory to the Architect and his decision as to acceptable quality is final.
- C. Workmanship proven to be of poor quality or unsatisfactory in the commissioning phase of the project as deemed by the Architect shall be removed and replaced to the satisfaction of the Architect.

3.02 EQUIPMENT PERFORMANCE

- A. All equipment, devices, controls, and hardware shall be proven to operate successfully throughout the guarantee period. Systems shall be proven during all weather seasons and be demonstrated to affect the design conditions at times. System components or equipments items that fail to consistently deliver the design conditions shall be removed and replaced as directed by the Architect. The cost of required equipment replacements shall be borne by the Contractor.
- B. All equipment shall be tested after installation and be proven to deliver the manufacturers quoted design capacity. When capacity is in question as deemed by the Architect, the Contractor shall perform a detailed and comprehensive field performance test to certify the equipment capacity. System effect or installed performance factors may not be applied to performance ratings unless they were previously included when the equipment was submitted for approval. Equipment that fails to deliver manufacturers quoted design capacity shall be removed and replaced at the Contractors expense.
- C. Workmanship proven to be of poor quality or unsatisfactory in the commissioning phase of the project as deemed by the Architect shall be removed and replaced to the satisfaction of the Architect.

3.03 EQUIPMENT CONNECTIONS

- A. All equipment shall be installed and connected in accordance with the best engineering practice and in accordance with manufacturer's instructions and recommendations. Auxiliary piping, piping specialties, water seals, valves, and electric connections recommended by the manufacturer, required by code or required for proper operation shall be provided.

3.04 WATERPROOFING

- A. Under no circumstances shall waterproofing be damaged or penetrated. Should conditions arise which indicate such necessity, notify the Architect.

3.05 CUTTING AND PATCHING

- A. Cutting and patching associated with the work in the existing structure shall be performed in a neat and workmanlike manner. Existing surfaces, which are damaged by the Contractor, shall be repaired or provided with new materials. All patching shall be done with materials and methods similar to existing adjacent work, subject to approval of the Architect. Structural members shall not be cut or penetrated. Holes cut through concrete and/or masonry to accommodate new work shall be cut by reciprocating or rotary, non-percussive methods.
- B. The Contractor shall submit to the Architect for approval dimensioned drawings showing all penetrations through structural slabs or walls required for mechanical and electrical work. Drawings shall clearly show opening size, plan location, and/or elevation as applicable. All openings shall be approved by the Architect prior to starting work.
- C. Patching of areas disturbed by installation of new work shall match existing adjacent surfaces in material, texture, and color.

3.06 PROTECTION WORK

- A. When working in and around the building, extreme care shall be exercised with regard to protection of the structure and mechanical and electrical services. Repair or replace, to the satisfaction of the Architect, any work damaged in the performance of the new work.

3.07 SURVEYS AND MEASUREMENTS

- A. Base all measurements (both horizontal and vertical) from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check correctness of same as related to the work. Verify locations of existing utilities and inverts of same prior to the start of any systems shown connecting to existing utilities.
- B. Should the Contractor discover any discrepancy between actual measurements or conditions, and those indicated, which prevent following good practice or the intent of the drawings and specifications, he shall notify the Architect and shall not proceed with his work until he has received instruction from the Architect.

3.08 HANDLING AND STORAGE OF MATERIAL

- A. Proper and suitable tools, equipment and appliances for the safe and convenient handling and placing of all materials and equipment shall be used. During loading, unloading, and placing, care shall be taken in handling the equipment and materials so that no equipment or materials are damaged.
- B. All mechanical and/or electrical equipment delivered to the job site shall be stored on pedestals, above the ground and under roof or other approved covering. All enclosures for equipment shall be weatherproof. All motors, drives, switchgear, panels, etc. which are not totally enclosed, that are involved in the work, shall be stored in a heated, dry, water protected area with a minimum temperature of fifty degrees (50) Fahrenheit. All valves shall be stored under roof on wood pedestals, above ground. All insulation shall be stored under roof or in trailers, adequately protected from the weather. The Contractor shall follow all written instructions and recommendations of the manufacturer and all requirements of the Architect in oiling, protection and maintenance of equipment during storage. It shall be the Contractor's complete responsibility for the storage and care of the equipment and materials.
- C. If any equipment and/or materials are found to be in poor condition at the time of installation the Architect may, at his discretion, order the Contractor to furnish and install new equipment and/or material at no cost to the Owner.

3.09 COOPERATION WITH OTHER TRADES

- A. Mechanical and Electrical trades shall give full cooperation to other trades and shall furnish in writing, with copies to Architect any information necessary to permit the work of all trades to be installed satisfactorily and with least possible interference or delay. Exact location of all mechanical and electrical equipment, devices, etc. in finished spaces shall be coordinated with Architectural reflected ceiling plans, elevations and details.

3.10 CLEANING AND PAINTING

- A. Thoroughly clean all exposed surfaces of equipment and material and leave in a neat, clean condition ready for painting. Restore and touch-up factory finishes which have been damaged during construction. Finished painting will be performed under another Division.
- B. Miscellaneous requirements include:
 - 1. Touch-up threads of zinc coated screwed pipe with Rust-O-Leum primer and one (1) coat of enamel conforming with painting specification.
 - 2. Paint behind grilles and registers in finished areas with two (2) coats of flat black paint following the proper surface preparation of the zinc coated metal.

3.11 ACCESSIBILITY

- A. Locate all equipment which must be serviced, operated, or maintained, in fully accessible positions to eliminate the need for access panels and doors. Equipment shall include, but not be limited to, valves, clean-outs, motors, controllers, dampers, drain points, etc. Where overhead equipment cannot be located above spaces with either no ceilings or removable acoustical ceiling tiles, contractor shall provide, as part of the contract, fourteen (14) gauge steel access doors where required and/or where directed. Locations shall be coordinated with the Architect and indicated on the composite installation and

coordination drawings. Access panels shall be Milcor or equal, to suit material in which installed. Access doors installed in fire rated walls or shafts shall be labeled and shall match rating of the construction. Doors shall be of sufficient size to allow access to all components; minimum size shall be eighteen (18) inches by eighteen (18) inches. Doors in Toilet Rooms shall be Type 304 stainless steel. Equipment deemed inaccessible by the Architect shall be reworked by the Contractor at no expense to the Owner. All doors shall have cylinder locks operable from same key. Submit shop drawings for approval.

3.12 EQUIPMENT BASES AND SUPPORTS

- A. Refer to Division 15, "Mechanical Vibration, Sound and Seismic Controls" for vibration isolation and seismic restraint requirements.
- B. Concrete bases, curbs, and supports will be furnished and installed under this Division and shall be in accordance with Division 3.

3.13 SLEEVES AND PLATES

- A. Sleeves shall be provided by the trade installing the pipes or ducts for which sleeves are to be used. All cutting and patching necessary to set sleeves which are not placed prior to construction shall be the responsibility of the trade providing the sleeves.
- B. Sleeves shall be provided for all piping, conduits, and ducts passing through all floor slabs and concrete, masonry, tile, and gypsum wall construction.
- C. Fasten sleeves securely in floors and walls so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials from being forced into space between pipe and sleeve during construction.
- D. Where pipe motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Where insulated pipes and ducts pass through sleeves, the sleeves shall be large enough to pass the pipe or duct and the insulation. Check floor and wall construction to determine proper length for various locations; make actual lengths to suit the following:
 - 1. Terminate sleeves flush with walls, partitions, and ceilings.
 - 2. Terminate sleeves two (2) inches above finished floors. Fill all voids between sleeves and structures with an approved sealant or grout as determined by the Architect. Refer to Architectural drawings and specifications for sealing requirements of sleeves in floor.
- E. Sleeves installed in load bearing concrete or masonry construction shall be completely grouted in place. See Architectural drawings for extent and location of such walls. Single and multiple pipe or conduit penetrations, as well as duct openings, shall be accurately located by field measurements and indicated on the drawings.
- F. Structural members shall not be cut or penetrated. Notify the Architect where penetrations of structural members are required. Holes cut through concrete and/or masonry, to accommodate new work, shall be cut by reciprocating or rotary, non-percussive methods.

3.14 FLASHING

- A. Openings for pipes and ducts through waterproofed floors and roof areas shall be flashed. Vent pipes through roof shall be flashed with spun aluminum base having a minimum of five (5) inch roof surface flange. Base shall extend five (5) inches above roof surface.

3.15 DEMOLITION

- A. All existing piping, conduit, equipment, ductwork, and materials not required for re-use or re-installation shall be removed. Any existing materials and equipment which are removed and are desired by the Owner, or are indicated to remain the property of the Owner, shall be delivered to him on the premises by the Contractor where directed by the Architect. All other materials and equipment which are removed shall become the property of the Contractor and shall be removed by him from the premises.
- B. Existing piping that remains concealed, buried, or otherwise contained in the remaining slabs and walls shall be capped, plugged, or otherwise sealed. All pipes shall be cut so that their capped or plugged ends will be below the finished floors or behind finished surfaces.
- C. Existing wiring, where possible, shall be removed or pulled through conduits. Wiring remaining shall be cut back behind the termination of conduits so that conduits can be adequately capped, plugged, or sealed.

3.16 CONNECTIONS AND ALTERATIONS TO EXISTING WORK

- A. When existing mechanical and electrical work is removed, all pipes, valves, ducts, and materials shall be removed to a point below the finished floors or behind finished walls and capped. Such points shall be far enough behind finished surfaces to allow for the installation of the normal thickness of finished material.
- B. When the work specified hereinafter connects to existing equipment, piping, or ductwork, the Contractor shall perform all necessary alterations, cuttings, or fitting of existing work as may be necessary or required to make satisfactory connections between the new and existing work and to leave the completed work in a finished and workmanlike condition, to the entire satisfaction of the Architect.
- C. When the work specified hereinafter or under other divisions of the contract necessitates relocation of existing equipment, piping, or ductwork, the Contractor shall perform all work and make all necessary changes to existing work as may be required to leave the completed work in a finished and workmanlike condition, to the satisfaction of the Architect. All work resulting in an extra to the contract shall be approved by the Owner and Architect before proceeding.
- D. All cutting and patching necessary for the installation of the mechanical work shall be done under this Division. Any damage done to the work already in place shall be repaired at the Contractor's expense. Patching shall be uniform in appearance and shall match the surrounding surface.

3.17 INTERRUPTION OF EXISTING UTILITIES

- A. Interruptions during periods of normal building occupancy shall be kept to a minimum. Interruptions shall only occur after a schedule of proposed outage times is submitted to and approved by the Architect.
- B. At the end of each interruption, all services shall be restored so that normal use of the building can continue.

END OF SECTION 15000

SECTION 15070

MECHANICAL VIBRATION, SOUND AND SEISMIC CONTROLS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, General Requirements and all other Specification Sections apply to the work specified in this section.
- B. The 2009 International Building Code and SEI/ASCE 7-05 Standard apply to all work associated with the seismic installation of all new mechanical and electrical equipment. Refer to Architectural and Structural drawings for seismic loads and additional seismic information.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Elastomeric hangers.
 - 2. Spring hangers.
 - 3. Pipe riser resilient supports.
 - 4. Resilient pipe guides.
 - 5. Restrained vibration isolation roof-curb rails.
 - 6. Seismic snubbers.
 - 7. Restraining cables.
 - 8. Certification of seismic restraint designs and installation supervision.
 - 9. Certification of seismic attachment of housekeeping pads.
- B. Work includes vibration control devices, materials, and related items for mechanical and electrical systems. Perform all work as shown on the drawings and as specified herein to provide complete vibration isolation systems in proper working order.
- C. The requirements of Division 15, Section "Mechanical and Electrical General Provisions" shall apply to work specified under this section.

1.03 DEFINITIONS

- A. Effective peak velocity related acceleration coefficient.
- B. OSHPD: Office of Statewide Health Planning & Development for the State of California. OSHPD assigns a unique anchorage preapproval "R" number to each seismic restraint it tests. The number describes a specific device applied as tested.
- C. Life Safety Systems:
 - 1. All systems involved with fire protection including sprinkler piping, service water supply piping and fire dampers.
 - 2. All systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers and all flowpaths to fire protection and/or emergency lighting systems.

- D. Positive Attachment: A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, ductwork, fire protection, electrical conduit, bus duct, or cable trays, or any other equipment are not acceptable on this project as seismic anchor points.
- E. Transverse Bracing: Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.
- F. Longitudinal Bracing: Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.
- G. Failure: For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8" and/or horizontal permanent deformation greater than 1/4".

1.04 SUBMITTALS

- A. Product Data: Include load deflection curves for each vibration isolation device.
- B. Shop Drawings: Signed and sealed by the manufacturer's qualified professional engineer. Before ordering any products, submit shop drawings of the items listed below. The shop drawings must be complete when submitted, be based on equipment actually purchased and must be presented in a clear, easily understood form. Incomplete or unclear presentation of shop drawings may be reason for rejection of the submittal. Include the following:
 - 1. Product Description: A complete description of products to be supplied, including product data, dimensions, specifications, and installation instructions.
 - 2. Selection Data: Detailed selection data for each vibration isolator supporting equipment, including:
 - a. Equipment identification mark;
 - b. Isolator type;
 - c. Actual load;
 - d. Static deflection expected under the actual load
 - e. Specified minimum static deflection.
 - 3. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by the manufacturer's registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.
 - 4. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
 - 5. Seismic-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
 - 6. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y, and z planes.
 - 7. Seismic restraint calculations.
 - 8. Provide Approved Agencies Certificate of Compliance meeting Seismic Category C for all components. Tests shall include anchorage, structural and on line capability from analytical or shaker test method.

- C. Submission of samples may be requested for each type of vibration isolation device. After approval, samples will be returned for installation at the job if requested. All costs associated with submission of samples shall be borne by the Contractor.
- D. Welding certificates.
- E. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.05 MANUFACTURER RESPONSIBILITIES

- A. Manufacturer of vibration isolation and seismic restraint equipment shall have the following responsibilities:
 - 1. Determine vibration isolation and seismic restraint sizes and locations.
 - 2. Provide piping and equipment isolation systems and seismic restraints as scheduled or specified.
 - 3. Guarantee specified isolation system deflection.
 - 4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
 - 5. Provide certification by a licensed engineer employed by the manufacturer that all mounts and restraints meet the project requirements for seismic loading.
- B. Substitution of internally isolated mechanical equipment in lieu of the specified isolation of this Section must be approved for individual equipment units and is acceptable only if above acceleration loads are certified in writing by the equipment manufacturer and stamped and sealed by a licensed civil or structural engineer.

1.06 RELATED WORK

- A. Supplementary Steel
 - 1. Provide any incidental materials and supplementary support steel for all equipment, piping, ductwork, etc., such as mounting brackets, attachments and other accessories, that may be needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, at no additional cost.
- B. Attachments
 - 1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

1.07 QUALITY ASSURANCE

- A. Seismic-restraint devices shall have horizontal and vertical load testing and analysis performed according to OSHPD and shall bear anchorage preapproval "R" number, from

OSHPD or another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer. Testing and calculations must include both shear and tensile loads and 1 test or analysis at 45 degrees to the weakest mode.

- B. Seismic restraints for mechanical systems shall comply with SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd edition 2008.
- C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
- D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
- E. Should any rotating or electrical equipment cause excessive noise or vibration when properly installed on the specified isolators, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.
- F. Upon completion of the work, the Architect shall inspect the installation and shall inform the installing contractor of any further work that must be completed. Make all adjustments as directed by the Architect that result from the final inspection. This work shall be done before vibration isolation systems are accepted.
- G. The contractor shall provide a quality assurance plan prepared by a registered design professional for all mechanical, plumbing and electrical equipment and systems. The plan shall include the provisions of the 2009 International Building Code, per section 1705.2 and 1705.3. The plan shall be submitted to the Architect for review and approval. The contractor shall coordinate the requirements of the plan with the Owner and shall cooperate with the Owner's Seismic Quality Assurance coordinator.

1.08 COORDINATION

- A. Coordinate installation of equipment supports, floor penetrations and roof penetrations.

1.09 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Seismic Snubber Units: Furnish replacement neoprene inserts for all snubbers.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 VIBRATION ISOLATORS

A. Manufacturers:

1. Ace Mounting Co., Inc.
2. Amber/Booth Company, Inc.
3. B-Line Systems, Inc.
4. California Dynamics Corp.
5. Isolation Technology, Inc.
6. Kinetics Noise Control, Inc.
7. Mason Industries, Inc.
8. Vibration Eliminator Co., Inc.
9. Vibration Isolation Co., Inc.
10. Vibration Mountings & Controls/Korfund.

B. General:

1. The installed vibration isolation system for each floor or ceiling mounted item of equipment shall have a maximum lateral motion under equipment start up and shut down conditions of 1/4 inch. Motions in excess shall be restrained by approved spring type mounting.
2. All electrical connections, drain connections, etc., made to equipment which rests on vibration isolators, shall be sufficiently flexible to permit the equipment to be properly isolated.
3. The type of isolation, base, and minimum static deflection shall be as required for each specific equipment application, but not less than that specified herein when supported on a solid concrete structural slab having a thickness of not less than four (4) inches. If vibration isolators with a deflection greater than the minimum specified are required to meet the noise criteria for the adjacent spaces, suitable isolation system shall be submitted. Should vibration isolators installed for the equipment prove inadequate to prevent transmission of equipment vibrations to the building structure or limit equipment vibration originated noise in the building spaces to acceptable levels, the isolators shall be replaced with units having the largest deflection that can be practicably installed.
4. All springs installed out-of-doors shall be cadmium-plated, zinc electroplated or powder-coated after fabrication. Hardware and other metal parts shall be cadmium-plated or galvanized. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard No. 14.
5. All isolators installed out-of-doors shall have base plates with bolt holes for fastening the isolators to the support members.
6. Isolator types are scheduled to establish minimum standards. At the Contractor's option, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories and seismic restraint features must not degrade the isolation performance of the isolators.
7. Static deflection of isolators shall be as provided in the EXECUTION section and as shown on the drawings. All static deflections stated are the minimum acceptable deflection for the mounts under actual load. Isolators selected solely on the basis of rated deflections are not acceptable and will be disapproved.

- ### C. Elastomeric Hangers: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

- D. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
 - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
- E. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.
- F. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-inch thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.03 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers:
 - 1. Amber/Booth Company, Inc.
 - 2. B-Line Systems, Inc.
 - 3. California Dynamics Corp.
 - 4. Kinetics Noise Control, Inc.
 - 5. Loos & Co., Inc.; Cableware Technology Division.
 - 6. Mason Industries, Inc.
 - 7. TOLCO Incorporated.
 - 8. Unistrut Diversified Products Co.; Wayne Manufacturing Division.
 - 9. Vibration Eliminator Co., Inc.
 - 10. Vibration Isolation Co., Inc.
 - 11. Vibration Mountings & Controls/Korfund.
- B. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 40, plus or minus 5, with a flat washer face.
- C. Restraining Cables: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement.
- D. Anchor Bolts: Seismic-rated, drill-in, and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488/E 488M.

E. General Requirements:

1. Equipment, piping, ductwork, conduit, lighting and electrical devices shall be braced and supported in accordance with International Building Code, 2009 - Chapter 16.
2. This Contractor shall provide the services of a professionally registered Seismic consultant to perform duties indicated below. The Contractor shall submit with his bid, the hourly billing rate for their Seismic consultant to provide additional services beyond the specified scope.

F. HVAC Ductwork:

1. Attachments and supports for HVAC ductwork systems shall be designed to meet the force and displacement provisions of SEI/ASCE 7-05 Standard.

G. Piping

1. Attachments and supports for piping systems shall be designed to meet the force and displacement provisions of SEI/ASCE 7-05 Standard.

H. Mechanical Equipment, Attachments and Supports

1. Attachments and supports for mechanical equipment shall be designed to meet the force and displacement provisions of SEI/ASCE 7-05 Standard.

I. Seismic details indicated on the drawings are not intended to limit the Contractor. Alternated methods of support, attachment and bracing must be designed by the Seismic Consultant and submitted to the Architect for review.

J. Sprinkler system piping shall be supported and braced in accordance with NFPA 13.

2.04 RESILIENT PENETRATION SLEEVE/SEAL

- A. Resilient penetration sleeve/seals shall be field-fabricated from a pipe or sheet metal section that is 1/2 inch to 3/4 inch larger than the penetrating element in all directions around the element, and shall be used to provide a sleeve through the construction penetrated. The sleeve shall extend one (1) inch beyond the penetrated construction on each side. The space between the sleeve and the penetrating element shall be packed with glass fiber or mineral wool to within 1/4 inch of the ends of the sleeve. The remaining 1/4 inch space on each end shall be filled with acoustical sealant to form an airtight seal. The penetrating element shall be able to pass through the sleeve without contacting the sleeve. Alternatively, prefabricated sleeves accomplishing the same result are acceptable.

2.05 RESILIENT LATERAL SUPPORTS

- A. These units shall either be a standard product of the vibration isolation mounting manufacturer, or be custom fabricated from standard components. These units shall incorporate neoprene isolation elements that are specifically designed to provide resilient lateral bracing of ducts or pipes.

2.06 FLEXIBLE DUCT CONNECTIONS

- A. Flexible duct connections shall be made from coated fabric. The clear space between connected parts shall be a minimum of three (3) inches and the connection shall have a minimum of 1.5 inches of slack material.

2.07 FLEXIBLE PIPE CONNECTIONS

- A. Flexible pipe connections shall be fabricated of multiple plies of nylon cord, fabric, and neoprene; and shall be vulcanized so as to become inseparable and homogeneous. Flexible connections shall be formed in a double sphere shape, and shall be able to accept compressive, elongating, transverse, and angular movements.
- B. The flexible connections shall be selected and specially fitted, if necessary, to suit the system temperature, pressure, and fluid type. In addition, suitable flexible connections should be selected which do not require rods or cables to control extension of the connector.
- C. Connectors for pipe sizes two (2) inches or smaller shall have threaded female union couplings on each end. Larger sizes shall be fitted with metallic flange couplings.

2.08 GROMMETS:

- A. Grommets shall be specially formed to prevent bolts from directly contacting the isolator base plate, and shall be sized so that they will be loaded within the manufacturer's recommended load range.
- B. Grommets shall either be custom made by combining a neoprene washer and sleeve, or a manufactured product:

2.09 ACOUSTICAL SEALANT:

- A. Sealants for acoustical purposes as described in this specification shall be silicone or a nonsetting sealants.

2.10 FLEXIBLE ELECTRICAL CONNECTIONS

- A. Type A:
 - 1. Flexible Electrical Connection Type A shall be a prefabricated unit incorporating a flexible and watertight outer jacket, grounding strap, plastic inner sleeve to maintain smooth wire way, and end hubs with tapered electrical threads to fit standard threaded rigid metal conduit.
 - 2. Flexible Electrical Connection Type A shall be Crouse-Hinds "XD Expansion/Deflection Coupling", Spring City Electrical Mfg. Co. "Type DF Expansion and Deflection Fitting", or approved equal.
- B. Type B:
 - 1. Flexible Electrical Connection Type B shall be field fabricated using a minimum two (2) foot length of flexible conduit or cable.
- C. Type C:
 - 1. Flexible Electrical Connection Type C shall be field fabricated using a minimum equal four (4) foot length of flexible conduit or cable.

2.11 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be electrogalvanized. Hot-dip galvanized metal components for exterior use.
3. Baked enamel for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATION:

- A. General:
 1. Refer to the PRODUCTS section of this specification for vibration isolation devices identified on the drawings or specified herein.
 2. The static deflections of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected solely on the basis of rated deflection are not acceptable and will be disapproved.
- B. Pipes:
 1. All heating water and drain piping that is connected to vibration-isolated equipment shall be isolated from the building structure at their first three support points.
 2. Piping shall be isolated from the building structure by means of vibration isolators, resilient lateral supports, and resilient penetration sleeve/seals.
 3. Isolators for the first three support points adjacent to connected equipment shall achieve one half the specified static deflection of the isolators supporting the connected equipment. When the required static deflection of these isolators is greater than 1/2 inch, spring neoprene isolators shall be used. When the required static deflection is less than or equal to 1/2 inch, neoprene isolators shall be used.
 4. Where lateral support of pipes is required within the specified limits, this shall be accomplished by use of resilient lateral supports.
 5. Pipes within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.
- C. Ductwork:
 1. All sheet metal ducts that are connected to vibration-isolated equipment shall be isolated from the building structure at their first three support points by neoprene isolators. All isolators shall achieve 0.1 inch minimum static deflection.
 2. Ducts within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.
 3. Flexible duct connections shall be provided as called for above under Major Equipment and wherever shown on the drawings.

3.03 INSTALLATION

A. General:

1. Locations of all vibration isolation devices shall be selected for ease of inspection and adjustment as well as for proper operation.
2. Installation of vibration isolation equipment shall be in accordance with the manufacturer's instructions.
3. In all cases, isolated electrical equipment shall be positioned so that it is free standing and does not come in rigid contact with the building structure or other systems.
4. Isolators:
 - a. All vibration isolators shall be aligned squarely above or below mounting points of the supported equipment.
 - b. Hanger rods for vibration-isolated support shall be connected to structural beams or joists, not the floor slab between beams and joists. Provide suitable intermediate support members as necessary.
 - c. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.
 - d. Parallel running pipes may be hung together on a trapeze that is isolated from the building. Isolator deflections must be the greatest required by the provisions for pipe isolation for any single pipe on the trapeze. Do not mix isolated and unisolated pipes on the same trapeze.
 - e. Pipes, ducts and equipment shall not be supported from other pipes, ducts and equipment.
 - f. Resiliently isolated pipes, ducts and equipment shall not come in rigid contact with the building construction or rigidly supported equipment.
 - g. The installed and operating heights of equipment vibration-isolated with floor spring and neoprene travel limited isolators or roof isolators or with roof curb or roof rail isolation bases shall be identical. Limit stops shall be out of contact during normal operation. Adjust isolators to provide 1/4 inch clearance between the limit stop brackets and the isolator top plate, and between the travel limit nuts and travel limit brackets.
 - h. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.
 - i. Roof isolators shall be installed in strict accordance with the manufacturer's instructions.
5. Flexible Duct Connections:
 - a. Sheet metal ducts and plenum openings shall be squarely aligned with the fan discharge, fan intake, or adjacent duct section prior to installation of the flexible connection, so that the clear length is approximately equal all the way around the perimeter. Flexible duct connections shall not be installed until this provision is met. There shall be no metal-to-metal contact between connected sections, and the fabric shall not be stretched taut.
6. Flexible Pipe Connections:
 - a. Install flexible pipe connections in strict accordance with the manufacturer's instructions.
7. Grommets:
 - a. Where grommets are required at hold down bolts of isolators, bolt holes shall be properly sized to allow for grommets. The hold down bolt assembly shall include washers to distribute load evenly over the grommets. Bolts and washers shall be galvanized.
8. Resilient Penetration Sleeve/Seals:

- a. Maintain an airtight seal around the penetrating element and prevent rigid contact between the penetrating element and the building structure. Fit the sleeve tightly to the building construction and seal airtight on both sides of the construction penetrated with acoustical sealant.
- 9. Flexible Electrical Connections:
 - a. Type C connections shall be installed in a grossly slack "U" shape or a 360 degree loop.
 - b. Rigid conduit on the isolated-equipment side of the flexible connection, and the flexible connection itself, shall not be tied to the building construction or other rigid structures.
- B. Install restraining cables at each trapeze and individual pipe hanger. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.
- C. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.
- D. Install resilient bolt isolation washers on equipment anchor bolts.

3.04 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. Isolator seismic-restraint clearance.
 - 2. Isolator deflection.
 - 3. Snubber minimum clearances.

3.05 ADJUSTING

- A. Adjust active height of spring isolators.
- B. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
- C. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

3.06 CLEANING

- A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 1.

3.08 VIBRATION ISOLATOR AND SEISMIC-RESTRAINT SCHEDULE

Vibration Isolation Schedule

<u>Equipment</u>	<u>Isolation Type</u>	<u>Minimum Static Deflection</u>	<u>Base Type</u>	<u>Remarks</u>
First Three (3) Pipe Hangers near Isolated Equipment	Spring Hangers	1.5"	---	-----
First Two (2) Pipe Hangers near Non-Isolated Equipment	Spring Hangers	1.0"	---	-----

3.09 SEISMIC INSTALLATION INSPECTION

- A. On completion of installation of all vibration isolation and seismic restraint devices herein specified, a representative of the isolation materials manufacturer shall inspect the completed system and report in writing any installation errors, improperly selected isolation or restraint devices, or other faults that could affect the performance of the system. Contractor shall submit a report to the Architect, including the manufacturer's representative's final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

END OF SECTION 15070

SECTION 15100
BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, General Requirements and all other Specification Sections apply to the work specified in this section.

1.02 SCOPE

- A. This section includes requirements for items of mechanical equipment, materials and procedures which are common to more than one section of Division 15 and which are general in nature and use. This section applies to all sections of Division 15.
- B. The requirements of Division 15, Section "Mechanical and Electrical General Provisions" shall apply to all work specified under this section.

1.03 SHOP DRAWINGS

- A. Submit shop drawings for all items of materials specified in this section in accordance with the General Requirements.

1.04 TESTS AND ADJUSTMENTS

- A. The Contractor shall furnish labor, instruments, equipment, and materials required to perform tests prescribed in the sections describing the various systems. All tests shall be performed in the presence of the Owner and/or the Architect. Forty-eight (48) hours prior notice shall be given to the Owner and Architect for all tests. A written test report shall be submitted following all tests and before systems are insulated.
- B. Replace or repair defects found during inspection or tests with new materials. Caulking of welded joints, screwed joints, cracks, or holes is not acceptable. Correct leaks in screwed fittings by remaking joints. Cut out and reweld. Repeat tests after defects have been eliminated.
- C. Where reasonable doubt exists as to a system's ability to comply with contract requirements, perform any reasonable test required by the Architect.
- D. Make static pressure tests and prove to the satisfaction of the Architect the piping is tight before pipes are concealed. Tests shall be provided as hereinafter specified.
- E. Use test instruments tested for accuracy by an approved laboratory or by the instrument manufacturer, and furnish certificates showing degree of accuracy to the Architect when requested. Make calibration histories for each instrument available for examination.
- F. Where gauges, thermometers and other instruments which are to be left permanently installed are used for tests, do not install until just prior to the tests to avoid possible changes in calibration.

1.05 REFERENCES AND DEFINITIONS

- A. Unless otherwise specifically indicated, the term, and requirements of, "domestic" water systems shall apply universally to all potable, HVAC make-up and industrial laboratory water systems.

PART 2 - PRODUCTS

2.01 HANGERS:

- A. See Division 15, Section "Mechanical and Electrical General Provisions" for general requirements.
- B. Hangers and accessories shall be Anvil International, Carpenter-Patterson, Michigan, B-Line, or Basic Engineering of the types specified in Division 15, Section "Mechanical and Electrical General Provisions".
- C. It shall be the responsibility of the Contractor to provide an adequate pipe suspension system in accordance with recognized engineering practices, using standard, commercially accepted pipe hangers and suspension equipment.
- D. The Contractor shall engage a qualified professional engineer to design an engineered pipe hanger and support system for all pipe systems of this Contract. Contractor shall perform calculations to ensure that the pipe support system being provided is adequate for the service. For all pipe hangers, supports, anchors, guides, etc., the Contractor shall submit a pipe hanger assembly drawing in accordance with the recommendations provided by MSS SP-89. Provide proposed equipment manufacturer, manufacturer's model number and size, construction, finish, quantities and/or lengths. Utilize columns shown on Contract Drawings for the location plan. Indicate pipe system, line size, insulation thickness, and Contract Drawing for which the plan view of the pipe hanger location can be found.
 - 1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.
- E. All brackets used for supporting piping shall be provided by the Contractor and shall be of welded steel construction with a design safety factor of not less than five.
- F. The design of all hangers and supports shall be in accordance with the provisions of the current issue of the MSS-Sp-58 document developed as a standard by the Manufacturers' Standardization Society.
- G. Hangers for steel pipe, except as noted otherwise, shall be spaced at least every ten (10) feet. Hangers for cast iron pipe shall be provided at each joint. Hangers for copper pipe shall be placed at least every eight (8) feet, except pipes 3/4 inch and smaller shall have hangers at six (6) foot intervals.
- H. Plastic and polypropylene piping systems shall be provided with continuous pipe support using light gauge sheetmetal angles strapped to pipes.

- I. Where concentrated loads of valves, fittings and similar items occur, closer hanger spacing will be necessary.
- J. Vibration hangers shall be provided as hereinafter specified in Division 15, Section "Mechanical Vibration, Sound and Seismic Controls".
- K. Pipe Shields
 - 1. On insulated piping smaller than 2", provide insulation protection shield equal to Anvil International Figure 167. Shield shall comply with Manufacturers Standardization Society (MSS) SP-58 (Type 40).
- L. Hangers in direct contact with copper piping systems shall be copper plated.
- M. All hangers shall be prime painted for interior locations and galvanized coated for exterior locations.
- N. All hangers shall be provided with seismic restraints.

2.02 IDENTIFICATION, VALVE TAGS AND CHARTS

- A. A complete identification system shall be provided for all mechanical and electrical components which conform to the requirements published in ASME A13.1, NFPA 13 and the Fuel Gas Code.
- B. Product Data and Samples: In accordance with Division 1 Section "Submittal Procedures", submit the following:
 - 1. Manufacturer's technical product data and installation instructions for each type of identification device specified. Include a list of all piping systems indicating a proposed nomenclature where a manufacturer's standard pre-printed nomenclature does not match up exactly with what is specified.
 - 2. Samples of each color, lettering style, and other graphic representation required for:
 - a. Brass valve identification tag.
 - b. Pipe contents and identification markers.
 - c. Valve Schedules: For each piping system. Reproduce on standard-size bond paper. Tabulate valve number, piping system, system abbreviation as shown on tag, room or space location of valve, and variations for identification. Mark valves intended for emergency shut-off and similar special uses. Besides mounted copies, furnish copies from maintenance manuals specified in Division 1.
 - d. Plastic equipment identification plates.
 - e. Stencils.
- C. All control devices, i.e.; panels, switches, starters, pushbutton stations, relays, temperature controls, etc., shall be clearly identified as to their function and the equipment controlled. All equipment such as air terminal boxes, fans, heaters, etc., shall be marked to clearly identify equipment and space or duty they serve. Mechanical equipment shall be identified using engraved laminated black and white phenolic legend plates. Letters shall be minimum 3/4 inch high white on surrounding black. Plates shall be mounted by means of sheet metal screws. Submit nameplate list for approval.
- D. Piping shall be identified with colored, prerolled, semirigid plastic labels as manufactured by Seton or approved equal. Labels shall be Seton "Set mark" system and shall be set

around pipes with a field installed high strength cement compound applied along their longitudinal edge. Labels shall be placed around the piping or insulation every twenty (20) feet and with one (1) label on each pipe in rooms smaller than ten (10) feet. Provide labels on branch lines not more than 5 ft from main header. Provide labels on lines that penetrate walls or floors on each side of penetration not more than 5 ft from penetration. A label shall be placed at every major valve and at least six (6) feet from exit or entrance to an item of equipment. At Contractor's option, piping concealed above suspended ceilings only may be identified by stenciling with black paint and taped color bands in accordance with the coding system herein specified. On exterior piping, utilize stencils to paint contrasting letters identifying pipe contents and direction of flow. Letter size and color shall comply with the requirements of adhesive pipe labels.

- E. For supply and exhaust air terminal units located above the ceiling, in addition to a label on the device, labels are to be permanently affixed to the ceiling grid framing as near to the item as possible using epoxy glue. Where hard ceilings are used, the label is to be affixed to the frame of the access panel for the unit. Labels are to be black core white or beige Bakelite. The lettering is to be 3/8" inches high. The minimum label size is 3/4" wide by 1" long. Terminal units shall be identified as indicated on the mechanical drawings and ATC graphics. The thermostat that controls each air terminal unit shall be identified with an identical but appropriately sized label.
- F. Labels shall have minimum 3/4 inch high black letters for pipes one (1) inch and larger, and 1/2 inch letters for smaller pipes. All labels shall have flow arrows. Color coding and stencil designations shall be as follows:

<u>Service</u>	<u>Color</u>	<u>Label Designation</u>
Domestic Cold Water	Green	Cold Water
Domestic Hot Water	Yellow	Hot Water
Domestic Hot Water Recirc	Yellow	Hot Water Recirc.
Sanitary	Brown	Sanitary Sewer
Storm Water	Brown	Storm Water
Natural Gas	Yellow	Natural Gas
Laboratory Compressed Air	Yellow	Lab Air
Laboratory Vacuum	Yellow	Lab Vac
Heating Water Supply	Yellow	Heating Water Supply
Heating Water Return	Yellow	Heating Water Return

- G. All valves, except as specified below, shall be provided with colored plastic valve tags with stamped-in numbers. Tags shall be secured to valve wheels with a metal chain. Stop valves on individual fixtures or equipment where their function is obvious, or where the fixture of equipment is immediately adjacent, need not be so equipped. Care shall be exercised in scheduling and selecting valve numbers to be indicated on a drawing. Drawing shall show locations, details of arrangements, identity, and function of all service and control valves. One (1) copy of each drawing and schedule shall be mounted and framed under plastic protection where directed. Blueprints are not acceptable. A copy of each drawing and schedule shall also be included as a part of the operations and maintenance manuals. Valve tags shall be Seton or approved equal minimum 1-1/2 inch round tags with white characters describing system and valve designation.
- H. Identify fire protection systems (sprinkler and fire alarm) as hereinafter specified as required by NFPA Standards.

2.03 PIPE, FITTINGS AND JOINTS

- A. General: Items are referred to by type and shall conform to the latest editions of standards listed below:
- B. Provide pipe and fittings for fire protection as hereinafter specified in Division 15, Sections "Fire Protection."
- C. All piping shall be new domestic pipe material, manufactured in the United States of America (USA) and be suitable for the specific use indicated on drawings and in the specifications.
- D. Piping Material:

<u>Service</u>	<u>Piping</u>	<u>Fittings</u>	<u>Joints</u>
1. Sanitary Drainage:			
a. Above ground within building	J	VIII	i
b. Vent piping	J	VIII	i
2. Domestic Cold water, Hot Water, Tempered Water and Hot Water Recirculation	F	III	e
3. Heating Water Supply and Return:			
a. 2-1/2" and larger	C	VII	b
b. 2" and smaller	C	IV	c
c. 2" and smaller (optional)	F	III	e
4. Natural Gas:			
a. 2" and smaller	C	IV	c
5. Laboratory Air, Vacuum	F	III	f
6. Acid Waste Drainage and Vent	N	XIV	k

- E. Piping Assembly:

<u>Type</u>	<u>Designation</u>
1. Black steel pipe, ASTM A53/106 Grade B Seamless ANSI Schedule 40	C
2. Seamless copper water tube, ASTM B88, Type L, hard	F
3. Cast iron soil pipe, service weight No-Hub, ASTM A-888. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and listed by NSF International.	J
4. Enfield flame retardant polypropylene acid resistant drainage pipe, ASTM D635, Schedule 40	N

- F. Fitting Materials:

	<u>Type</u>	<u>Designation</u>
1.	Wrought copper and bronze drainage fittings, ANSI A16.29	II
2.	Wrought copper solder joint fittings, 150 pound ANSI B16.22	III
3.	Black malleable iron screwed fittings, 150 pound, ANSI B16.3 for less than seventy-five (75) pounds per square inch and 300 pounds for seventy-five (75) pounds per square inch or more	IV
4.	Steel butt-welding fittings ANSI B16.9 using long-turn ells, ANSI B16.5 weld neck or slip on flanges & Bonney Forge Weldolets and Thredolets. Wall thickness to match pipe.	VII
5.	Cast iron soil pipe fittings, No Hub, ASTM A-888	VIII
6.	Enfield acid waste fittings and adapters. Connections containing EVA components are prohibited	XIV

G. Joint Materials:

	<u>Type</u>	<u>Designation</u>
1.	Welded: Mechanical Contractors Association of America, Inc. Guidelines for Quality Piping Installation (1995), Section 2.1.O	b
2.	Threaded: American Standard for Pipe Threads, ANSI B2.1	c
3.	Soldered: ASTM B32 tin-antimony 95-5	e
4.	Brazed: Silver alloy brazing equal to Silfos and Easy-Flo by Handy and Harman. The use of flux is prohibited	f
5.	No-Hub neoprene gasket and stainless steel corrugated shield, Tyler No-Hub coupling	i
6.	Enfield mechanical joints and adapters. Connections containing EVA components are prohibited.	k

2.04 VALVES

A. General:

1. Valves shall be provided where indicated on the drawings and as herein specified.
2. Valves shall be placed in such manner as to be easily accessible for hand wheel operation and stuffing maintenance.
3. Install shut-off valves in piping where shown or where listed below:
 - a. To isolate all items of equipment.
 - b. To isolate motorized flow control valves.
 - c. To isolate branch lines and riser at mains.
4. Valve pipe connections shall be screw, solder or weld flange as required to be consistent with other parts of the piping system.
5. Where piping or equipment may subsequently need to be removed, provide valves with bodies having integral flanges or full lugs drilled and tapped to hold valve in place so that downstream piping or equipment can be disconnected and replaced with blank-off plate while valve is still in service.
6. Where valves specified are not available in the pipe size noted on the drawing, the next larger size valve shall be provided.
7. Valves shall be provided for fire protection systems as specified in Division 15, Section "Fire Protection."

B. Balancing Valves:

1. Provide balancing valves where indicated and required to balance water flow through the piping system.
2. Balancing valves, 1-1/4 inches and larger, for systems piping shall be DeZurik as follows: PEC, flanged above two (2) inches with Buna filled PTFE U-ring seal and isobutene-isoprene plug facing, suitable for 250 degrees Fahrenheit continuous operation. Valves in chilled water systems may have seal and plug facing suitable for 180 degrees Fahrenheit. Valves six (6) inches and smaller shall have lever actuators and valves eight (8) inches and larger shall have gear operators. All actuators shall have adjustable memory stops.
3. Balancing valves one (1) inch and smaller shall be Armstrong Model CBV or as manufactured by TA Hydronics or approved equal.

C. Ball Valves:

1. Ball valves shall be used in all water systems size two (2) inches and smaller.
2. Ball valves shall be Nibco, Jamesbury, Apollo or Watts.
3. Three (3) piece ball valves sizes 1/2 inch to two (2) inch shall be used for all water and laboratory compressed air, vacuum and carbon dioxide gas piping systems to accommodate replacement of internal parts. Valves shall be equal to Nibco Figure No. 595-Y-66, swing out design, bronze body, full port, stainless steel ball, and stainless steel stem (ASTM A-276 Type 316), reinforced TFE seats. Body bolts and nuts shall be zinc dichromate plated steel and valve shall be suitable for 150 pounds per square inch saturated steam service. Valves shall be threaded or soldered to suit piping systems which they are installed.
4. Valves shall be equipped with lever handle with extended stem for insulation thickness which shall indicate position of ball orifice and have stops for fully open and closed position. Construction shall be such that power actuator can be used. Ball opening shall be full pipe size.
5. Valve shall be suitable for flow in either direction and must be leak proof at all pressures up to 150 pounds per square inch gauge (psig) and temperatures from minus twenty (-20) degrees Fahrenheit to 350 degrees Fahrenheit in open or shut position.

D. Drain Valves:

1. Drain valves shall be ball type as hereinbefore specified with hose end adapter and shall be provided at low points of all piping systems, and where indicated, 3/4 inch minimum.

E. Gas Valves:

1. Shut-off valves for natural gas service shall be ball type Jamesbury Clincher Type 2000 or approved equal for sizes up to two (2) inch. Valve shall have screwed ends, brass body, and 316 stainless steel trim. Valves shall meet UL Guide Designation YRPV for gas shut-off valves.
2. Shut-off valves for natural gas service shall be ball type Jamesbury Series 5150 ANSI Class 150 or approved equal for sizes greater than two (2) inches. Valve shall be flanged ends, ductile iron body, and 316 stainless steel trim. Valves shall meet UL Guide Designation YRPV for gas shut-off valves.

F. Valve Schedule:

1. Unless otherwise specified, valves shall be Nibco, Stockham, or Crane equal to the Nibco figure numbers indicated below:
 - a. Domestic Hot, Cold, Tempered and Recirculated Water Systems:
Globe - Solder end S-211-Y

	Check - Solder end	S-413-Y
b.	Heating Water:	
	Globe - 2" and under	T-211-B
	Globe - Solder end	S-211-Y
	Check - 2" and under	T-413-B
	Check - Solder end	S-413-B

2.05 PIPING SPECIALTIES

- A. Manual air vents shall be key-operated type installed as shown on drawings or as required for proper venting of equipment. Vents at top of vent chambers and coils shall be 1/4 inch ball valves.
- B. Automatic air vents on water systems shall be Sarco, Bell and Gossett, Taco or Metraflex equal to Sarco Type 13W, 150 pounds per square inch (psi). Provide shut-off valve on each vent. Vents above suspended ceilings shall have 1/4 inch soft copper drain line extended to nearest floor drain or service sink.
- C. Strainers shall be Mueller Steam Specialty Company, Inc., or approved equal, No. 351 for two (2) inch and smaller, No. 758 (125 lbs.) or No. 725 (250 lbs.) for 2-1/2 inch and larger. Basket strainers shall be Mueller Steam Specialty Company, Inc. or approved equal, No. 185. Provide valved blow-down connections on each strainer consisting of a ball valve set between two (2) short nipples. Blow-down valve shall be full size of strainer blow-down connection. Screens shall be stainless steel with perforations as follows:
- D. Coil flowmeter fittings shall be Taco Sentinel or approved equal, brass construction suitable for 150 pounds per square inch gauge (psig) working pressure and 250 degrees Fahrenheit operating temperature and shall be equipped with brass quick-disconnect valves for connecting flowmeter. The fitting shall have a maximum head loss of one (1) foot water at design flow rate and shall have an accuracy of plus or minus five percent for water temperatures from fifty (50) degrees Fahrenheit to 215 degrees Fahrenheit. Provide one (1) Taco differential pressure gauge Part No. 7007 or approved equal, compatible with the flow meter fittings supplied.
- E. Install wells in heating water piping for automatic temperature control sensors. Exact locations and number of wells required shall be determined through coordination with the work required under Division 15, Section "Building Automation and Temperature Control System".
- F. Gas pressure regulators shall be Fisher Controls Type HSR Series industrial gas regulators to provide precision gas pressure control necessary to optimize burner combustion. Regulators must be approved by the Owner's Insurance Underwriters for the specific use on the project.
- G. Pressure Gauges:
 - 1. Shall be Ashcroft, Trerice, Crosby or Marsh equal to Ashcroft "Quality" Type 1010 or 1014, 4-1/2 inches diameter case, bottom or back connected for easy reading. Dial shall have black letters on white background.
 - 2. Each gauge shall be mounted within six (6) feet of the floor on backboard or on pipe. Submit gauge locations and scale ranges for approval. Normal operating point shall occur at 1/3 to 2/3 of the gauges range. Pressure gauges shall be suitable for field calibration and be provided with pressure snubbers.
 - 3. Provide Crane 1/4 inch ball valve where "gauge cocks" are indicated.

4. Select gauge such that at normal service the gauge pointer is at the middle half of the scale range.
- H. Thermometers shall be Mueller, Trerice, Taylor or American equal to Mueller figure numbers specified. Thermometers shall be Figure V-22, 4-1/2 inches dial, chrome face ring, with remote bulb and separable socket. Straight, multi-angle type thermometers may be used if mounted within six (6) feet of floor and shall be Mueller Series AW or AWD, as applicable, nine (9) inch red reading mercury type. Provide extension necks where services are insulated. Select scale such that at normal service the unit reads at the middle portion of the scale range. Submit thermometer locations and scale ranges for approval.

2.06 TEST PLUGS

- A. Pressure and temperature test plugs where indicated or required shall be 1/4 inch npt fittings, suitable to receive either a 1/8 inch outside diameter (OD) temperature or pressure probe. Fittings shall be solid brass with Nordel valve core, fitted with a color coded marked cap with gasket. The entire assembly shall be rated at 1000 pounds per square inch gauge (psig). Plugs shall be manufactured by Peterson Equipment Company, Inc., Richardson, Texas, or Sisco P/T plugs.

2.07 DIELECTRIC FITTINGS

- A. General: Provide assembly or fitting with insulating material isolating joining of dissimilar metals, to prevent galvanic action and stop corrosion.
- B. Description: Combination of copper alloy and ferrous; threaded, soldered, plain end, or weld neck types matching piping system materials.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.
- D. Dielectric Unions: Factory-fabricated, union assembly, for 250 psig minimum working pressure at 180 deg. F.
- E. Dielectric Flange Insulating Kits: Field assembled, companion flange assembly, full face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers. Provide Class 150 or Class 300 flanges to match system pipe requirements.
- F. Dielectric Couplings: Galvanized steel coupling with inert and non-corrosive, thermoplastic lining, threaded with 300 psig minimum working pressure at 225 deg. F.
- G. Dielectric Nipples: Electroplated steel nipple with inert and non-corrosive, thermoplastic lining, threaded with 300 psig minimum working pressure at 225 deg. F.

2.08 FLEXIBLE CONNECTORS

- A. General: Provide stainless steel braided flexible connectors with design pressure and temperature rating meeting or exceeding the test pressures and operating temperatures of the systems in which they are installed. Pipe sizes 2-inch and smaller shall be socket welded or threaded matching system requirements. Pipe sizes above 2-inch shall be Class 150 or Class 300 flanged matching system requirements.

- B. Stainless steel hose / Steel pipe, flexible connectors: Corrugated, stainless steel inner tubing covered with stainless steel single wire braid. Include steel nipples or steel flanges welded to hose. Minimum length shall be three times pipe diameter up to 4-inch pipe size and two times pipe diameter up to 18-inch pipe size.

2.09 EXPANSION

- A. All piping shall be so installed that it will in no way be distorted or strained by expansion or contraction. Except as noted, all expansion and contraction shall be taken up by means of swing joints, loops, bends or long offsets. Swing joints made up with at least three (3) elbows shall be provided in branches from mains in runouts. Size loops for the total pipe expansion without cold springing, but field cold spring 1/2 the pipe on expansion corrected for ambient temperature.
- B. Where expansion joints are indicated or required, select joints with a traverse of 150 percent of the pipe expansion from an ambient of forty (40) degrees Fahrenheit to the maximum system operating temperature.
- C. All expansion joints shall be suitable for minimum operating pressure and temperature of 150 pounds per square inch (psi) and 300 degrees Fahrenheit respectively.
- D. Expansion joints shall be of the following types:
 - 1. Corrugated Type - Flexonics "Low-Corr" joints for pipes three (3) inches and larger. Flexonics Model H or HB for pipes smaller than three (3) inches.
 - 2. Slip Type - Flexonics "Slip Pak" with anchor base.
- E. Submit, for approval, manufacturers' shop drawings of each expansion joint provided depicting length of pipe, location of anchors and guides, calculated expansion offset and type of joint employed.

2.10 MISCELLANEOUS MATERIALS FOR SUPPORTS, HANGERS, ANCHORS AND GUIDES

- A. The Contractor shall provide all miscellaneous materials required to properly install all supports, hangers, anchors and guides, including:
 - 1. Steel Plates, Shapes and Bars: Provide products complying with ASTM A36.
 - 2. Cement Grout: Portland Cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.
 - 3. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

PART 3 - EXECUTION

3.01 CLEANING, FLUSHING, INSPECTING

- A. General: Clean exterior surfaces of piping systems of superfluous materials, and prepare for application of specified coatings (if any.) Clean interior of pipe by mechanical means to remove welding slag, metal filings, dirt, and debris. Flush out piping systems to the satisfaction of the Owner before proceeding with required tests. Inspect each run of each system for completion of joints, supports, and accessory items.
 - 1. Inspect Power Piping in accordance with procedures of ASME B31.1.

- B. The Contractor shall submit a detailed pipe flushing plan detailing the efforts to be taken to ensure a completely clean piping system. Any damage to existing or new equipment or components shall be repaired or replaced at the Contractor's expense to the satisfaction of the Owner.
- C. The Contractor shall clean and flush all installed piping systems with a clean water solution with additives formulated to assist in the removal of welding slag, metal filings, oil, and grease. Flushing operations shall maintain a minimum velocity of six feet per second for a minimum four hour time frame. Repeat flushing operations to the satisfaction of the Owner and until flushing water is completely clear. System pumps may be utilized for flushing operations with fine mesh start-up screens. Clean screens often and replace with final system screens at completion of flushing operations. The Contractor shall provide all temporary equipment and piping necessary to complete the flushing operations.
- D. Refill and vent water systems being sure to add water after venting to completely fill system.
- E. Disinfect new or repaired water mains and water service piping in accordance with AWWA A601 and section 610 of the 2009 International Plumbing Code.
- F. Provide water treatment services as indicated in other Division 15 specification Sections.

3.02 PIPING INSTALLATION

- A. Install piping without undue stress or strain in locations shown and run parallel to the lines of the building, except to grade them as specified in neat and workmanlike manner using a minimum of fittings. Provide such fittings, valves and accessories as may be required to meet the conditions of installation. Contractor shall inform himself fully regarding any peculiarities and limitations of space available for installation of material under each section of specifications. Install piping to suit necessities of clearance with ducts, conduits, and other work, and so as not to interfere with any passages or doorways and allow sufficient head room at all places. Use proper reducing fittings for changing piping sizes.
- B. Cut pipes accurately to measurements established in the field in a neat and workmanlike manner without damage or without forcing or springing. Perform cutting by means of an approved type of mechanical cutter of the wheel type where practicable. Ream pipe after cutting to remove all burrs.
- C. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings and accessories that may be required. Carefully investigate the architectural and structural conditions affecting the work, and arrange such work accordingly, providing such fittings, and accessories as may be required to meet such conditions. Drawings (plans, schematics, and diagrams) indicate the general location arrangement and restrictions of the piping systems. Location and arrangement of piping layout shall take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated on the Contract Drawings unless deviations to layout are approved on the Coordination Drawings. The Contract Drawings are diagrammatic in nature and are not welding fit-up documents. The Contractor is responsible for a complete installation. Refer to individual system specifications for requirements for coordination drawing submittals.

- D. Install at low points of gas piping and at the foot of each riser and each drip, a "T" fitting and six (6) inch long capped drip pocket of same size and riser or drip. Grade horizontal gas pipe to prevent traps. Pipe all green gas vents to the exterior as required by Code. Make all joints with graphite and oil and in accordance with National Fuel Gas Code requirements.
- E. Install unions and flanges where shown and on each side of all pieces of equipment and other similar items, and in such a manner that the unions can be readily disconnected. Do not place any union or flange in a location which will be inaccessible after completion of the project unless so shown on drawings or specified.
 - 1. Unions in steel pipe 2-1/2 inches and smaller, shall be 250 pound malleable iron, brass seat type. Use 150 pound forged steel flanges for piping three (3) inches and larger. Gaskets shall be 1/8 inch thick. Unions in copper pipe two (2) inches and smaller shall be wrought copper with red bronze ring nut. Use 150 pound ASME copper flanges for piping 2-1/2 inches and larger. Use dielectric unions or couplings where nonferrous metal is joined to ferrous metal.
- F. Use reducing fittings, eccentric where required to prevent pocketing of air and water or both, to make changes to pipe sizes.
- G. HVAC piping shall be installed plumb, level, and square with low point drains and high point vents. Sanitary waste and vent piping shall be sloped per code.
- H. Contractor shall fully coordinate the installation of all piping systems with all other trades including sheet metal, electrical, sprinkler, ceiling systems, etc.

3.03 JOINTS

- A. Steel Pipe Joints:
 - 1. Threaded Pipe Joints, 2" and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B1.20.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed. Align threads at point of assembly. Tighten joint with wrench. Do not use pipe or pipe fittings with threads that are damaged or corroded. Do not use pipe sections that have cracked or open welds. Comply with the provided pipe material classification requirements for allowance of threaded pipe within each service type. Threaded pipe will not be allowed for high temperature hot water service.
- B. Non-Ferrous Pipe Joints:
 - 1. Brazed and Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.31.0 – Standard Code for Pressure Piping, Power Piping and ANSI B9.1 – Standard Safety Code for Mechanical Refrigeration.
 - 2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emory cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
- C. Weld pipe joints in accordance with ASME Code for Building Services Piping, B31.9. Weld piping in accordance with recognized industry practice and as follows:
 - 1. Weld pipe joints only when ambient temperature is above 0 degree F.

2. Bevel pipe ends at a 37.5 degree angle, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
 3. Use pipe clamps or tack-weld joints with 1" long welds; 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
 4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
 5. Do not weld out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.
- D. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
- E. Hubless Cast-Iron Joints: Comply with coupling manufacturer's installation instructions.

3.04 WORKMANSHIP

- A. Cut pipes accurately to measurements established at structure. Install pipes without springing or forcing.
- B. Clear windows, doors, and other openings with all pipes and ductwork.
- C. Arrange pipes to permit expansion and contractions without misalignment or damage.
- D. During construction all openings in piping and equipment shall be closed with caps or plugs to keep out all foreign matter and to prevent leakage.
- E. All piping in finished spaces shall be run concealed unless otherwise indicated.

3.05 SLEEVES AND PLATES

- A. Sleeves shall be provided by the trade installing the pipes for which sleeves are to be used. The sleeves shall be carefully located in advance of the construction of walls and floors where new construction is involved. All cutting and patching necessary to set sleeves which are not placed prior to construction shall be the responsibility of the trade providing the sleeves.
- B. Sleeves shall be provided for all piping passing through all floor slabs and concrete, plaster, gypsum, or masonry wall construction.
- C. Where pipe motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Where sleeves pass insulated pipes, the sleeves shall be large enough to pass the pipe and the insulation. Check floor and wall construction to determine proper length for various locations; make actual lengths to suit the following:
 1. Terminate sleeves flush with wall.
 2. Terminate sleeves two (2) inches above finished floors.

- D. Submit for approval shop drawings showing size, type, and location of all sleeves and penetrations through poured concrete walls. See Architectural Drawings for extent and location of such walls.
- E. All pipe sleeves shall be constructed of Schedule 40 steel pipe unless otherwise indicated on the drawings.
- F. See drawings for additional sleeve requirements.
- G. Fasten sleeves securely in floors and walls so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials from being forced into space between pipe and sleeve during construction. Caulk the annular space with elastic caulk compound or as noted to make tight.
- H. Where watertight sleeves are indicated, provide Link Seal rubber seals, as manufactured by Thunderline Corporation, between pipes and sleeves, or provide sleeves as detailed.

3.06 FLOW METER FITTINGS

- A. Locate and arrange piping, both upstream and downstream of fitting to conform to the manufacturer's published literature.
- B. When water flow is measured in horizontal pipe, locate the connection nipples at or slightly above the horizontal centerline of the pipe to minimize the entrance of gases and impurities.
- C. Provide each fitting with an integral tab, or a metal tag on a stainless steel wire, extending outside the pipe covering, and stamp or print in a plainly visible position the manufacturer's name and address; the model number of the meter to which it is to be connected; the name, number or location of the equipment served; the specified rate of flow and the multiplier (including unity, where applicable) to be applied to the meter reading.
- D. Provide fittings with shutoff valves and with quick connecting hose fittings for portable meters.

3.07 TESTS

- A. The following tests shall be conducted by the Contractor and all piping shall be proven tight in the presence of the Architect or his representative. These tests shall be conducted before any insulation is installed and any insulation installed prior to tests shall be removed. Provide all equipment and labor required. Tests shall be at least four (4) hours in duration, after all piping has been proven tight. Piping may be tested in sections as approved by the Architect. Tests shall be as specified herein and a written test report shall be submitted to the Architect within two (2) days following each individual test. All test reports shall be included in the operation and maintenance manuals.
- B. The domestic water piping shall be hydrostatically tested to 150 pounds per square inch gauge (psig). All openings in the water piping shall be plugged; the system, or portion thereof, filled with water, and tested with a pump to a pressure of 150 pounds per square inch gauge (psig). Domestic water system piping shall be disinfected after tests in

accordance with 2009 International Plumbing Code and the regulations of the City of Columbia, University of South Carolina and the State of South Carolina Health Departments.

- C. The sanitary and miscellaneous drain systems shall be hydrostatically tested. Tests shall be as required by code and as a minimum shall comprise of the plugging of all openings in the lines, filling the system (or portion thereof), with water until all joints are proven tight. Piping shall be tested with a minimum head of ten (10) feet of water.
- D. All heating water piping shall be hydrostatically tested to 1-1/2 times the system working pressure or a minimum of 100 pounds per square inch gauge (psig), whichever is greater.
- E. Fire protection system shall be tested in accordance with applicable NFPA Standards. Refer to Division 15, Section "Fire Protection".
- F. Natural gas piping shall be tested to 1-1/2 times the system working pressure or a minimum of 50 pounds per square inch gauge (psig), whichever is greater. Test procedure shall meet the requirements of the National Fuel Gas Code and applicable local codes. Test procedure shall also satisfy the local code authority or enforcement agency.
- G. Laboratory gas piping (compressed air) shall be hydrostatically tested to 1-1/2 times the system working pressure or a minimum of 100 pounds per square inch gauge (psig), whichever is greater.
- H. All heating water piping systems shall be filled with water and thoroughly flushed clean of foreign matter after erection and before connection of equipment.
- I. After heating water systems have received their final filling, employ a qualified water testing laboratory to analyze the water and to provide proper treatment to bring the pH to a level between 6.5 and 7.25. Furnish three (3) certified copies of the test report to Architect. Include the test report data, water analysis, any treatment provided for initial treatment, and recommended type of continuous treatment to be provided for the make-up water to the systems.

3.08 STERILIZATION

- A. Domestic water system piping shall be disinfected in accordance with State of South Carolina Health Department requirements and Section 610 of the 2009 International Plumbing Code. A written test report shall be submitted to the Owner and Architect within five (5) days following the sterilization process and before occupancy is granted. All written reports shall be included in the operation and maintenance manuals.
- B. After final testing for leaks, all new domestic water lines shall be thoroughly flushed by Contractor to remove foreign material. Before placing the systems in service, Contractor shall engage a qualified water service Contractor to sterilize the new water lines. Sterilization shall include as a minimum the following procedure:
 - 1. Through a 3/4" hose connection in the main entering the building, pump in sufficient sodium hypochlorite to produce a free available chlorine residual of not less than 200 parts per million. The Contractor shall provide plumbing connections and power for pumping chlorine into the system.

2. Proceed upstream from the point of chlorine application opening all faucets and taps until chlorine is detected. Close faucets and taps when chlorine is evident.
3. When chlorinated water has been brought to every faucet and tap with a minimum concentration of 200 parts per million chlorine, retain this water in the system for three (3) hours. CAUTION: Over-concentration of chlorine and more than three (3) hours of retention may result in damage to piping system which shall be replaced by the Contractor at no additional cost.
4. At the end of the retention period, no less than 100 parts per million of chlorine shall be present at the extreme end of the system.
5. Proceed to open all faucets and taps and thoroughly flush all new lines until the chlorine residual in the water is less than 1.0 parts per million.
6. Obtain representative water samples, at least two (2), from the system for analysis by a recognized bacteriological laboratory.
7. If the samples tested for coliform organisms are negative, a letter and laboratory report shall be submitted by the water service organization to the Contractor, certifying successful completion of the sterilization.
8. If any samples tested indicate the presence of coliform organism, the entire sterilization procedure shall be repeated.

3.09 MOLD AND CONDENSATION PREVENTION

- A. Piping Systems: Cold piping systems (such as cold water) shall not be operated prior to insulation and vapor barrier installation in order to prevent condensation on the piping.
- B. Air Systems: Air handling systems shall not be operated at supply air temperatures below fifty (50) degrees F and all supply air ductwork shall be insulated prior to operation. Coils shall be insulated to prevent condensation when heating valve is closed. Air systems shall not be operated in portions of the building not yet fully enclosed, where systems can be exposed to warm, humid air conditions.
- C. Room thermostats shall not be set lower than sixty-eight (68) degrees F. Programmable thermostats shall be set to prevent lower temperature setting from the exterior of the thermostat by room occupants.
- D. Contractor shall notify the Architect immediately if signs of condensation or mold are discovered.

END OF SECTION 15100

SECTION 15200
MECHANICAL SYSTEMS INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, General Requirements and all other Specification Sections apply to the work specified in this section.

1.02 SCOPE

- A. Work included in this section is the thermal insulating done in the field, on the mechanical systems as specified herein.
- B. Work excluded in this Section are the following:
 - 1. Thermal building insulation.
 - 2. Sound absorbing duct lining.
- C. The requirements of Division 15, Section "Mechanical and Electrical General Provisions" shall apply to the work specified under this Section.

1.03 DEFINITIONS

- A. The k factor means the number of British thermal units of heat transmitted per (sq. ft.) (Fahrenheit temperature difference) through a material with flat, parallel sides one (1) inch apart. The material shall be tested and rated according to ASTM Test Method C-177.
- B. Unless otherwise specified, the term "concealed", as used in this specification, shall include all items hidden from normal sight. This includes items within furred spaces, pipe and duct shafts, above suspended ceilings and within return air plenums.
- C. Unless otherwise specified, the work "exposed" shall refer to all work other than "concealed" work.
- D. Unless otherwise specified, the term "exterior", as used in this specification, shall include all items being or situated outside. Items located within a crawl space shall be considered exterior.
- E. Unless otherwise specified, the term "conditioned", as used in this specification, shall be a heated or cooled space, or both, within a building and, where required, provided with humidification or dehumidification means, so as to be capable of maintaining a space condition falling within the comfort envelope set forth in ASHRAE 55.

1.04 SUBMITTALS

- A. Provide shop drawings in accordance with Division 15, Sections "Mechanical and Electrical General Provisions" and the General Requirements which shall include all insulation, jackets, finishes, corner beads, pump covers, etc. Shop drawings shall additionally describe each system or component to be insulated, insulation type and thickness, and method of installation.

- B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.06 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields.
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.07 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All insulating materials, including adhesives, jackets and coatings, to be used on the project must be delivered to the building in the manufacturer's unopened container and must bear the manufacturer's stamp or label giving name of manufacturer, brand and description of material.
- B. After the necessary tests have been conducted to prove the water and air systems tight, all piping, ductwork and equipment to be insulated shall be thoroughly cleaned and then covered. Insulation materials shall be the product of Owens Corning, CSG, Schuller or Armacell equal to the products specified herein.

2.02 TYPES OF INSULATION

- A. Type I - Pipe Insulation:
 - 1. Provide heavy density fiberglass pipe insulation with vapor barrier jacket. The k factor shall not be more than 0.23 at seventy-five (75) degrees Fahrenheit mean temperature. Insulation shall be equal to Johns Manville Micro-Lok meeting ASTM C 547 with FSK jacket.
- B. Type II - Pipe Insulation:
 - 1. Provide closed cell elastomeric tubular insulation with built-in vapor barrier. The k factor shall not be more than 0.25 at seventy-five (75) degrees Fahrenheit mean temperature. Insulation shall be equal to Armacell AP Armaflex or AP Armaflex SS. The use of polyethylene, polyolefin or engineered polymer insulation is prohibited.
- C. Type IV - Duct Insulation:
 - 1. Provide blanket type lightweight fiberglass duct insulation with vapor barrier facing. The compressed k-factor shall not exceed 0.27 at seventy-five (75) degrees Fahrenheit mean temperature and a minimum installed R-Value of 6.0 (hr•ft²•°F)/Btu. Insulation shall be equal to Johns Manville flexible fiberglass blanket Microlite XG Formaldehyde-free Type 100 meeting ASTM C 553 with factory-applied FSK facing.
- D. Type V - Duct and Equipment Insulation:
 - 1. Provide board type fiberglass insulation with vapor barrier facing. The k factor shall not exceed 0.22 at seventy-five (75) degrees Fahrenheit mean temperature, and the density shall not be less than 6.0 pounds per cubic foot (pcf). Insulation shall be equal to Johns Manville 817 Spin-Glas meeting ASTM C 612 with FSK facing.
- E. Type VII - Equipment or Exterior Duct Insulation:
 - 1. Provide flexible elastomeric thermal sheet insulation with built-in vapor barrier. The k factor shall not exceed 0.27 at seventy-five (75) degrees Fahrenheit mean temperature. Insulation shall be equal to Armacell AP Armaflex or AP Armaflex SA.
- F. Type XI – Fire Barrier Insulation
 - 1. Provide patented inorganic blanket encapsulated with scrim reinforced foil insulation with k-factor of 0.21 in a dual layer installation. Insulation shall be equal to 3M Fire Barrier Insulation 15A.

2.03 ADHESIVES, SEALERS AND COATINGS

- A. The vapor barrier on all insulation systems shall be maintained at all times. Any penetration into the vapor barrier shall be sealed vapor tight. All joints, fittings etc shall be sealed vapor tight.
- B. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated. They shall not corrode, soften or otherwise attach such material in either the wet or dry state and must be suitable for the service temperatures.
- C. Any cement, sealer or coating used shall be resistant to vermin and mold and shall be durable. It shall not discolor on aging; and where applied on the final surface of the insulation, it shall be light in color and be capable of being painted.
- D. For indoor applications:
 - 1. Use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Adhesives, coatings and compounds shall be equal to the following:
 - 1. Vapor barrier adhesive for sealing joints on pipe and duct insulation - Foster 85-75.
 - 2. Adhesive for installing canvas jackets - Foster 30-36.
 - 3. Adhesive for installing duct insulation - Foster 85-20 and 81-91.
 - 4. Adhesive for installing cellular-glass insulation - Foster Brand 81-84.
 - 5. Adhesive for installing elastomeric insulation - Foster Brand 85-75, Armaflex 520.
 - 6. Adhesive for installing mineral-fiber insulation - Foster Brand 85-60/85-70, Childers CP-127.
 - 7. Adhesive for ASJ, FSK and PVDC jackets - Foster Brand 85-50, Childers CP-82.
 - 8. Joint sealants for cellular-glass insulation - Foster Brand 30-45, Childers CP-76.
 - 9. FSK and metal jacket flashing sealants - Foster Brand 95-44, Childers CP-76.
 - 10. ASJ, vinyl, PVDC, and PVC jacket flashing sealants - Childers Brand CP-76
 - 11. Two coats of WB Armaflex finish or glass mesh with mastic for all Armaflex located outside.

2.04 FABRIC JACKETS

- A. All exposed piping, ductwork, and equipment in addition to the insulation jackets specified, shall be covered with an additional UL listed jacket of eight (8) ounce canvas. This shall be in addition to the insulation jackets specified.

2.05 FITTING AND VALVE COVERS

- A. Pipe fittings and valves shall be insulated with Zeston premold one (1) piece PVC insulated fitting cover and factory precut insulation. Fittings shall have edges of one (1) piece cover sealed with Zeston vapor barrier pressure sensitive tape.

2.06 METALLIC COMPONENTS

- A. Staples shall be outward clinching type of 304 or 316 stainless steel.
- B. Bands shall be galvanized steel, aluminum, brass, or nickel-copper alloy, of 3/4 inch nominal width. The band thickness, exclusive of coating, shall be not less than 0.005

inch for steel and nickel copper alloy, 0.007 inch for aluminum, and 0.01 inch for brass.

- C. Wire shall be fourteen (14) gauge, nickel-copper alloy or copper clad steel, or sixteen (16) gauge, soft annealed, galvanized steel.
- D. Wire netting used for exposed surfaces of insulation that is to be cement finished shall be twenty-two (22) gauge, one (1) inch galvanized mesh, with continuous twenty-six (26) gauge galvanized steel corner beads having 2-1/2 inch wings.
- E. Protect external corners on insulation of ducts and equipment exposed in occupied spaces by corner beads two (2) inches by two (2) inches, .016 inch thick aluminum adhered to heavy duty Kraft paper.
- F. All exterior piping and ductwork shall be additionally covered with a sixteen (16) mil embossed aluminum weatherproof jacket. Jacketing shall be ITW's Lock-On (Childers) type with an integrally bonded polysurlyn moisture retarder over the entire surface in contact with the insulation. Jackets are to be fabricated with continuous modified Pittsburg Z-lock on the longitudinal seam and each butted section of jacketing shall be joined and sealed with factory fabricated butt strap and sealant. Fittings shall be insulated and weatherproofed using similar materials.

2.07 INSULATION SCHEDULE:

- A. Insulation materials furnished must meet the minimum thickness requirements of National Voluntary Consensus Standard 90.1 (current accepted edition), "Energy Efficient Design of New Buildings" of the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE).

<u>Service</u>	<u>Type</u>	<u>Thickness</u>
B. Domestic Water Pipe (Hot, Cold, Tempered, & Recirc.,) Optional sizes 1" and smaller	I	1"
	I	1/2"
C. Domestic Water Piping Concealed in Walls and Cabinet Enclosures	II	1/2"
D. Heating Water Supply and Return		
1. 1 1/2" or smaller	I	1"
2. 2" and larger	I	2"
E. Air Conditioning Supply Air Ductwork		
1. Concealed	IV	2"
2. Exposed	V	2"
3. Diffuser Bodies	V	1"
F. Handicapped Lavatory Water and Sanitary Piping	II	1/2"

PART 3 - EXECUTION

3.01 GENERAL:

- A. All insulation shall be installed by skilled workmen regularly engaged in this type of work.
- B. Insulation shall be continuous at all hangers, hanger rods, supports, sleeves and openings. Continuous vapor barrier must be provided for all cold surfaces. Insulation shall be sealed where it terminates because of a valve, union, flange, etc.
- C. Provide continuous insulation and jacketing when passing thru interior wall, floor, and ceiling construction.
 - 1. At Through Penetration Firestops: Coordinate insulation densities with the requirements of approved firestop system being installed. Refer to Division 7, Section "Through Penetration Firestop Systems".
 - 2. Insulation densities required by approved firestop system may vary with the densities specified in this Section. When this occurs use the higher density insulation.
- D. Do not intermix different insulation materials on individual runs of piping or ductwork.
- E. Arrange to permit expansion and contraction without causing damage to insulation or surface.
- F. Actual insulation thickness must be at least equal to the minimum specified in the schedule at all locations including supports in contact with cold surfaces. Where the manufacturer's rated or nominal thickness is less than the minimum specified, a thicker material or more layers will be requested so that the stated minimum thickness will be attained or exceeded.
- G. Install insulation materials in a first class manner with smooth and even surfaces. Scrap pieces of insulation shall not be used where a full length section will fit.
- H. Unless otherwise specified herein, the application of all insulation materials, accessories and finishes shall be in accordance with the manufacturer's published recommendations.
- I. Insulation materials shall not be applied until all surfaces to be covered are clean and dry; all foreign material, such as rust, scale, dirt, etc., has been removed, and where specified, surfaces have been painted. Insulation shall be clean and dry when installed and during the application of any finish. The insulation on pipe fittings, valves and pipe joints shall not be installed before the piping is tested and approved.
- J. Omit insulation of the following unless directed otherwise.
 - 1. Brass or copper pipe specified to be chrome plated.
 - 2. Traps and pressure reducing valves, relief piping from safety valves, and unions, flanges and expansion joints on heating water system.
 - 3. All fire protection piping.
 - 4. Existing adjacent insulation.
 - 5. ASME stamps, manufacturer's nameplates.
 - 6. Access plates on fan housings.
 - 7. Cleanouts or handholes.
 - 8. Components within factory preinsulated HVAC equipment.
 - 9. Factory - preinsulated flexible ductwork and HVAC equipment.
 - 10. Vibration - isolating connections.

- K. Replace and repair insulation disturbed by testing and balancing procedures required under Division 15, Section "Testing and Balancing".

3.02 PIPE INSULATION

- A. High density pipe saddles shall be provided at all points of support as hereinbefore specified.
- B. Insulate all valves and strainers. Use premolded covers and factory precut insulation where applicable. Unions and flanges shall not be insulated except on cold services.
- C. Insulate valves up to and including bonnets, except for cold water valves which shall be insulated over packing nuts in a manner to permit removal for adjustment and repacking.
- D. Insulate strainers in a manner to permit removal of the basket without disturbing the insulation of the strainer. Obtain (Architect's/Engineer's) approval of installation method.
- E. Insulate all exposed piping under lavatories and sinks with a white, fitted/molded antimicrobial undersink pipe cover equal to Truebro Lav Guard 2. Cover shall have internal, E-Z Tear-To-Fit trim feature for square, clean trimming (internal ribs) and built-in, concealed E-Z Grip fasteners (no cable-tie fasteners allowed).
- F. Application - Type I Insulation:
 - 1. Insulate all pipes in a neat and workmanlike manner. Seal all longitudinal laps of jackets and staple every six (6) inches. Where the piping operates below ambient temperature, the staples shall be coated with vapor barrier adhesive. All butt joints shall be wrapped with a three (3) inch minimum wide strip of jacketing material securely sealed in place.
 - 2. Insulate valves and fittings with pre-cut blanket type fiberglass insulation and PVC covers as specified. Insulation shall be of the same thickness as that on adjoining pipe. The ends of the insulation shall be tucked snugly into the throat of the fitting and the edges adjacent to the pipe covering tufted and tucked, fully insulating the pipe fitting. The one (1) piece PVC fitting cover shall then be secured by stapling, tack fastening, banding or taping the ends to the adjacent pipe covering. Chilled water supply and return piping and cold water systems piping shall be insulated as above and have all seam edges of the cover sealed with ZESTON vapor barrier adhesive mastic. The circumferential edges of cover shall be wrapped with ZESTON vapor barrier pressure sensitive color matching tape. The tape shall extend over the adjacent pipe insulation and overlap itself at least two (2) inches on the downward side.
 - 3. Where fittings are operating above ambient they may, in lieu of the proceeding paragraph, be covered with a three (3) hour, hydraulic setting, combination insulating and finishing cement having k factor not greater than 0.87 at a mean temperature of 200 degrees Fahrenheit. The thickness of this cement shall be such that the surface is substantially flush with the pipe covering. Where the insulation terminates at a fitting that is not covered, the end of the insulation shall be beveled off with this same cement. All fittings insulated in this manner shall be covered by a fabric jacket as specified, which shall be cemented down with lagging adhesive.
 - 4. Where expansion joints are required to be insulated, they shall be covered with readily removable sections of insulation of same composition and thickness as provided for adjacent piping.
- G. Application - Type II Insulation:

1. The material shall be slit lengthwise to permit installation or slipped over pipe before connections are made. Self-seal insulation may also be installed.
2. All joints and seams must be thoroughly bonded, both mechanically and hermetically, by the adhesive recommended by the insulation manufacturer. Also, the manufacturer's recommendations shall be followed as to the adhesive to use where the insulation needs bonding to metal or other material used for any surface treatment where a finish coat of paint is required.
3. All penetrations of the insulation must be thoroughly sealed so that the insulation itself will form a complete vapor barrier. Insulation shall run continuous at hangers and supports to form a complete vapor barrier. Wherever the insulation terminates, the edges shall be sealed to the metal.
4. Insulation shall be extended to stop valves under plumbing fixtures and/or within cabinets. Water and waste lines serving handicap plumbing fixtures shall be insulated and painted to match adjacent surface.

3.03 DUCT INSULATION

- A. Provide accessories as required to prevent distortion and sagging of duct insulation. Provide welded pins, adhesive clips and wire ties as recommended by the manufacturer and directed by the (Architect/Engineer).
- B. Insulation shall cover all standing seams and metal surfaces. Provide corner beading on all exposed ducts.
- C. Staples shall be sealed to maintain vapor barrier.
- D. Neatly cut insulation at dampers, temperature control sensors, and controllers. Butter exposed edges with approved mastic coating.
- E. Application - Type IV Insulation:
 1. Insulation shall be cut slightly longer than perimeter of duct to insure full thickness at corners. All insulation shall be applied with edges tightly stitched with staples. Provide vapor barrier mastic sealer at seam. The insulation shall be additionally secured to the bottom of all square ducts eighteen (18) inches or wider by means of welded pins and speed clips. The protruding ends of the pins shall be cut off flush after the speed clips have been applied. The vapor barrier facing shall be thoroughly sealed where the pins have pierced through with a tape of the same material by applying a vapor barrier adhesive to both surfaces as recommended by the manufacturer.
 2. All hanger rods, support members, joints and penetrations of the vapor barrier shall be sealed with full thickness insulation and vapor barrier mastic sealer. All cuts or tears shall be sealed with strips of the aluminum foil tape and vapor barrier adhesive.
- F. Application - Type V Insulation:
 1. All insulation shall be applied with edges tightly butted. Insulation shall be impaled on pins welded to the duct and secured with speed clips. Spacing of pins shall be as required to hold insulation firmly in place but not less than one (1) pin per square foot, and pins shall be placed within three (3) inches of each corner of insulation. All joints and penetrations of the vapor barrier shall be sealed with a three (3) inch wide strip of the same material, applied with Foster 85-75, or to both surfaces as recommended by the adhesive and vapor barrier mastic sealer manufacturer.
 2. If, through space or size restriction or other causes, the welded pin method is impossible, the insulation shall be secured to the duct with adhesive such as

Foster 81-91 or equal. The adhesive shall cover the entire surface of the sheet metal when applied to underside of horizontal duct but may be applied in strips or spots for application to top and sides with a minimum of fifty (50) percent coverage.

3.04 FABRIC JACKET

- A. Apply jacket to insulated breeching and equipment. Onto the dry cement surface apply a brush coat of Foster Sealfas 30-36 at the rate of sixty (60) to seventy (70) square feet per gallon. Embed into wet coating the canvas jacket, smoothed out to avoid wrinkles and overlap all seams a minimum of two (2) inches. Apply a second brush coat of Sealfas 30-36 to the entire surface at the rate of sixty (60) to seventy (70) square feet per gallon.
- B. Where jacket is to be installed on piping, apply Foster 30-36 adhesive to the canvas jacket by dipping to completely wet and saturate the canvas. While wet, position on the pipe insulation and pull tight, bond, lap and smooth out all wrinkles. Finish with a sealer coat of adhesive.

END OF SECTION 15200

SECTION 15300

PLUMBING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, General Requirements and all other Specification Sections apply to the work specified in this section.

1.02 SCOPE

- A. This section includes the soil, waste, drain, vent and domestic water systems from their source of supply or point of disposal to and including their connection to equipment and fixtures.
- B. The requirements of Division 15, Sections "Mechanical and Electrical General Provisions" shall apply to all work specified under this section. Sterilization shall comply with Section 610 of the 2009 International Plumbing Code.

1.03 CODES

- A. All plumbing work shall comply with the 2009 International Plumbing Code and the regulations of the City of Columbia and the State of South Carolina Health Departments. Obtain all approvals before starting plumbing work. Request all inspections during the course of work.
- B. All residential type faucets, electric water coolers and drinking fountains shall meet the requirements of NSF Standard 61, Section 9.

1.04 QUALITY ASSURANCE

- A. All building domestic and service water heating systems shall meet the mandatory provisions for performance as documented in ASHRAE 90.1-2007 Section 7.4. The minimum performance requirements listed in ASHRAE 90.1-2007 Table 7.8 must be met.

1.05 SERVICES

- A. Contractor shall arrange for and coordinate water, gas, foundation drainage, storm, and sanitary services. Contractor shall perform all work within the building.
- B. Contractor shall arrange and pay for all permits required for service connections.

1.06 EQUIPMENT CONNECTIONS

- A. Provide all plumbing connections required by equipment which is provided on this project. Certain items of equipment shall be provided under this section and certain items will be furnished and set under other sections of the specifications. In all cases, provide valved

water supplies, waste and vent lines, and, unless noted otherwise, make final connections after equipment is in place.

PART 2 - PRODUCTS

2.01 PIPE, VALVES AND FITTINGS

- A. Provide materials as hereinbefore specified in Division 15, Section "Basic Materials and Methods". All floor, wall and ceiling penetrations for piping shall be sealed with appropriate sealant.

2.02 CLEANOUTS

- A. Cleanouts shall be placed in piping throughout the building, where noted and where required by code and at not greater than seventy five (75) foot intervals. Cleanouts on piping below floors, at ends of runs and changes of direction of piping shall consist of Y branches, the full size of pipes to which they are connected with cleanout plugs and covers as listed below or as detailed. Extend cleanouts on concealed piping to finished walls, floors and grade. Cleanouts shall be Josam, Zurn or J.R. Smith equal to Josam numbers indicated below.
- B. At base of vertical piping and in walls - Series 58910-Z cleanout tee with countersunk bronze threaded plug. Where risers are concealed, provide Series 58760 cleanout tee with plug and nickel satin access cover and frame.
- C. Cleanouts on exposed and above ceiling horizontal piping shall be Series 58900 with bronze threaded plug.
- D. Cleanouts in waterproofed equipment rooms - Series 58460A with bronze plug.

2.03 PLUMBING FIXTURES

- A. Provide all plumbing fixtures indicated on the drawings and as specified herein. All exposed metal parts of all fixtures, including all trim and fittings, shall be brass, chromium plated. Each hot and cold water connection to each fixture shall be provided with a stop valve and all nipples shall be chrome plated red brass. Provide backflow devices on all faucets and fittings requiring same. Devices may be inline type when not provided integral with the faucet. All faucet handles, where possible, shall have color coded "indexes" identifying the service used. All "serrated" or slip hose connection spout outlets shall have Allen wrench operated volume controls to control "splashing" of water as it hits sink bottoms. Water supplies for handicapped lavatories and sinks shall be insulated. Waste line for handicapped lavatories and sinks shall be offset and insulated. Refer to Division 15, Section "Mechanical Insulation" for insulation type and thickness.
- B. The Contractor shall provide metal supports necessary to adequately and substantially hang and set all fixtures subject to the approval of the Architect. No wood grounds, wood plugs, or expansion bolts shall be permitted for fixture support. Provide carriers where specified below and as required to hang fixtures.
- C. Insulate all exposed piping under lavatories and sinks with a white, fitted/molded antimicrobial undersink pipe cover equal to Truebro Lav Guard 2. Cover shall have

internal, E-Z Tear-To-Fit trim feature for square, clean trimming (internal ribs) and built-in, concealed E-Z Grip fasteners (no cable-tie fasteners allowed).

- D. Unless otherwise specified, plumbing fixtures shall be American Standard, Crane or Kohler, equal to American Standard or other manufacturer of the types listed below. Flush valves shall be Zurn, Delany or Cambridge Brass, equal to Zurn of the types listed below.

1. P-1 Lab Sink:

Fixture: Refer to Architectural drawings

Water Faucet: Refer to Architectural drawings.

Strainer: Enfield No. W301 with removeable plug and No. W151 female adaptor

Trap: Enfield No. W1021 p-trap

Supplies and Stops: Chicago Faucet No. 1006

Remarks: Acid resistant drain pipe and fittings. Contractor shall verify and coordinate rough-in locations.

2. P-2 Emergency Eyewash:

Fixture: Refer to Architectural drawings

Remarks: Emergency fixture shall be in compliance with ANSI Z358.1-2004.

3. P-3 Emergency Eyewash/Shower:

Fixture: Refer to Architectural drawings

Remarks: Emergency fixture shall be in compliance with ANSI Z358.1-2004.

4. P-4 Refrigerator Ice Maker Connection:

Fixture: IPS Guy Gray Model MIB1HA ice maker outlet box

Remarks: 20 gauge box and 20 gauge faceplate, white powder coat on cold rolled steel finish, 1/4 turn ball valve with 1/2" sweat connection and hammer arrester. Provide plumbing connections in accordance with manufacturer's written instructions.

5. FH-1 Fume Hood Sink:

Fixture: Refer to Architectural drawings

Water Faucet: Refer to Architectural drawings.

Strainer: Refer to Architectural drawings.

Trap: Enfield No. W1021 p-trap

Supplies and Stops: Chicago Faucet No. 1006

Remarks: Acid resistant drain pipe and fittings. Contractor shall verify and coordinate rough-in locations

2.04 NATURAL GAS VALVE CABINET

- A. Valve cabinet shall be recessed type and consist of the following components: A steel valve box housing single shut-off ball valves with tube extensions, an aluminum frame, and a pull-out removable window. Boxes shall be provided to accommodate size and type of gas valves as indicated on Contract Drawings. No cabinet shall serve more than one laboratory.
- B. The valve box shall be constructed of 18 gauge steel complete with a white epoxy finish and provided with (2) two galvanized steel brackets for the purpose of mounting to structural support. The assembly trim shall accommodate various finished wall thickness of up to one inch and be field adjustable.
- C. The doorframe assembly shall be constructed of anodized aluminum mounted to the back box assembly by screws as provided and shall have a sliding removable front consisting of an opaque door with a pre-mounted pullout ring and smoke colored window. Access to the zone shut-off valves shall be by merely pulling the ring assembly to remove the window from the doorframe. The window shall be capable of re-installation without the use of tools and only after the valve handles have been returned to the open position. The window shall be labeled "Caution – Laboratory Gas Shut-Off Valve - Close Only in Emergency".
- D. Mount engraved rigid plastic identification plate on wall above cabinet. Color code identification plate to match gas identification color. Identification plate must be clearly visible at all times. Provide inscriptions on plate to read in substance: "NATURAL GAS VALVE CONTROL TO ROOM [identify room number]."
- E. Valves shall be same as specified herein for line shut-off valves except locking devices are not required.
- F. Each valve shall be supplied with an identification bracket bolted directly onto the valve body for the purpose of applying an approved identification label. A package of labels shall be supplied with each valve box assembly for application by the installer.
- G. All valves shall be securely attached to the box and provided with pipe stub extensions of sufficient length to protrude beyond the sides of the box for connection to system piping. Suitable plugs or caps shall be installed by the manufacturer to prevent contamination of the assembly prior to installation.
- H. For installation in 2-hr fire rated walls, provide fire putty around the box and provide a U.L. Listed intumescent pad to the back of the valve box. Valve box assembly, including fire putty and intumescent pad, shall not be covered up until inspected and approved by Architect.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPING

A. Interior Drainage Systems:

1. Soil, waste, vent, and drain piping for sanitary drainage, shall be of the sizes noted, and shall be run as indicated. Pipes must be run in straight lines and have a uniform grade between elevations noted. No branch drain shall have a grade less than that indicated for the main drain to which it is connected. Where elevations are not given, horizontal pipes shall have a uniform grade of 1/4 inch per foot where possible but in no case less than 1/8 inch per foot and shall be installed to the inverts shown. All piping shall be adequately supported as specified in Division 15, Section "Mechanical and Electrical General Provisions". All main vertical soil and waste stacks shall be extended as vents full size to approximately 18 inches above the roof of the building. Two (2) or more vent lines shall be connected together where practicable and extended as one (1) pipe through the roof. Vent pipes in roof spaces shall be run as close as possible to the underside of the roof without forming traps in pipes. Vent pipes may be connected to other vent pipes or to main vent stacks provided the connections are at least four (4) feet above the floor on which the fixtures are located so that no vent pipe can be used as a waste. Openings in roof for vent pipes shall be flashed and made watertight. Use vent stack flashing sleeves where applicable. Handicapped plumbing fixtures shall be rough-in to suit the specific mounting of the fixture. Waste lines shall be offset for lavatories and sinks to accommodate wheelchair type strainers and traps shall be insulated.
2. Changes in direction shall be made by appropriate use of forty-five (45) degree wyes, 1/2 wyes, or long sweep 1/4, 1/6, 1/8, or 1/16 bends. Sanitary tees or short quarter bends may be used on vertical stacks of drainage lines where change in direction of flow is from horizontal to vertical; except use long turn tee wyes when two (2) fixtures have common drain. Straight tees, elbows, and crosses may be used on vent lines. Make no change in direction of flow greater than ninety (90) degrees. Where different sizes of drainage pipes or pipes and fittings are to be connected, use standard increasers and reducers of proper size. Reduction of size in horizontal drainage piping in direction of flow is prohibited.
3. Drilling and tapping of drains, soil, waste, or vent piping, and use of saddle hubs and bands are prohibited.
4. Connect piping to fixtures or equipment by couplings or unions so that devices may be replaced with no disturbance to piping.

B. Water Piping Systems:

1. Water piping shall be complete from service connection to all fixtures, equipment, outlets, etc. Sizes of pipes shall be shown or as specified.
2. Chromium plated piping shall be threaded and made up carefully, and not more than one (1) full turn of thread shall be exposed beyond any fitting.
3. Ends of pipes or tubing and recesses of fittings to be bronzed or soldered shall be thoroughly cleaned. Joints shall be assembled without binding. Brazing material or solder shall penetrate fully and shall fill the joint completely.
4. All brass and copper pipe and tubing shall be free from cuts, dents or other surface damage at the time of final inspection. Damaged pipe or tubing shall be removed and replaced with new pipe or tubing.
5. Horizontal runs of brass and copper pipe and tubing over fifty (50) feet in length shall be anchored to wall or floor construction. Anchors shall be located near the midpoints of the runs so as to force the expansion equally to the ends or in a direction where expansion can take place without excessive strain. Swing joints, offsets, expansion joints, etc., shall be provided where necessary to accommodate

expansion of piping, which will be approximately two (2) inches in 100 feet of brass or copper hot water piping.

6. Where non-ferrous metal piping and zinc-coated metal piping are jointed, dielectric (insulating) couplings, fittings or unions shall be provided.
7. Where pipe sizes shown or specified differ from the connection sizes of meters, pumps, fixtures, outlets, etc., reducing fittings shall be installed.
8. Water supplies for wall hung lavatories shall be roughed in as high as possible and still permit connections to the faucet. Water supplies shall be insulated for handicapped fixtures and rough-in shall be on accessible side of fixture for flush valves and flush handles.

3.02 CLEANOUTS

- A. Where soil, waste, or roof drainage risers connect to a sewer or drain extending from the building above the lowest floor, the fitting at the base of each stack or downspout shall be a sanitary tee or a combination Y and 1/8 bend with cleanout plug in the end of the run of the main.
- B. Each vertical soil, waste, and vent pipe and each downspout and roof drainage pipe which connects to horizontal drain piping below ground shall be fitted with a test tee above the lowest floor or ground. Where accessible, test tee may be installed in the horizontal pipe at the base of the riser.

3.03 TRAPS

- A. Each fixture and piece of equipment connected to the sanitary system shall be equipped with a trap. Provide traps for storm water lines where required by code. Each trap shall be placed as close to the fixture as possible and no fixture shall be double trapped. All traps on bell and spigot pipe shall be extra heavy cast iron and all traps on threaded pipe shall be galvanized cast iron recessed drainage type.

END OF SECTION 15300

SECTION 15400
FIRE PROTECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this section.

1.02 GENERAL DESCRIPTION

- A. Provide all materials, equipment, and labor, including all required drilling, for the modifications of the existing supervised automatic sprinkler system serving the School of Public Health Lab 305 renovation project within the 3rd floor of the Arnold School of Public Health.
- B. The sprinkler system(s) shall be supplied from the existing automatic fire pump and served from existing sprinkler zone assemblies. Any new waterflow switches and valve tamper shall be furnished and installed under this contract.
- C. The piping for each system shall be sized in accordance with hydraulic calculations to comply with the hydraulic requirements found in NFPA Standard 13-2007, and the Owner's Insurance Underwriter Standards.
- D. All core drilling of floors and walls shall be included under this contract. All electrical work related to this contract shall be provided under Division 16, Electrical.
- E. Secure all required approvals and inspections from City of Columbia, University of South Carolina and the State of South Carolina.
- F. Submit all required drawings and calculations.
- G. All work must be performed in accordance with these specifications and other related documents.
- H. Contractors shall field verify all existing conditions and be solely responsible for design and installation of the system(s) in accordance with the specifications.

1.03 INTENT OF SPECIFICATIONS

- A. The work performed shall be complete in every respect. Each system that has been installed or modified shall be complete in accordance with the applicable codes, standards, University's Insurance Underwriter requirements, Manufacturer's recommendations and Underwriters Laboratories, Inc. (UL) listings.
- B. Upon completion of this work, the Owner shall be provided with the following:
 - 1. Complete information and record drawings describing and depicting all systems as installed, including all information necessary for maintaining, troubleshooting, and expanding the systems.

2. Complete documentation of system testing.
3. Certify that each system installed or modified has been inspected and tested, has been installed or modified entirely in accordance with the applicable code, standards, Manufacturer's recommendations and UL listings, and is in proper working order. Contractor shall use "Contractor's Material and Test Certificates for Aboveground Piping and Underground Piping".

1.04 SCOPE

- A. The requirements of Division 15, Sections "Mechanical and Electrical General Provisions" and "Basic Materials and Methods" shall apply to work specified under this section.
- B. The area of work shall be fully sprinklered throughout in accordance with NFPA Standard 13-2007. Provide new automatic sprinkler protection and modifications to the existing fire protection piping in accordance with NFPA Standard 13-2007, except as made more stringent herein.
- C. Modify the existing fire protection system as required and as indicated on the drawings.
- D. Provide sprinkler system supervisory switches and waterflow indicators as required. All electrical work related shall be provided under Division 16, ELECTRICAL.
- E. Provide all required drains and inspector test connections, connected and ready to use.
- F. Prepare and submit shop drawings, record drawings, and other submittals required herein.
- G. Flush and test the sprinkler systems.
- H. Guarantee all new equipment, systems, and modifications during installation for a one (1) year period after final acceptance of the work by the Architect.
- I. Provide all required drilling for sprinkler and water supply pipe.
- J. Pipe sizes shall be as required by NFPA Standards but in no case less than those shown on the drawings. For the Contractor's information, the Fire Sprinkler System Specification Sheet is hereinafter included.
- K. Sprinkler heads shall be provided as required by NFPA Standards. Sprinkler head locations shall be coordinated with the Architectural reflected ceiling plans. Sprinkler shop drawings shall indicate the ceiling grid, lighting fixtures, air devices, etc. Generally, sprinkler heads shall be centered in tiles, plus or minus two (2) inches from tile centerlines.
- L. Provide specialty heads, shut-off valves with tamper switches on sprinkler pipes serving special use areas, such as elevator shafts, elevator machine rooms, electric rooms, etc. as required by local code and the authority having jurisdiction.
- M. All requirements of the State of South Carolina, the State Fire Marshal's Office, and the Local/County Fire Prevention Bureaus shall apply to this specification. Provide systems according to NFPA 13-2007 and State Engineer Manual Section 5.13.

- N. The sprinkler contractor shall provide all required construction coordination as specified in Division 15, Section "Mechanical and Electrical General Provisions". All coordination issues and conflicts shall be resolved by the Contractor(s) at no additional cost to the Owner. Resolutions may include, but not be limited to, moving pipe mains, sprinkler heads, drain and test piping, valves, etc.

1.05 RELATED WORK SPECIFIED ELSEWHERE

- A. Provide and install all piping as required by NFPA Standards and approved plans in accordance with all applicable standards. Piping installation and hangers shall be in accordance with Division 15, Section "Basic Materials and Methods", unless specified otherwise in this Section.

1.06 WORKING CONDITIONS

- A. The Contractor shall be responsible for attending a pre-construction meeting and construction coordination meetings with the Owner and Architect.
- B. The existing standpipe system or any building fire protection component shall not be taken out of service without the prior written approval of the Owner and notification of the City of Columbia and University of South Carolina Fire Department and Fire Marshal. When required to be removed from service and after approval from the City of Columbia and the University of South Carolina Fire Department and Fire Marshal, the standpipe system shall not be out-of-service for more than four (4) hours.

1.07 CODES, STANDARDS, ORDINANCES, AND PERMITS

- A. All work shall conform to the requirements of the applicable portions of the latest editions of the National Fire Protection Association (NFPA) Standards and Recommended Practices listed herein:
 - 1. NFPA 13 - "Standard for the Installation of Sprinkler Systems", 2007 Edition
 - 2. NFPA 14 - "Standard for the Installation of Standpipe and Hose Systems", 2007 Edition
 - 3. NFPA 24 - "Recommended Practice for the Installation of Private Fire Service Mains and their Appurtenances", 2007 Edition
 - 4. NFPA 25 - "Recommended Practice for the Inspection, Testing, and Maintenance of Sprinkler Systems", 2008 Edition
 - 5. NFPA 70 - "National Electrical Code", 2005 Edition
 - 6. NFPA 72 - "Standard for the Installation, Maintenance, and Use of Local Protective Signaling Systems", 2007 Edition
 - 7. NFPA 101 - "Standard Code for Life Safety from Fire in Buildings and Structures"
 - 8. State Fire Marshall of SC Guide for Water Based Extinguishing Systems, 2002
 - 9. The Fire Protection Sprinkler Systems Act. SC Code of Laws Title 40 Chapter 10.
- B. All work and materials shall conform to all Federal, State, and local codes and regulations governing this installation including the current editions of the International Building and Fire Prevention Codes, and the International Building Code, as modified or interpreted by the State of South Carolina to permit use of current NFPA Standards.
- C. All designs, work, and materials shall conform to the Owner's Insurance Underwriter guidelines and standards.

- D. If there is a conflict between the referenced NFPA Standards, Federal, State or local codes, Insurance Underwriter requirements, and this specification, it shall be the Contractor's responsibility to bring the conflict to the attention of the Architect for resolution.
- E. All devices, systems, equipment, and materials furnished and installed shall be of types or models approved by City of Columbia, the State of South Carolina and Underwriters Laboratories for use in systems and occupancies of this type.

1.08 QUALIFICATIONS OF CONTRACTOR

- A. The Contractor shall hold all licenses and obtain all permits necessary to perform work of this type.
- B. The Contractor shall have at least five (5) years of experience in installation of systems of this type and be familiar with all applicable local, State, and Federal laws and regulations.
- C. The Contractor shall be regularly engaged in the design, installation, testing, and servicing of automatic sprinkler systems.
- D. The Contractor shall provide a job site supervisor who shall be present at all times that work is actively in progress.

1.09 SUBMITTALS

- A. General:
 - 1. The Owner and Architect or their representative(s) will review all submittals for conformance to these specifications.
 - 2. If the Contractor's submittals, upon review by the Owner or Architect do not conform to the requirements of these specifications, the Contractor shall be required to resubmit with modifications, within seven (7) working days of receipt of the Architect's notification to the Contractor. The contractor shall be responsible for the extra expenses for subsequent review of rejected submittals necessitated by the Contractor's failure to provide a complete and accurate submittal meeting the requirements of the specifications. Such extra fees shall be deducted from payments to the Contractor.
 - 3. If the Contractor's submittals conform to the requirements of these specifications, the Architect will issue a Certificate of Compliance. Subsequently, the Fire Sprinkler System Specification Sheet and Certificate of Compliance will accompany the shop drawing submittal to the State Fire Marshal for review and approval.
- B. Hydraulic Calculations
 - 1. The contractor shall submit hydraulic calculations based on the information provided on the Fire Sprinkler Specification Sheet (FSSS).
- C. Shop Drawings:
 - 1. In accordance with South Carolina State Fire Marshal policy memo 3-008, the shop drawing transmittal shall include the following data:
 - a. Square footage of the largest floor.
 - b. Number of stories.
 - c. Contact information for the General Contractor including contact name, company name and mailing address.

2. The Contractor shall submit sufficient quantity of AutoCAD prepared shop drawings, catalog cuts, and hydraulic calculations to the Architect for approval. Shop drawings shall show light fixtures, ducts, mechanical equipment, structural elements, and all other items which may affect the layout of sprinkler heads and piping. Plans showing sprinkler work shall be not less than 1/8 inch per foot.
 - a. The AutoCAD prepared shop drawings shall be consistent and compatible with AutoCAD format being used by the Architect.
 - b. Shop drawings shall show all of the information required by NFPA Standard 13-2007 for working plans and shall include drawings showing the location of all equipment, controls, piping, valves, and drains.
 - c. Shop drawings shall show locations of pipe supports, seismic braces and end-of-line pipe restraints in plan view. Shop drawings shall also detail pipe supports, seismic braces and end-of-line restraints.
 - d. The shop drawings shall indicate all areas to be sprinklered and type of hazard, locations and sizes of water supply pipe, major drains and tests, alarm check valve and water motor gong, risers and other main piping and valves, and the location of fire department connections. Complete riser diagrams shall also be submitted. The drawings shall locate by dimension all fire protection piping and sprinkler heads.
 - e. Shop drawings shall be provided in sufficient detail to show compliance with the Standards referenced on the Fire Sprinkler System Specification Sheet (FSSSS) to the degree required by the regulations of the State Fire Marshal.
 - f. Provide all electrical wiring diagrams of flow switches, alarms, and supervising equipment for coordination under Division 16, Electrical. All wiring shall be provided under Division 16, Electrical.
- D. Samples:
1. Submit to Architect one sample of each type of sprinkler head to be provided. Samples shall be retained by the Engineer.
- E. Operation and Maintenance Manual
1. Refer to Division 15, Section "Mechanical and Electrical General Provisions" for additional requirements of operation and maintenance manuals. The Contractor shall provide the Architect with a loose-leaf manual containing the following data:
 - a. A detailed description of the new sprinkler system(s), including the provisions for system expansion.
 - b. A detailed description of routine maintenance required or recommended including a maintenance schedule and detailed maintenance instructions for each type of device installed.
 - c. Manufacturer's data sheets and installation manuals/instructions for all equipment installed.
 - d. A list of recommended spare parts.
 - e. Service directory for all components in the system.
 - f. Eleven (11) inches by seventeen (17) inches reduced copies of the as-built drawings.
 2. Within thirty (30) days of authorization to proceed, the Contractor shall submit to the Architect four (4) copies of the draft manual for approval (excluding as-built drawings).
 3. Within thirty (30) days of the completion of the work, six (6) copies of the approved manual with as-built drawings shall be delivered to the Owner.
- F. Record Drawings:
1. The Contractor shall provide and maintain on the site an up-to-date record set of approved shop drawing prints which shall be marked to show each and every change made to the sprinkler system from the original approved shop drawings.

This shall not be construed as authorization to deviate from or make changes to the shop drawings approved without written instruction in each case. This set of drawings shall be used only as a record set.

2. Upon completion of the work, the record set of prints shall be used to prepare complete, accurate final record drawings (CAD) reflecting any and all changes and deviations made to the sprinkler system.
3. Upon completion of the work, one set of black line record drawings shall be submitted to the Architect for review and approval.
4. Upon approval of the black line record drawings, four (4) additional sets of black line record drawings and one set of unprotected AutoCAD 2006 disks shall be delivered to the Owner.

G. Drawing Approval by Code Authority:

1. The Contractor's shop drawings are subject to approval by the Authority Having Jurisdiction (AHJ).

1.010 GUARANTEE PERIOD

- A. The Contractor shall guarantee all materials and workmanship for a period of one (1) year beginning with the date of final acceptance by the Owner and Architect. The Contractor shall be responsible during the design, installation, testing, and guarantee periods for any damage caused by him or his subcontractors or by defects in his or his subcontractors' work, materials, or equipment.
- B. During the warranty period, the Contractor shall provide emergency repair service for the sprinkler system within eight (8) hours of a request by the Owner for such service. This service shall be provided on a twenty-four (24) hour per day, seven (7) days per week basis.

1.011 SPARE PARTS AND SPECIAL TOOLS

- A. Spare Parts: Contractor shall install two (2) metal sprinkler cabinets containing a minimum total of four (4) sprinklers, of each type, finish, and temperature rating used on the project. Contractor shall provide two (2) sets of sprinkler wrenches compatible with each type of sprinkler provided. The cabinet shall be installed at the locations approved by the Owner.
- B. The Contractor shall supply the Owner two (2) complete sets of special tools and equipment necessary to perform routine maintenance on the sprinkler systems.

1.012 FINAL APPROVAL AND ACCEPTANCE

- A. Final approval and acceptance of the work will be given when the following occurs:
 1. The complete sprinkler system(s) have been inspected, tested, and approved by the Authority Having Jurisdiction (AHJ).
 2. Required submittals, system operation and maintenance manuals, record drawings, spare parts, special tools, and training have been provided to, reviewed, and accepted by the Owner and Architect.

PART 2 - PRODUCTS

2.01 DESIGN CRITERIA

- A. Hydraulically calculated wet-pipe sprinkler systems shall be installed, designed to produce uniform discharge over the design area, and shall conform to the hydraulic requirements of NFPA Standard 13-2007, the FSSS and to the requirements as specified herein. The following density requirements apply:
 - 1. Light Hazard areas, the density required must be calculated from the Light Hazard density curve in NFPA Standard 13-2007, with a minimum area of application of 1,500 square feet. The suggested density is 0.10 gpm per square foot over the hydraulically most remote 1,500 square feet in areas including, but not limited to, administration, public areas, toilet rooms, corridors and lobbies.
 - 2. Ordinary Hazard Group I areas, density required must be calculated from the density Ordinary Hazard Group I curve in NFPA Standard 13-2007, with a minimum area of application of 1,500 square feet. The density shall be 0.15 gpm per square foot over the hydraulically most remote 1,500 square feet in areas including, but not limited to, laboratories, laboratory support areas, mechanical rooms and electric rooms.
 - 3. The design calculations shall include an allowance for outside hose streams and a ten (10) pound per square inch safety factor for future water supply deterioration.
 - 4. Confirm densities and areas of application with the Owner's Insurance Underwriter, local codes, and the authority having jurisdiction, as increases may be required. All required increases in densities and areas of application shall be provided by the Contractor at no additional cost to the Owner.
- B. Contractor shall follow the hydraulic design criteria contained in the NFPA Standard 13-2007 as interpreted by the State of South Carolina and the Owner's Insurance Underwriter and as shown on the FSSS.
- C. Contractor shall furnish and install hydraulic calculation signs for each new sprinkler zone.
 - 1. Signs shall include all information indicated in Appendix A, NFPA Standard 13-2007.
 - 2. Signs shall be rigid, flat steel or aluminum plaques with embossed enamel background and lettering.
 - 3. Signs shall be secured by chain or durable wire to each sprinkler zone control valve.

2.02 GENERAL

- A. All equipment and system components furnished and installed shall be new and of first quality, and be listed by Underwriters Laboratories Inc. (UL) or approved by Factory mutual (FM) for their intended use. All such equipment and system components shall be installed within the limitations of the respective UL listings or FM approvals.
- B. Each item of equipment shall be capable of performing its function over an extended period of time with a minimum of attention and maintenance. All equipment shall be constructed using new materials designed and built in accordance with the best practices of the industry. Each major item of equipment shall bear the manufacturer's name or trademark; serial number; UL label; operating instructions and hydraulic temperature characteristic conditions, etc., if applicable.

- C. Unless specified otherwise, the standard manufactured products of Grinnell, Viking, or Reliable shall be provided. Equipment and installation shall comply with the latest edition of NFPA Standard 13-2007.

2.03 PIPING

- A. Fire protection system piping shall meet the requirements of NFPA Standard 13-2007 and the following:
1. Schedule 40 black steel pipe meeting ASTM A-795 requirements with the following:
 - a. Black cast-iron screwed fittings 125 pound steam, 175 pound water ANSI B16.4 and threaded joints conforming to ANSI B1.20.1
 - b. Mechanical grooved pipe couplings and fittings for roll or cut pipe sizes 2-1/2 inches and larger.
 2. A flexible coupling shall be provided at or near all building expansion joints.
 3. Pressure ratings of all fittings shall meet or exceed maximum working pressures available within the system.
 4. All piping and hangers where exposed to the weather or installed in a corrosive atmosphere shall be protected against corrosion. No piping shall be subject to freezing.
 5. If piping systems utilizing mechanical couplings are used, all coupling and pipe fittings such as elbows, tees, reducers, etc. (not including valves and specialties) shall be provided by one manufacturer and shall be part of a UL/FM approved assembly.
- B. Flexible Sprinkler Hose Fittings
1. Manufacturer: FlexHead Industries, Inc.
 2. Description: Flexible Sprinkler Hose Fittings for use in commercial suspended ceilings and sheetrock ceilings.
 3. Regulatory Requirements: In accordance with NFPA 13-2007.
 4. Product Performance Criteria:
 - a. FM Approved for its intended use pursuant to FM 1637 Approval Standard for Flexible Sprinkler Hose with Threaded End Fittings.
 - b. UL Listed for its intended use pursuant to UL 2443 Standard for Flexible Sprinkler Hose with Fittings for Fire Protection Service.
 - c. Seismically qualified for use pursuant to ICC-ES AC-156 Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.
 5. FlexHead Flexible Hose Assemblies and End Fittings:
 - a. 100% Type 304 Stainless Steel.
 - b. Straight Hose Assembly Lengths: 2ft length, Model #2024, 175 psi maximum rated pressure. Fully welded non-mechanical fittings, braided, leak-tested with minimum 1-inch true-bore internal corrugated hose diameter.
 - c. Elbow Hose Assembly Lengths (For use in confined spaces): 2ft length, Model #2024E, 175 psi maximum rated pressure. Fully welded non-mechanical fittings, braided, leak-tested with minimum 1-inch true-bore internal corrugated hose diameter.
 6. FlexHead Ceiling Bracket:
 - a. Type G90 Galvanized Steel.
 - b. Direct attachment type, having integrated snap-on clip ends positively attached to the ceiling using tamper-resistant screws.
 - c. Flexible Hose Attachment: Removable hub type with set screw.

2.04 CONTROL AND DRAIN VALVES

- A. Fire Protection system control valves shall be the following types:
 - 1. Gate Valves 2-1/2 inch and over shall be UL listed 175 pounds per square inch (psi) water working pressure (WWP), OS&Y with cast iron body and flanged end equal to Stockham Fig. No. G-634.
 - 2. Gate Valves 2 inch and under shall be UL listed, 175 pounds per square inch (psi) water working pressure (WWP), OS&Y with bronze body and screwed end equal to Stockham Fig. B-133.
 - 3. Check Valves 2-1/2 inch and over shall be UL listed, 175 pounds per square inch (psi) water working pressure (WWP), swing check with cast iron body and flanged end equal to Stockham Fig. G-939. For vertical installations, provide UL listed wafer check valve, 175 psi WWP equal to Grinnell.
 - 4. Butterfly valves with integral valve supervisory switches, whose entire assembly is approved for use in sprinkler systems for pipe sizes 1-1/2 inch and smaller.
 - 5. Ball drips shall be Elkhart Fig. No. 702.
- B. Riser control valves shall be of the OS&Y gate type with valve supervisory switch.
- C. All valves must be UL listed or FM approved for their intended use.
- D. All water supply control valves and drain valves shall be permanently marked to show their function and sprinkler system zone which they serve. Valve marking shall correspond to campus wide valve marking procedure.
- E. Pressure ratings of all valves shall meet or exceed maximum working pressures available within the system.
- F. Provide inspector's test and drain assemblies.
- G. Provide check valve in accordance with NFPA Standard 13-2007.

2.05 AUTOMATIC SPRINKLERS

- A. Sprinklers shall be listed by Underwriter's Laboratories and only new sprinklers shall be used. Any sprinkler that incurs damage, is painted, or is sprayed with any fire retardant or obstructive material shall be replaced at no cost to the Owner. Sprinklers shall be provided and installed in accordance with NFPA Standard 13-2007 and properly coordinated with other work including duct and electric fixture installation. The correct type of sprinkler head shall be used in every location.
- B. The correct temperature rating of every sprinkler head shall be used according to the maximum ceiling temperature rating and requirements in NFPA Standard 13-2007. All sprinklers with the exception of specified decorative types and bulb type sprinklers shall have their frame arms colored at the factory in accordance with the standard table in NFPA Standard 13-2007. High temperature heads shall be used where required by NFPA Standard 13-2007 and the Authority Having Jurisdiction.
- C. Sprinklers that may be subject to mechanical damage due to their location (under stairwells, or low hanging sprinklers in corridors, storage rooms or under ducts) shall be provided with approved guards (Reliable Model MA or equivalent). Sprinklers under open gratings shall be provided with approved shields.

- D. Automatic sprinklers shall be of the following types:
 - 1. Quick Response sidewall, semi-recessed pendent or concealed sprinklers shall be installed in all areas, including offices, laboratories, classrooms, corridors, storage rooms, multipurpose rooms, and other technically appropriate areas. Sprinkler heads in gypsum, plaster and wood ceilings shall be concealed type. Sprinkler heads in acoustical ceiling tile shall be semi-recessed pendent type. Quick Response sprinklers shall be ordinary temperature rated. All sprinklers in these areas shall be Quick Response which will permit removal and replacement of ceiling without cutting tiles.
 - 2. Standard upright or pendent sprinklers shall be installed in areas not provided with Quick Response Sprinklers.
 - 3. Architect will select finish for all automatic sprinklers from samples of available finishes supplied by Contractor from the manufacturer.
 - 4. All sprinklers within a space shall be from the same manufacturer and have the same heat response element, including temperature rating and response characteristics.
 - 5. Sprinklers located on exterior piping systems, or located in corrosive atmospheres shall be corrosion resistant.
 - 6. It shall be the Contractor's responsibility to install all sprinklers securely and in a manner acceptable to the Owner and Architect.

2.06 SUPERVISORY AND ALARM EQUIPMENT

- A. Vane-type waterflow indicators with adjustable pneumatic retard (0-90 seconds) shall be used to indicate waterflow in each sprinkler system zone.
- B. Valve supervisory switches (riser control valves) shall be provided for all new valves controlling the water supply to the sprinkler system(s).
- C. Valve supervisory switches shall be the yoke mounted type. Contractor shall not use remote mounted, wire loop type switches.
- D. All electrical wiring of flow switches and valve tamper switches into the fire alarm system shall be provided under Division 16, ELECTRICAL. The sprinkler contractor is responsible for providing, installing, and adjusting the devices as necessary for proper operation.
- E. All valves controlling water supply shall be electrically supervised in accordance with requirements of IBC Section 903.4 and NFPA Standards. The switches shall be a single circuit limit switch mounted to the piping so that when the valve is fully opened the limit switch actuator holds the contacts open. If the valve is closed to a point where the stem has reached a distance of 1/5 of total travel to the closed position, the limit switch actuator shall close to the switch contacts.

2.07 HANGERS

- A. Provide hangers from the building structure in strict accordance with NFPA Standard 13-2007. Provide seismic bracing and supports for all fire protection piping to comply with NFPA Standard 13-2007 and IBC Section 1621.1. Submittal shall detail seismic bracing and pipe supports and show locations of each. All pipe supports and seismic bracing shall be of UL listed components. Engineered pipe supports will only be allowed if shop drawings containing calculations according to NFPA Standard 13-2007 (9.1.1.4) are approved by the AHJ prior to the start of installation.

3.01 INSPECTION

- A. The contractor shall examine daily all areas in which the work will be performed. The Contractor shall immediately report unsatisfactory working conditions to the Architect for resolution. The Contractor shall not proceed with work until all unsatisfactory working conditions have been resolved.

3.02 INSTALLATION

- A. General:
1. The Contractor shall thoroughly review with the Architect pipe routing, sprinkler location, and method of installation. Any facet of sprinkler installation that does not meet with the Owner's approval shall be revised by the Contractor to the Owner's satisfaction at no expense to the Owner.
 2. Due to the need to maximize area availability, each zone may be constructed in phases requiring multiple hydrostatic tests, set-up, clean-up, etc.
 3. All holes made by the Contractor in any new wall, ceiling, or floor shall be patched restoring the wall, ceiling, or floor to its original appearance, condition, fire resistance, and integrity.
 4. Location of all equipment, controls, piping, valves and drains shall be coordinated with other sections and trades so as to be easily accessible for operation and maintenance. Location is subject to approval.
 5. All sprinklers and equipment shall be installed in accordance with manufacturer's instructions. All special tools recommended by the manufacturer shall be used.
 6. The sprinkler contractor shall provide all required construction coordination as specified in Division 15, Section "Mechanical and Electrical General Provisions". All coordination issues and conflicts shall be resolved by the Contractors at no additional cost to the Owner. Resolutions may include, but not be limited to, moving pipe mains, sprinkler heads drain and test piping, valves, etc.
- B. Installation of Piping:
1. Install all pipe, fittings, valves, controls, and hangers as indicated and required in accordance with NFPA Standard 13-2007 and NFPA Standard 14-2007.
 2. Piping installed under this Section shall be coordinated with that of all other Sections and trades so that all work may be installed in the most direct and workmanlike manner and so that interference between piping, ducts, equipment, electrical, architectural and structural features will be avoided.
 3. Piping shall be installed and arranged to protect it from freezing and corrosion, and shall be pitched for drainage. Installation of all piping shall be in coordination with air devices, ductwork, light fixtures, and any other work that may obstruct sprinklers.
 4. Drains and test piping shall be furnished and installed so that all parts of the system may be drained and tested properly. Low point drains shall be clearly marked and piped to the exterior of the building. A sign be provided in the existing fire pump room of the number and location of the low point drains.
 5. Piping shall not be exposed to freezing. All risers including the alarm check valve shall be equipped with drains with sizes as specified in NFPA Standard 13-2007. The alarm check valve drain ("main drain") shall be piped to the outside of the building at a point free from causing water damage.
 6. All valves controlling water supply for sprinklers shall be accessible for use by emergency and maintenance personnel. All valves controlling water supply for

sprinklers shall be electrically supervised and shall be red in color or painted red by the sprinkler subcontractor.

7. All sprinkler piping installed in areas with suspended ceiling shall be concealed in the walls and ceilings.
8. All exposed pipe which passes through a wall, ceiling, or floor shall be provided with escutcheon plates.
9. All exposed piping, equipment, and devices shall be installed as high as possible, but no less than 7'-6" above the finished floor, and so as not to obstruct any portion of a window, doorway, stairway or passageway, and shall not interfere with the operation or accessibility of any mechanical, plumbing, or electrical equipment.
10. Pipe which passes through fire-resistive barriers (including shaft walls and stairways) shall be sleeved and grouted to maintain the structural integrity and rating of the fire-resistive barriers.

C. System Drains:

1. All interior sectional control valves including riser control valves shall be provided with auxiliary drainage so located as to drain that portion of the system controlled by the sectional valve. These drains shall discharge either outside, to drain connection leading to the main drain, or to a drain system. Obtain approval of all discharge locations.
2. Auxiliary drains shall be provided to properly drain points of the system when a change in direction prevents drainage.
3. Drain and auxiliary drain valves shall be globe or angle valves as required and readily accessible for maintenance personnel. The Inspector's test shall be one (1) inch or larger globe valve installed not over seven (7) feet above the floor and in a readily accessible location. Test valves and the sight test shall be located at readily accessible points not above seven (7) feet above the floor.

D. Flexible Couplings, Hangers, and Sway Bracing:

1. Provide pipe hangers and supports for fire protection piping as hereinbefore specified in Division 15, Section "Mechanical and Electrical General Provisions" and in no case less than the requirements of NFPA Standard 13-2007.
2. All sprinkler piping shall be substantially supported from the building structure which must support the total load of the water filled pipe plus a minimum of 250 pounds applied at the point of hanging in accordance with NFPA Standard 13-2007. All hanging apparatus and equipment shall be of an approved type installed in accordance with NFPA Standard 13-2007.
3. All flexible couplings shall be designed and installed as required by NFPA Standard 13-2007 (including all appendices). Flexibility, internal pressure, and differential movement between the piping and building, earth, or other supporting structure(s) shall be allowed for, so that no allowable stress is exceeded in any member.
4. All sway bracing shall be designed and installed as required by NFPA Standard 13-2007. Sprinkler contractor shall provide two-way, four-way, lateral, longitudinal, etc. bracing for seismic protection.

3.03 IDENTIFICATION

- A. Identification signs similar to or the same as those recommended in NFPA Standard 13-2007 shall be affixed securely by chain to all valves. The signs shall be red in color (Reliable Model A, Style A and B, or equivalent). The main drain sign shall be labeled "MAIN DRAIN". Riser drains shall read "RISER DRAIN" or "DRAIN". Auxiliary drain signs shall be labeled "AUXILIARY DRAIN". Inspector's Test's signs shall be labeled "INSPECTORS TEST".

- B. All water supply control valves shall have a standard sign identifying the portion of the system controlled, noting that the valve must be kept open, and leaving a blank space for notification information. All valves which are placed in concealed spaces shall have the standard sign affixed in a visible location (valves hidden by a drop ceiling shall have a sign mounted on the ceiling or wall under the valve). Obtain final approval of the Architect of all sign locations in finished spaces.

3.04 INSTALLATION, ACCEPTANCES, AND TEST

- A. Installation, tests, and acceptance shall be in accordance with all applicable codes and authorities having jurisdiction.
- B. Installation shall be in accordance with all applicable codes, including the Occupational Safety and Health Acts. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.
- C. The Contractor shall make arrangements with the Architect for final inspection and witnessing of the final acceptance test. The Architect or the Owner will conduct a final inspection and witness the final acceptance test.
- D. The hydrostatic tests shall be documented and subject to third party witness. Failure to document any test or notify the Architect may require retesting at no cost to the Owner.
- E. All tests and inspections required by the referenced Codes and Standards, the Owner, AHJ, and the Architect shall be performed by the Contractor.
 - 1. When local code authorities or third parties are required to witness tests, the contractor shall be responsible for making all necessary arrangements with the code authorities and coordinating the work with the Architect.
 - 2. The Contractor shall be responsible for obtaining all test documents with necessary approval stamps and signatures for the code authorities. The Contractor shall submit one copy of the "Contractors Material and Test Certificates for Aboveground Piping" with all information filled out and original signatures.
- F. An Owner's Representative will visit the job site to inspect the work and witness acceptance tests when he has been advised by the Contractor that the work is completed and ready for test. If the work is not complete or the test is unsatisfactory, the Contractor shall be responsible for the Representative's extra time and expenses for reinspection and witnessing the re-testing of the work. Such extra fees shall be deducted from payments to the Contractor.
- G. Contractor shall provide at least five (5) working days notice for all tests. As a minimum the following test shall be provided:
 - 1. All piping shall be tested hydrostatically at not less the 200 pounds per square inch (psi) for two (2) hours. The hydrostatic test pressure shall be measured at the low point of the system. The hydrostatic test shall be for the entire system as installed and specified.
 - 2. All alarm equipment, drainage facilities, inspector's tests, etc., shall be operated while the control valves are wide open. The main drain shall be opened and remain open until the system pressure stabilizes. All air shall have been bled from the system at the top inspector's test connection prior to these tests.
- H. The following materials shall be furnished by the Contractor at the conclusion of the final acceptance test:

1. Operating and maintenance instructions.
 2. The spare sprinklers hereinbefore specified.
 3. Any and all special tools noted by the manufacturer required for the fire protection items furnished.
- I. After completion of installation and tests, clean interior and exterior surfaces of equipment and materials, painted or unpainted, installed under this section of specifications of dirt, rust, loose scale, oils, grease and other foreign matter.

3.05 MATERIAL HANDLING

- A. Storage:
1. The General Contractor will provide the Contractor with a storage space for the Contractor's use during this project. The Contractor will be responsible for the security of this space.
 2. The material storage area may be used for pipe cutting and threading, and component assembly.
 3. Overnight storage of material shall be limited to the assigned storage area. Materials brought to the work area shall be installed the same day, or returned to the assigned storage area unless otherwise previously approved by the General Contractor.
- B. Receiving and Handling:
1. The Contractor shall be responsible for all receiving, handling, and storage of his materials at the job site.
 2. Use of loading docks, service driveways shall be coordinated with the Owner.
- C. Rubbish Removal:
1. Contractor shall remove rubbish and debris resulting from his work on a daily basis. Rubbish not removed by the Contractor will be removed by the General Contractor and back-charge to the Contractor.
 2. Removal of debris and rubbish from the premises shall be coordinated with the General Contractor.

3.06 WELDING AND FLAME CUTTING

- A. Welding or flame cutting by the Contractor shall be permitted on the premises in accordance with NFPA 13-6.5.2.

3.07 FLOW TEST DATA

- A. Refer to attached sheets for project Fire Sprinkler System Specification Sheet and existing fire pump test data.

END OF SECTION 15400



Fire Sprinkler System Specification Sheet

(Per §40-10-250)



Project Data

Project name: University of South Carolina -PHRC Laboratory 305 Renovation

Location in
South Carolina:

Address: 921 Assembly Street, Columbia, SC 29203

State project: ☐ Yes ☒ No

City: Columbia

County: Richland

State project #: N/A

Water Supply Information

(flow test data must be less than 1 year old per §40-10-250(A)(1))

Date test conducted: 01/31/2011

Static pressure (psi): 65**

Residual pressure (psi): 96**

Flow (gpm): 533**

Distances of test gauges relative to the base of the riser:

Horizontal (ft): at pump

Vertical (elevation difference in ft): at pump

Source of water supply:

☐ Municipal dead-end ☐ Municipal circulation ☒ Other: Private Fire Main

Pipe Size (in.):

Test data by/from:

Name: Robert A. Davis

Title: none

Organization: Palmetto Automatic Sprinkler Co.

Telephone #:

Fire pump:

☒ Yes ☐ No

Pump Capacity (gpm): 1,000

Churn Pressure (psi): 106

☐ New ☒ Existing

Rated Pressure (psi): 96

Pressure @ 150% flow (psi): 89

On-site storage tank:

☐ Yes ☒ No

☐ New ☐ Existing

Tank capacity (gallons):

NFPA Hazard Classification

(attach continuation page when necessary)

Area #	Class or Code Reference	Description of Hazard Protected (commodity description, storage height, and arrangement as applicable.)
1	Light Hazard	Offices, Toilet Rooms
2	Ordinary Hazard Group I	Lab, Equipment Room

Design Parameters

(attach continuation page when necessary)

Area #	System Type	Density (gpm/ft ²) / Area (ft ²) or Other (reference code section)	Inside Hose (gpm)	Outside Hose (gpm)
1	Automatic - Wet	0.10 / 1500	0	100
2	Automatic - Wet	0.15 / 1500	0	250

Seismic Design Data: $S_s=0.54g$ centroid short period

Codes and Standards

(attach continuation page when necessary)

Applicable Codes, Standards & Editions (i.e. "2006 IBC", "2007 NFPA 13", etc.) for the Scope of Work on the Sprinkler System

2010 NFPA-13, 2009 ICC IBC, 2009 ICC IFC.

Scope of work: Relocation and addition of sprinkler heads to match new architectural layout.

**Static pressure = actual pump suction pressure at 0 flow.

**Residual pressure = actual pump discharge pressure at 100% flow as tested.

**Flow = actual 100% flow as tested.

Specifier's Information

Name: Craig Buck, P.E.

Engineering services provided through a firm: ☒ Yes ☐ No

Firm name: RMF Engineering, Inc.

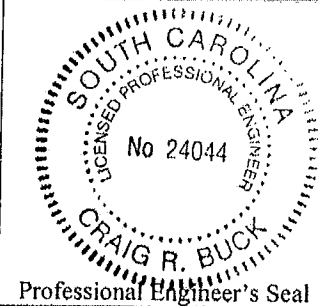
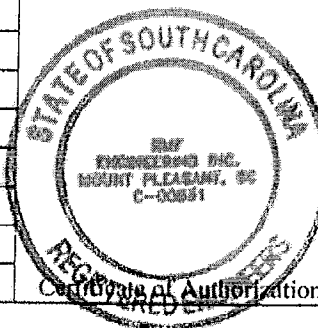
Address: 474 Wando Park Boulevard, Suite 100

City: Mount Pleasant

State: South Carolina Zip: 29464

Phone #: 843 971 9639 Fax #: 843 971 9641

E-mail: cbuck@rmf.com



Revision No.: _____

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Signature: C. Buck

Date: 11/28/2011

156A

Report of Inspection, Testing & Maintenance of Fire Pump Assemblies...continued

Inspecting Firm: Palmco Automatic Sprinkler Co. Inspection Contract: 7718Name of Inspected Property: USC Arnold School of Public HealthInspector Name: Robert A. DavisInspection Frequency: ☐ Monthly☐ Quarterly☒ Annually☐ OtherDate: 1/31/10

Annual Test Data

ELECTRIC PUMP SYSTEM:

Time controller during the station transition from Reduced Voltage to Full Voltage

Time required for motor to reach full speed

1 sec.

DIRECT PUMP SYSTEM:

2 sec.

Time required for engine to crank

Time required to reach running speed

sec

Observations while engine operating

sec

Oil Pressure

Roped Indicator

Water Temperature

Oil Temperature

psi

temp

°F

°F

PUMP:

Model: Guarara Ser # 05-1290505Type: 5-481-15481BFRated Capacity: 1000 GPMRated Pressure: 90 PSI & 83 @ 130% w/a maximum net of 105 PSIRated Flow: 1770Date of last actual flow test: 10/4/10

GOVERNOR:

Manufacturer: Jackson Clark / D9C294-4T with transfer switchModel: U2 5024Comments: (1) Replace sensing line gauges (2) Add support to sockey pump sensing line

NOTE: Pump Performance Curve

Test Data:

Flow	Suction Pressure (PSI)	Discharge Pressure (PSI)	Net Pump Pressure (PSI)	Pump Speed (RPM)	Pilot Pressure	Dia. of Nozzle Orifice	No. of Nozzles Flowing	Flow Based on Pilot Pres.	Opening Coefficient	Actual Flow (GPM)
Churn	65	171	106	1792						
100%	43	137	96	1786	10	2.5"	2	333	1.0	1066
150%	24	113	89	1783	20	2.5"	2	154	1.0	1508
	Volts	Lead #1	Lead #2	Lead #3		Amps	Lead #1	Lead #2	Lead #3	
Churn	460	481	483	483			48.7	49.4	49.2	
100%	3 phase	481	484	483		115	80.3	83.4	85.4	
150%		481	484	483			92.3	96.1	98.9	

Notes: sockey on @ 134 PSI OR @ 155Fire pump on @ 125 PSI

Signature and Title of Person Making Test

1862 Old Dunbar Rd.
W. Columbia, SC 29172
Company Name & Address

Palmetto Automatic Sprinkler Co., Inc

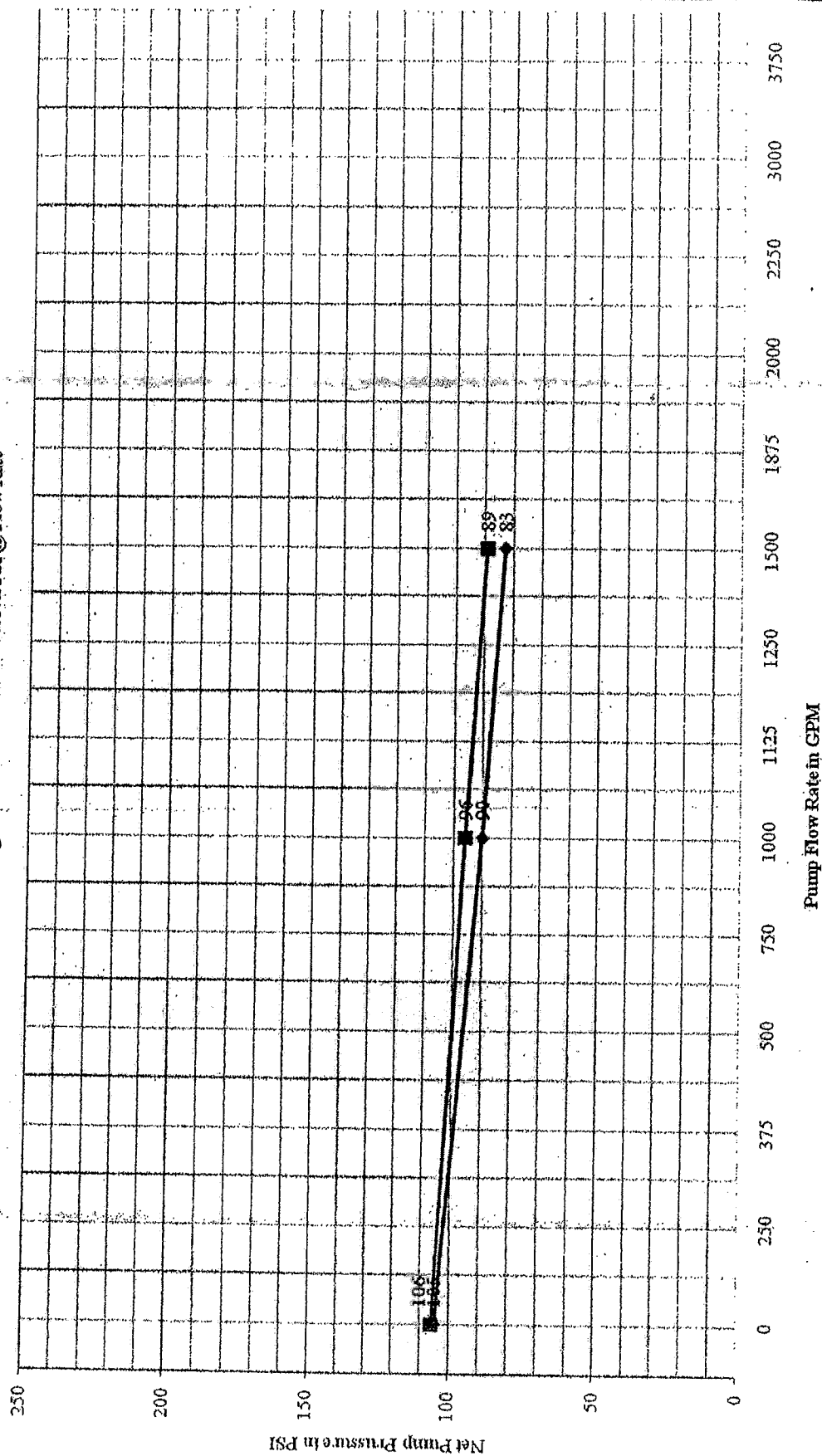
Post Office Box 2927

West Columbia, SC 29171

Phone: 803-794-1602 Fax: 803-794-8877

USC Arnold (New) School of Public Health

◆ Rated Net PSI @ Flow Rate ■ Actual Net PSI @ Flow Rate



SECTION 15800
AIR DISTRIBUTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, General Requirements and all other Specification Sections apply to the work specified in this section.

1.02 SCOPE

- A. This section includes the air distribution systems including those devices distributing the air to the spaces, and those items which collect, filter, control, and convey air.
- B. The requirements of Division 15, Section "Mechanical and Electrical General Provisions" shall apply to the work specified under this section.
- C. Except for duct pressure tests, all testing and balancing of the air distribution systems shall be performed under Division 15, Section "Testing and Balancing" of the Specifications.

PART 2 - PRODUCTS

2.01 EXHAUST AIR TERMINAL UNITS (NON-LABORATORY)

- A. Provide Titus, Kreuger, Price, Metalaire or Nailor, high pressure variable/constant air volume terminal reheat units as shown on the plans and specified herein, equal to Titus Model DESV with factory installed controls furnished under Division 15, Section "Building Automation and Temperature Controls".
- B. Terminals should be certified under the ARI Standard 880-94 Certification Program and carry the ARI Seal. Non-certified terminals may be submitted after testing at an independent testing laboratory under conditions selected by the engineering consultant, in full compliance with ARI Standard 880-94. These tests shall be witnessed by the engineering consultant with all costs to be borne by the terminal manufacturer. Testing does not ensure acceptance.
- C. The terminal casing shall be minimum twenty-two (22) gauge galvanized steel, internally lined with a non-porous, sealed liner which complies with UL 181 and NFPA 90A. Insulation shall be 1 3/16" thick, 4 lb. density, rigid board insulation. Liner shall be attached to unit casing by insulation adhesive and full-seam-length Z-strips to enclose and seal the insulation cut edges. Liners made of Mylar, Tedlar, Silane, or woven fiberglass cloth are not acceptable. Insulation shall be equivalent to Titus Steri-Loc or double wall lining. The discharge connection shall be slip and drive construction for attachment to metal ductwork. The casing shall be constructed to hold leakage to the maximum values shown in the following table:

Casing Leakage CFM

<u>Inlet Size</u>	0.25 Inch <u>Diff Ps</u>	0.5 Inch <u>Diff Ps</u>	1.0 Inch <u>Diff Ps</u>
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4, 5, 6	2	3	3
7, 8	3	3	5
9, 10	3	4	6
12	4	5	7
14	4	6	9
16	5	7	10

- D. The damper shall be heavy gauge steel with shaft rotating in Delrin or bronze oilite self-lubricating bearings. Nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicated damper position. Stickers or other removable markings are not acceptable. The damper shall incorporate a mechanical stop to prevent overstroking, and a synthetic seal to limit close-off leakage to the maximum values shown in the following table:

Damper Leakage CFM

<u>Inlet Size</u>	<u>1.5 Inch Diff Ps</u>	<u>3.0 Inch Diff Ps</u>	<u>6.0 Inch Diff Ps</u>
4, 5, 6	4	5	7
7, 8	4	5	7
9, 10	4	5	7
12	4	5	7
14	4	6	8
16	5	7	9

- E. Actuators shall be capable of supplying at least thirty-five (35) inch pound of torque to the damper shaft, and shall be mounted externally for service access. Terminals with internal actuator mounting or linkage connection must include gasketed access panel, removable without disturbing ductwork. Casing with access panel shall be constructed to hold casing leakage to the maximum values previously specified. Control of terminal unit shall be provided under another section of this specification. Inlet damper and motor operator shall provide full shut-off of air volume.
- F. At an inlet velocity of 2000 feet per minute, the differential static pressure required to operate any terminal size shall not exceed
1. eighteen hundredths (0.18) inch water gauge for the basic terminal, or
 2. twenty three hundredths (0.23) inch water gauge for the terminal with integral attenuator.
- G. Sound rating for the terminal shall generally not exceed thirty (30) NC at plus 1.5 inch static pressure. Sound performance shall be ARI certified with sound ratings tested at power levels 10^{-12} watts and shall not exceed values scheduled for individual installed terminal units. The unit manufacturer shall furnish certified sound power levels for both discharge sound and casing radiated sound, tested in accordance with ASHRAE Standard 36-72. Certified sound power levels shall be for terminals actually installed on the project including effects of lining material. Sound data based on prior ASHRAE Standards will not be acceptable. The tests shall be conducted in an ADC approved sound facility. The data shall include the second through sixth octave bands for all unit sizes and inlet static pressures. All attenuation factors shall be clearly defined. Provide additional approved attenuators as required to achieve the drawing scheduled values based on the installed condition of the terminals. Many of attenuation factors commonly used in the rating of terminal units are not applicable and shall not be considered.
- H. Each terminal unit shall be field tested under Division 15, Section "Testing and Balancing" at the design air volumes. Where field tests indicate volume greater than plus or minus ten (10) percent of design value, the terminal unit shall be readjusted or

recalibrated by the balancing contractor to achieve the design valves. Units which can not achieve the desired results shall be removed from the project and new units provided at no additional expense to the Owner.

- I. Control Specifications:
 1. The terminals shall be equipped with pressure independent controls which can be reset to modulate airflow between zero and the maximum cataloged cubic feet per minute. Maximum airflow limiters are not acceptable.
 2. The direct digital controls shall be supplied by the control contractor and mounted by the terminal unit manufacturer. Control contractor shall provide data sheets on all components to be mounted, indicating component dimensions, mounting hardware, and methods, as well as wiring and piping diagrams for each application identified by unit tag per the schedule in the drawings, to the terminal manufacturer.
 3. Controls shall be compatible with pneumatic inlet velocity sensors supplied by the terminal manufacturer. The sensor shall be multi-point center averaging type, with a minimum of four measuring ports parallel to the take-off point from the sensor. Sensors with measuring ports in series are not acceptable. The sensor must provide a minimum differential pressure signal of 0.03 inch wg. at an inlet velocity of 500 fpm. The sensor must provide control signal accuracy of plus or minus five (5) percent with the same size inlet duct at any inlet condition.
 4. Controls shall be field set by control contractor for the scheduled minimum and maximum flow rates. Flow measuring taps and flow curves will be supplied with each terminal for field balancing airflow. All pneumatic tubing shall be UL listed fire retardant (FR) type. Each terminal shall be equipped with labeling showing unit location, size, minimum and maximum cubic feet per minute setpoints, damper fail position, and thermostat action.
 5. The terminal manufacturer shall provide a Class II 24 VAC transformer and disconnect switch. Actuator shall be direct connection shaft mount type without linkage. All controls shall be installed in approved NEMA type sheet metal enclosure by terminal manufacturer.
 6. Box controllers in laboratory spaces with self calibration shall not interrupt flow.
- J. Hot water reheat coils shall be enclosed in a minimum twenty (20) gauge galvanized steel casing, with slip and drive construction for attachment to metal ductwork. Coils shall be factory installed on the terminal discharge. Fins shall be rippled and corrugated heavy gauge aluminum, mechanically bonded to tubes. Tubes shall be copper with minimum wall thickness of 0.016 inch with male solder header connections. Coils shall be leak tested to 300 pounds per square inch, with minimum burst pressure of 2000 pounds per square inch at ambient temperature. Number of coil rows and circuits shall be selected to provide performance as scheduled on the drawings. Coil performance data shall be based on tests run in accordance with ARI Standard 410.

2.02 AIR DEVICES

- A. Provide air devices of the minimum sizes and quantities indicated and of the types specified. Contractor shall carefully study the drawings and the field conditions to ascertain the air device requirements as to suitability, location, air capacity, required accessories, border and finish. Devices shall be selected to provide draft-free air distribution over entire area served and sound rating shall not exceed Noise Criteria (NC) 25.
- B. Border types shall be compatible with Architectural ceiling type for the room for which the air device is located. All devices shall have plaster frames when installed in plaster or drywall construction.

- C. Margins shall be as indicated or directed to suit field conditions.
- D. Provide Titus, Kreuger, Price, Metalaire or Tuttle & Bailey air devices in accordance with the schedule below and on the drawings.
- E. Air Device Schedule:

<u>Device</u>	<u>Type</u>	<u>Finish</u>	<u>Basis of Design</u>
Ceiling Supply Diffuser	A	#26 white	Titus/TDCA-AA
Exhaust Grille	B	#26 white	Titus/PAR-AA

1. Type A: Ceiling diffusers shall be Titus Model TDC-AA (aluminum) or prior approved equal for fixed, horizontal discharge pattern. These diffusers shall consist of an outer frame assembly of the sizes and mounting types shown on the plans and outlet schedule. A square or rectangular inlet shall be an integral part of the frame assembly and a transition piece shall be available to facilitate attachment of round duct. An inner core assembly consisting of fixed deflection louvers shall be available in one-, two-, three- or four-way horizontal discharge patterns. The inner core assembly must be removable in the field without tools for easy installation, cleaning or damper adjustment.
 - a. The finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering, or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.
 - b. Opposed blade volume damper shall not be provided. Throw Reducing Vanes (TRV) must be available to deflect a horizontal discharge airstream from each side of the TDC diffuser into diverging airstreams.
 - c. The manufacturer shall provide published performance data for the diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.
2. Type B: Perforated ceiling diffusers shall be Titus Model PAR-AA (aluminum, flush face) or approved equal for exhaust. Diffusers shall have a perforated face with 3/16-inch diameter holes on 1/4-inch staggered centers and no less than 51 percent free area. Perforated face shall be aluminum. The backpan shall be one piece stamped heavy gauge steel of the sizes and mounting types shown on the plans and outlet schedule. The diffuser neck shall have 1 1/8-inch depth for easy duct connection. Diffusers must discharge a uniform horizontal blanket of air into the room and protect ceiling against smudging. Pattern controllers in the supply models shall be mounted on the back of the perforated face and must be field adjustable to allow the discharged air to enter the room in either vertical or one-, two-, three- or four-way horizontal jets. The perforated face must be easily unlatchable from the backpan to facilitate option of the face for pattern controller adjustment.
 - a. The finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.
 - b. Opposed blade volume damper shall not be provided.
 - c. The manufacturer shall provide published performance data for the perforated diffuser. The diffuser shall be tested in accordance with

ANSI/ASHRAE Standard 70-1991.

- F. Paint the ductwork behind registers with flat black enamel so that bright surface cannot be seen. Properly prime galvanized surface prior to painting.

2.03 SOUND ATTENUATORS:

- A. Provide Vibro-Acoustics, Semco Incorporated, Industrial Acoustics Company, Commercial Acoustics, Ruskin, Aerosonics or Kinetics Noise Control sound attenuators equal to Vibro-Acoustics Rectangular Film Lined Low Velocity (RFL-LV) type as scheduled on the drawings and herein specified.
- B. Outer casings of silencers shall be made of twenty-two (22) gauge galvanized steel in accordance with ASHRAE Guide recommendation for high pressured duct construction. Seams shall be lock formed and mastic filled. Interior partitions for rectangular silencers shall be made of minimum twenty-six (26) gauge galvanized perforated steel. Filler material shall be of inorganic mineral or glass fiber of a density sufficient to obtain the specified acoustic performance and packed under not less than five (5) percent compression to eliminate voids due to vibration and settling. A Tedlar lining shall be provided to prevent fiber erosion. Material shall be inert, vermin and moisture proof. Combustion rating for the silencer acoustic fill shall be not less than the following, when tested in accordance with ASTM E84, NFPA Standard 255 or UL No. 723:

Flamespread classification	25
Smoke development rating	0
Fuel contributed	20

- C. Provide airtight construction by use of a duct sealing compound on the job site the same as for medium pressure ductwork. Silencers shall not fail structurally when subjected to a differential air pressure of eight (8) inches water gauge inside to outside of casing.
- D. Silencer ratings shall be determined in a duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with ASTM Specifications E 477. The test set-up and procedure shall be such that all effects due to end reflection, directivity, flanking transmission, standing waves, and test chamber sound absorption are eliminated. Acoustic ratings shall include Dynamic Insertion Loss (DIL) and Self-Noise (SN) Power Levels both for FORWARD FLOW (air and noise in same direction) and REVERSE FLOW (air and noise in opposite directions) with airflow at least 2,000 feet per minute entering face velocity. Data for rectangular and tubular type silencers shall be presented for tests conducted using silencers no smaller than the following cross-sections:

Rectangular, in. - 24 x 24, 24 x 30, or 24 x 36
Tubular, in. - 12, 24, 36, and 48

- E. Static pressure loss of silencers shall not exceed those scheduled. Airflow measurements shall be made in accordance with ASTM Specification E 477 and applicable portions of ASME, AMCA, and ADC airflow test codes. Tests shall be reported on the identical units for which acoustic data is presented.
- F. With submittals, the manufacturer shall supply certified test data on Dynamic Insertion Loss, Self-Noise Power Levels, and Aerodynamic Performance for Reverse and Forward Flow test conditions. Test data shall be for a standard product. All rating tests shall be conducted in the same facility, shall utilize the same silencer, and shall be open to inspection upon request from the Architect.

- G. Install silencers in accordance with manufacturer's printed instructions.

2.04 FIRE DAMPERS

- A. Provide where indicated on the plans, fire dampers constructed and tested in accordance with UL Safety Standard 555. Each fire damper shall have 1-1/2 hour fire protection rating, 212 degrees Fahrenheit fusible link, and shall include a UL label in accordance with established UL labeling procedures and shall have Static Rating for HVAC systems that shut down automatically in a fire or smoke emergency or Dynamic Rating for HVAC systems that remain operational during a fire or smoke emergency. Three (3) hour dampers shall be installed where required by wall or floor rating. Damper Manufacturer's literature submitted for approval prior to installation shall include comprehensive performance data developed from testing in accordance with AMCA Standard 500 and shall illustrate pressure drops for all sizes or dampers required at all anticipated air flow rates. Fire dampers shall be equipped for vertical or horizontal installation as required by the locations indicated on the drawings. Fire dampers shall be installed in wall and floor openings utilizing steel sleeves, angles, other materials, and practices required to provide an installation equivalent to that utilized by the manufacturer when dampers were tested at UL. Fire damper installation shall also meet all requirements of the authority having jurisdiction. Installation shall be in accordance with the damper manufacturer's instructions. Fire dampers shall be Ruskin Type IBD, DIBD, FD or approved equal of the following styles:
1. Low Pressure Rectangular Ducts - Style B.
 2. Low Pressure Round Ducts - Style CR.
 3. Medium Pressure Rectangular Ducts - Style C.
 4. Medium Pressure Round Ducts - Style CR.
 5. Medium Pressure Oval Ducts - Style CO.
 6. Dampers for grilles, diffusers, registers, etc. - Thinline.
- B. Fire damper assembly shall include fire damper and damper enclosure wall sleeve complete with duct attachment flanges, as detailed. Provide an access door at each fire damper located so as to permit easy maintenance of damper and fusible link. All fire dampers shall be installed in accordance with NFPA Requirements and the manufacturer's printed instructions.

2.05 DUCTWORK

- A. General:
1. The Duct Manual as herein referenced shall mean the "HVAC Duct Construction Standards – Metal & Flexible", 3rd Edition, 2005 as published by the Sheet Metal and Air Conditioning Contractors National Association, Inc.
 2. Unless noted otherwise, ductwork shall be constructed of prime, first quality galvanized steel of gauges as called for in the Duct Manual. Reinforce all ducts to prevent buckling, breathing, vibrations, or unnecessary noise. Such reinforcing shall be as recommended in Duct Manual, plus any additional reinforcing as required to meet job conditions. Longitudinal and cross joints, elbows, transitions, etc., shall be furnished as specified in Duct Manual, including recommended duct supports to suit job conditions.
 3. All uninsulated rectangular ductwork shall be crossbroken on all four (4) sides of each panel section. All vertical and horizontal sheet metal barriers, duct offsets and elbows, as well as the panels of straight sections of ducts, shall be crossbroken. Crossbreaking shall be applied between the standing seams or reinforcing angles. The center of the crossbreak shall be of the required height to assure each panel section being rigid, to prevent vibrations and "breathing".
 4. Laboratory exhaust air ductwork shall be fully welded type 304 stainless steel of

- gauges as called for in the Duct Manual.
 5. Support and restrain all ducts in accordance with the Duct Manual and SMACNA "Seismic Restraint Manual: Guidelines for Mechanical Systems", 3rd Edition, 2008.
 6. Supply air ductwork from air handling units to the air terminal units shall be "medium pressure" ductwork. Supply ductwork from air terminal units to air devices shall be "low pressure" ductwork.
 7. Laboratory exhaust air ductwork shall be "medium pressure" ductwork.
- B. Low Pressure Ductwork (0" to 2" Water Gauge):
1. Ductwork shall conform to requirements and details, unless specified or indicated otherwise in the SMACNA "HVAC Duct Construction Standards – Metal & Flexible", 3rd Edition, 2005. A copy of the duct manual shall be secured by the Contractor and shall be kept at the project for convenient reference.
 2. Concealed circular low pressure supply and exhaust ductwork shall be United McGill low pressure spiral ductwork and fittings, equal to United Uni-seal spiral lockseam duct.
 3. Flexible duct connections where indicated shall be "Ventglass" duct fabric as manufactured by Ventfabrics, Inc.
 4. Low pressure ductwork shall conform to the requirements and details contained in the Duct Manual and shall be constructed to the requirements for two (2) inches water gauge. Construction shall conform to the following:
 - a. Material gauges (galvanized steel) & general construction - Tables 1-5, 1-10 thru 1-13 Seal Class B
 - b. Longitudinal seams - Fig. #1-5, Types L-1, L-3 & L-4
 - c. Corner Closures - Fig. #1-13 & # 1-14
 - d. Hangers - Fig. #4-1 & 4-4 & Tables 4-1 & 4-2
 - e. Radius Elbows - Fig. #2-2, Type RE-1 and RE-3
 - f. Vaned Elbows (Applied to Square elbows) - Fig. #2-2 Type Re-2 & Figs. #2-3 & #2-4, double thickness vanes only
 - g. Transitions & Offsets - Fig #2-9
 - h. Branch connections - Fig. #2-8, 45° only
 - i. Volume dampers, up to 12" deep - Fig. #2-14, Figs. A&B w/Ventlok #555 quadrant
 - j. Volume dampers, over 12" deep - Fig. #2-15, Fig. A w/Ventlok #555 quadrant
 - k. Access doors - Cesco #HADF-10 hinged one (1) side w/Ventlok #100 latch, insulated, one (1) inch thick
 5. Duct sizes indicated on the drawings are air side sizes. Where duct lining is indicated, increase sheet metal sizes accordingly to compensate for thickness of lining.
 6. Seal all transverse joints in all low pressure supply ductwork with mineral impregnated woven fiber tape as manufactured by Hardcast, Inc.
 7. Provide stand-offs on volume dampers installed in all insulated ductwork.

8. Flexible ductwork shall be Genflex Type IL or approved equal. Flexible duct shall comply with NFPA Standard 90A and shall be U.L. listed as Class 1 Air Duct & Connector, Standard 181.
- C. Medium Pressure Ductwork (Over 2" and up to 6" Water Gauge):
1. Medium pressure ductwork consists of rectangular, flat-oval, and circular types as indicated on the drawings.
 2. Submit samples of medium pressure ductwork for approval as directed. Samples shall include longitudinal seams, transverse joints and reinforcement and others as requested. No ductwork shall be fabricated until duct construction samples are approved in writing by the Architect.
 3. All medium pressure duct systems shall be leak tested in strict conformance with "HVAC Air Duct Leakage Test Manual", 1985. Tests shall be witnessed by the balance subcontractor as hereinafter specified.
 4. Medium pressure ductwork shall conform to the requirements and details contained in the Duct Manual and shall be constructed to the requirements for six (6) inches water gauge. Construction shall conform to the following:
 - a. Reinforcement & Gauge - Tables #1-7, 1-10 thru 1-13
 - b. Transverse Joints - Figs. #1-4 Type T-21, #1-10, #1-12, #1-14, #1-15, Type T-21, and T-22, #1-16, #3-2 Type RT-1 and 2
 - c. Longitudinal Joints - Fig. #1-5 Type L-1 and L-3
 - d. Vanes and Vane Runners - Fig. #2-3
 - e. Branch Connections - Figs. #2-7 and 2-8
 - f. Transitions - Figs #2-9
 - g. Offsets - Figs. #2-9 Type 3
 - h. Supporting Systems - Figs. #4-16, #4-17, #6-4, and Tables #4-1, #4-2 and #4-3
 - i. Riser Supports - Fig. #4-6
 - j. Volume and Floor - High Velocity Air Foil Type, Ultra-Low Leakage when closed, Ruskin CD-50 suitable for electronic operator provided under Section 15850.
 - k. Supply and Exhaust Fan Isolation Dampers - High Velocity Air Foil Isolation Dampers Type, Ruskin OD102 fan outlet damper with silicone rubber blade seals, stainless steel jamb seals and bearings with integral shaft seals. Damper shall be suitable for electronic operator provided under Section 15850.
 - l. Duct Sealants - See Section 1 Basic Duct Construction Duct Sealing Commentary
 - m. Access Doors - CESCO #HADP-10 with cam latches, neoprene gasketing and insulated, one (1) inch thick.

- n. Acoustical Liner
 - In conformance w/SMACNA Standard
 - o. Welded
 - Coated with two (2) coats of corrosion Resistant aluminum paint.
 - Galvanized
 - Coated with two (2) coats of corrosion Resistant aluminum paint.
5. Circular Medium Pressure Ductwork shall be as manufactured by United Sheet Metal, Eastern or Semco, and shall consist of spiral pipe and welded fittings.
- a. Circular duct shall have locked seams so made as to eliminate any leakage under the pressures for which this system has been designed. Longitudinal seam duct shall have fusion welded butt seam. Circular duct shall be manufactured of galvanized steel meeting ASTM A653/A924 by the spiral lockseam method and in the minimum gauges listed:

<u>Diameter</u>	<u>Minimum Gauge</u>
3" thru 8"	26 Ga.
9" thru 14"	26 Ga.
15" thru 26"	24 Ga.
27" thru 36"	22 Ga.
37" thru 50"	20 Ga.

- b. All fittings are to have continuous welds along all seams. All divided flow fittings are to be manufactured as separate fittings, not as tap collars welded into spiral duct sections. Fittings and couplings shall be of the following minimum gauges:

<u>Diameter</u>	<u>Minimum Gauge</u>
3" thru 14"	24 Ga.
15" thru 26"	22 Ga.
27" thru 50"	20 Ga.

- c. All ninety (90) degree tees and forty-five (45) degree laterals, either full size or reducing, shall be conical pattern produced by machine or press forming. The entrance shall be free of weld build-up, burrs or irregularities. Provide tangential tees where indicated and required.
- d. Elbows in diameters three (3) inches through eight (8) inches shall be two (2) section die-stamped elbows. All other elbows shall be gored construction with all seams continuous-welded. Elbows shall be fabricated to a centerline radius of 1.5 times the cross section diameter. All elbows not die-stamped shall be fabricated according to the following schedule:

<u>Elbow Angle</u>	<u>Number of Gores</u>
Less than 30°	2
30° thru 60°	3
Over 60°	5

- e. The reduction of divided flow fittings shall be conical spun section in the thirty-six (36) reductions in sizes four (4) inches through twenty-two (22) inches.
- f. Spun bellmouth connections shall be used at each round take-off from the high pressure plenum.
- g. Offset fittings shall be constructed so that length of offset is not less than two (2) duct diameters.
- h. Galvanized areas that have been damaged by welding shall be coated with corrosion resistant aluminum paint, minimum two (2) coats.
- i. Supports and sealants shall conform with applicable portions of the medium pressure Duct Manual.
- j. Flexible ductwork shall be as previously specified for low pressure duct

systems.

2.06 INSULATED METAL PLENUM CASINGS

- A. Prefabricated acoustic/thermal plenums shall be installed where shown on the plans and shall be manufactured by Semco Incorporated, Vibro-Acoustics, Industrial Acoustics Company or Commercial Acoustics equal to Semco Incorporated "SilentAir" panels and components.
- B. Materials
 - 1. Acoustical enclosures shall be of dual wall tongue and groove panel construction finished and installed as located and sized on the contract drawings. The use of contractor's shop constructed enclosures shall not be allowed.
 - 2. Individual wall, floor and roof panels shall be constructed of 18 gauge, G90 galvanized steel, solid exterior skin and a 22 gauge, G90 galvanized steel, perforated interior skin. Panel thickness shall be 4" unless otherwise indicated on the drawings. Panels shall have a maximum width of 45 ½ inches. Panel spans up to 16'-0" shall be furnished as one piece.
 - 3. Perforated interior panel sheets shall be supplied with 3/32" diameter holes spaced on 3/16" staggered centers.
 - 4. Panel interior shall be completely filled with a minimum three pound per cubic foot density glass fiber insulation. Insulation shall be corrosion, moisture resistant, vermin proof and rated noncombustible as defined by NFPA Standard 220 when tested in accordance with ASTM E136.
 - 5. Internal longitudinal stiffeners shall be a minimum of 18-gauge galvanized steel and spaced so that the span does not exceed panel reinforcement 16" apart. Stiffeners shall have a depth equal to the panel thickness and be connected to both the inner and outer skin so as to provide an integral structural reinforcement within the panel.
 - 6. Double-wall insulated panels installed on the roof for the exhaust air connection to the exhaust fans structure shall have interior panels constructed of solid stainless steel.
- C. Construction
 - 1. Panel shall be constructed utilizing roll formed tongue and groove joints. Male edge of panel shall be metal enclosed and filled with insulation. Completed enclosures shall contain no insulation voids in joints between panels. Manufacturers furnishing individual panels with an open male channel shall fill the open channel with insulation as heretofore specified shall be attached permanently to the panel. Field insulation will not be allowed.
 - 2. In addition to panels, sufficient trim of a minimum of 16 gauge galvanized shall be provided in standard lengths to erect casing leaving no exposed panel edges. Base channel shall have 9/16" holes pre-punched 24" on center for securing with approved fasteners to curb or pad. Sufficient panel sealant and self-tapping fasteners shall be provided to erect enclosure per manufacturer's instructions.
 - 3. Panel sealant shall be a gray colored, single component, non-sag, non-staining, permanently flexible, gun-able butyl rubber of the highest quality and conforming to federal specification TT-S-001657 for "sealing compounds, single component, butyl rubber base, solvent release type."
 - 4. All duct openings shall be provided by the panel manufacturer. Penetrations made in the field shall be cut and sealed in accordance with manufacturer's instructions.
 - 5. Structural integrity of the completed enclosure shall provide for maximum panel deflections of 1/240 of free span when enclosure is subjected to a test pressure of 10" water column without the use of any fasteners at panel joints. Data used to

determine structural performance shall have been the result of independent testing of a representative sample of the manufacturer's regular production which shall have been certified by the independent tester. Panels shall have been tested by subjecting them to an air pressure simulating the loading imposed under normal operation. Panel tests as a result of application to artificial loads unevenly distributed over the entire panel surface will not be accepted.

6. Structural steel required to limit the deflection herein specified shall be designed and furnished by the enclosure manufacturer and installed by the contractor. All equipment supports shall be designed, furnished and installed by the contractor and shall be hot-dipped galvanized steel and shipped in standard lengths. Prime paint coating will not be accepted.

D. Performance

1. Acoustical performance for both airborne noise transmission and radiated noise transmission shall be as follows:

Sound Absorption Coefficients

Octave Band Frequency (Hz)	125	250	500	1000	2000	4000	NCR
(a) 2-inch panel construction	0.58	0.93	1.16	1.18	1.15	1.12	1.10
(b) 4-inch panel construction	0.70	1.14	1.18	1.14	1.14	1.16	1.15

Sound Transmission Losses

Octave Band Frequency (Hz)	125	250	500	1000	2000	4000	STC
(a) 2-inch panel construction	26	29	33	44	52	60	38
(b) 4-inch panel construction	26	32	38	51	60	67	43

2. The plenum installation shall be capable of withstanding a positive internal static air pressure of 10 inches w.g. and negative internal static air pressure of 10 inches w.g.
3. Thermal performance of all prefabricated panel assemblies shall have the following maximum thermal conductivities (U-value) at a mean temperature of seventy-five (75) degrees Fahrenheit.

2-inch panel construction	–	0.10 BTU/HR-Ft ² -°F
4-inch panel construction	–	0.06 BTU/HR-Ft ² -°F

4. The plenum design shall meet the combustion requirements as defined by NFPA Standard 220 when tested in accordance with ASTM E136. Surface burning characteristics per ASTM E84 shall be:

Flame Spread Classification	–	25
Smoke Developed	–	50

E. Certification

1. With submittals, the manufacturer shall provide certified test data on Transmission Loss and Sound Absorption Coefficients. The panel manufacturer shall have published data equal in all respects to panels manufactured by SEMCO Incorporated. Performance data certified by an industry recognized independent acoustical testing laboratory shall be submitted to the engineer to verify that the completed housing will meet or exceed the requirements in this specification. Such data shall have been the result of certified independent testing of a representative sample of the manufacturer's regular product in

accordance with applicable provisions of the American Society for Testing and Materials Procedures (423-77) and (E90-70). Performance of the enclosure shall not be impaired through prolonged exposure to noise, vibration, pressure or dampness.

2. The manufacturer shall warrant that when plenums are installed in a workmanlike manner in strict accordance with these specifications and instructions, plenums shall meet the acoustical, thermal and air pressure performance specified.
3. Plenum components shall be furnished clean, well made and free of defects adversely affecting appearance, serviceability or performance.

F. Submittals

1. Provide certified test data on transmission loss and sound absorption coefficients. Test data shall be for a standard product. Signed by manufacturers of casings certifying that the acoustic performance of factory-fabricated casings complies with requirements.
2. Show sound-absorption coefficients in each octave band equal to or greater than those scheduled, when tested according to ASTM C 423.
3. Show airborne sound transmission losses equal to or greater than those scheduled, when tested according to ASTM E 90.
4. Submit full "D" size approval drawings showing the following: Fabrication, assembly, and installation, including plans, elevations, sections and details. Also, show structural where required.

PART 3 - EXECUTION

3.01 AIR DEVICES

- A. Install air devices in accordance with the manufacturer's latest published installation instruction to insure against incorrect air pattern, drafts, and dirt smudging.
- B. Construct, and install sheet metal duct or plenum connections to air devices in accordance with terminal manufacturer's recommendations.
- C. Make modifications to the duct systems as required to accommodate actual sizes of air devices furnished, e.g., transformations and collar sizes without additional cost.
- D. Make joints between each devices and its components, connecting duct, or the mounting surface airtight, using gasket or its equivalent.

3.02 AIR TERMINAL UNITS

- A. Install units such that access panels, volume regulators and damper motors are readily accessible for maintenance and adjustment.
- B. Rigidly support units so they remain stationary. Provide cross-bracing or other means of stiffening as necessary. Use method of support such that distortion and maloperation of units cannot occur.

3.03 DUCTWORK

- A. Install hangers, supports, and their attachments, generally in conformance with SMACNA standard referred to in this section of the specifications and applicable portions of article "Piping, Conduit and Supports", of Division 15, Section "Mechanical

and Electrical General Provisions".

- B. Furnish hangers in accordance with SMACNA standards.
- C. Neatly erect ducts and plenums of sizes and arrangements shown and detailed and as required to carry out intent of specifications and drawings. Work must meet approval of the Architect in all its parts and details.
- D. Sizes shown are air side sizes. Where ducts are shown as lined, dimensions shall be increased to reflect that thickness of the lining.
- E. Install ductwork in such a manner as to meet the recommendations of NFPA Standard 90A.
- F. Provide each air outlet with a collar adequately stiffened, fastened, and made suitable for securing air device thereto. Make field changes in ductwork, such as those required to accommodate the sizes of factory fabricated equipment actually furnished, i.e., coils, air filters, fans, damper and air terminal units and similar items, without additional cost. Provide duct flanges to match those of connecting factory fabricated equipment. When necessary, relocate and modify ductwork to avoid obstructions such as structural members, piping and conduit, in a manner acceptable to the Architect.
- G. Construct and install all ductwork in accordance with the SMACNA Standards specified. Coordinate the installation of all duct systems with all other trades including plumbing, electrical, sprinkler, ceiling systems, etc.
- H. Leak Testing of Ductwork:
 - 1. When deemed necessary by the Architect, test low pressure ductwork for leaks by sealing openings and pressurizing system to that static pressures as indicated on the mechanical schedules. Use test methods approved by SMACNA and Architect. Seal all joints. Leakage shall not exceed three (3) percent of air flow specified at the system's nominal static pressure.
 - 2. Medium pressure ductwork shall be pressure tested as hereinbefore defined.

END OF SECTION 15800

SECTION 15850

BUILDING AUTOMATION AND TEMPERATURE CONTROL SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, General Requirements and all other Specification Sections apply to the work specified in this section.

1.02 SCOPE

- A. The project involves the expansion of the USC School of Public Health Building Automation and Central Energy Management System. A full communications interface and complete interoperability with the existing automatic temperature control system shall be provided to perform the functions herein described or indicated in the contract documents.
- B. The Building Automation System (BAS) manufacturer shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified.
- C. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation or identification number and sequence of operation all bearing the name of the manufacturer. The installing manufacturer shall certify in writing, that the shop drawings have been prepared by the equipment manufacturer and that the equipment manufacturer has supervised their installation. In addition, the equipment manufacturer shall certify, in writing, that the shop drawings were prepared by their company and that all temperature control equipment was installed under their direct supervision.
- D. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.
- E. BAS manufacturer shall be responsible for all BAS and Temperature Control wiring for a complete and operable system. All wiring shall be done in accordance with all local and national codes.

1.03 WORK BY OTHERS

- A. Mechanical contractor installs all wells, valves, taps, dampers, flow stations, etc. furnished by BAS manufacturer.
- B. Electrical Contractor provides:
 - 1. 120V power to all BAS and/or Temperature control panels. Where not shown on plans, locations shall be determined by the BAS contractor and coordinated with the Architect and electrical contractor.
 - 2. Wiring of all power feeds through all disconnect starters to electrical motor.

3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by BAS manufacturer
- C. Products furnished but not installed under this section
 1. Laboratory Airflow Control Device
 2. Control Valves
 3. Flow Switches
 4. Pressure and Temperature Sensor Wells and Sockets
 5. Flow Meters
 6. Automatic Dampers
- D. Products installed but not furnished under this section
 1. Smoke Detectors
- E. The control manufacturer shall cooperate with the air and water balancing agency in the performance of their work as required or directed.

1.04 QUALITY ASSURANCE

- A. The BAS system shall be designed and installed, commissioned and serviced by manufacturer employed, factory trained personnel. Manufacturer shall have an in-place support facility within 20 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment.
- B. The manufacturer shall provide full time, on site, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the BAS.
- C. The Bidder shall be regularly engaged in the manufacturing, installation and maintenance of BAS systems and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project.
- D. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.
- E. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network.

1.05 SUBMITTALS

- A. Submit complete sets of documentation in the following phased delivery schedule:
 1. Valve and damper schedules
 2. Equipment data cut sheets
 3. System schematics, including:
 - a. sequence of operations
 - b. point names
 - c. point addresses
 - d. interface wiring diagrams
 - e. panel layouts.
 - f. system riser diagrams

4. Auto-CAD compatible as-built drawings
- B. Upon project completion, submit operation and maintenance manuals, consisting of the following:
 1. Index sheet, listing contents in alphabetical order
 2. Manufacturer's equipment parts list of all functional components of the system, Auto-CAD disk of system schematics, including wiring diagrams
 3. Description of sequence of operations
 4. As-Built interconnection wiring diagrams
 5. Operator's Manual
 6. Trunk cable schematic showing remote electronic panel locations, and all trunk data
 7. List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.)
 8. Conduit routing diagrams

1.06 WARRANTY

- A. Provide all services, materials and equipment necessary for the successful operation of the entire BAS system for a period of one year after beneficial use.
- B. The adjustment, required testing, and repair of the system includes all computer equipment, transmission equipment and all sensors and control devices.
- C. The on-line support services shall allow the local BAS subcontractor to dial out over telephone lines to monitor and control the facility's building automation system. This remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays.

1.07 IDENTIFICATION

- A. Identify control wires and compressed air piping with a distinctive number on a nonconducting tag attached to each end or at junction points or by color coding of that wire or tube. Designate on control diagram the identifying color and/or number or other identifying designation used.
- B. Identify all control equipment and devices, including panels, controllers, valves, and automatic dampers, firestats, etc., by a method approved by the Architect. Designations shall match those used on control diagrams and shop drawings.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Johnson Controls Inc.

2.02 NETWORKING COMMUNICATIONS

- A. The design of the BAS shall network operator workstations and stand alone DDC Controllers. The network architecture shall consist of multiple levels for communication efficiency, a site-wide (Management Level Network) Ethernet network based on TCP/IP protocol, high performance peer to peer building level network(s) and DDC Controller floor level local area networks with access being totally transparent to the user when

accessing data or developing control programs.

- B. Peer to Peer Building Level Network:
 - 1. All operator devices either network resident or connected via dial up modems shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the peer to peer network. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time.
 - 2. The peer-to-peer network shall support a minimum of 100 DDC controllers and PC workstations
 - 3. Each PC workstation shall support a minimum of 4 peer to peer networks hardwired.
 - 4. The system shall support integration of third party systems. This system shall exchange data between the two systems for interprocess control. All exchange points shall have full system functionality as specified herein for hardwired points.

2.03 DDC CONTROLLER FLOOR LEVEL NETWORK:

- A. This level communication shall support a family of application specific controllers and shall communicate with the peer to peer network through DDC Controllers for transmission of global data.

2.04 DDC & HVAC MECHANICAL EQUIPMENT CONTROLLERS

- A. The DDC & HVAC Mechanical Equipment Controllers shall reside on the Building Level Network.
- B. DDC & HVAC Mechanical Equipment Controllers shall use the same programming language and tools. DDC & HVAC Mechanical Equipment Controllers which require different programming language or tools on a network are not acceptable.
- C. DDC & HVAC Mechanical Equipment Controllers which do not meet the functions specified for DDC Controllers or for HVAC Mechanical Equipment Controllers are not acceptable.

2.05 DDC CONTROLLER

- A. DDC Controllers shall be a 16-bit stand-alone, multi tasking, multi user, real time digital control processors consisting of modular hardware with plug in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point I/O schedule. Each controller shall support a minimum of three (3) Floor Level Application Specific Controller Device Networks.
- B. Each DDC Controller shall have sufficient memory to support its own operating system and databases, including:
 - 1. Control processes
 - 2. Energy management applications
 - 3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
 - 4. Historical/trend data for points specified
 - 5. Maintenance support applications
 - 6. Custom processes
 - 7. Operator I/O
 - 8. Dial up communications

9. Manual override monitoring
 - C. Each DDC Controller shall support firmware upgrades without the need to replace hardware.
 - D. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.
 - E. DDC Controllers shall provide a minimum two RS 232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. DDC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.
 - F. As indicated in the point I/O schedule, the operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points.
 1. Switches shall be mounted either within the DDC Controllers key accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.
 2. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.
 - G. DDC Controllers shall provide local LED status indication for each digital input and output for constant, up to date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.
 - H. Each DDC Controller shall continuously perform self diagnostics, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
 - I. Isolation shall be provided at all peer to peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
 1. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V
 2. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
 3. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
 4. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)
 - J. Isolation shall be provided at all peer to peer panel's AC input terminals to suppress induced voltage transients consistent with:
 1. IEEE Standard 587 1980
 2. UL 864 Supply Line Transients
 3. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)
 - K. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real time clock and all volatile memory for a

minimum of 60 days.

1. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
2. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS 232C port, via telephone line dial in or from a network workstation PC.

2.06 HVAC MECHANICAL EQUIPMENT CONTROLLERS

- A. HVAC Mechanical Equipment Controllers shall be a 12-bit stand-alone, multi tasking, multi user, real time digital control processors consisting of modular hardware with plug in enclosed processors.
- B. Each HVAC Mechanical Controller shall have sufficient memory to support its own operating system and databases, including:
 1. Control processes
 2. Energy management applications
 3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
 4. Historical/trend data for points specified
 5. Maintenance support applications
 6. Custom processes
 7. Operator I/O
 8. Dial up communications
- C. Each HVAC Mechanical Equipment Controller shall support firmware upgrades without the need to replace hardware.
- D. HVAC Mechanical Equipment Controllers shall provide a RS 232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals.
- E. HVAC Mechanical Equipment Controllers shall provide local LED status indication for each digital input and output for constant, up to date verification of all point conditions without the need for an operator I/O device.
- F. Each HVAC Mechanical Equipment Controller shall continuously perform self diagnostics, communication diagnosis and diagnosis of all components. The HVAC Mechanical Equipment Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
- G. Isolation shall be provided at all peer to peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
 1. RF-Conducted Immunity (RFI) per ENV 50141 (IEC 1000-4-6) at 3 V
 2. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
 3. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
 4. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)
- H. Isolation shall be provided at all peer to peer panel's AC input terminals to suppress induced voltage transients consistent with:
 1. IEEE Standard 587 1980
 2. UL 864 Supply Line Transients

3. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)
 - I. In the event of the loss of normal power, there shall be an orderly shutdown of all HVAC Mechanical Equipment Controllers to prevent the loss of database or operating system software. Non volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real time clock and all volatile memory for a minimum of 72 hours.
 1. Upon restoration of normal power, the HVAC Mechanical Equipment Controller shall automatically resume full operation without manual intervention.
 2. Should HVAC Mechanical Equipment Controller memory be lost for any reason, the user shall have the capability of reloading the HVAC Mechanical Equipment Controller via the local RS 232C port, via telephone line dial in or from a network workstation PC.

2.07 DDC & HVAC MECHANICAL EQUIPMENT CONTROLLER RESIDENT SOFTWARE FEATURES

- A. General:
 1. The software programs specified in this Section shall be provided as an integral part of DDC and HVAC Mechanical Equipment Controllers and shall not be dependent upon any higher level computer for execution.
 2. All points shall be identified by up to 30 character point name and 16 character point descriptor. The same names shall be used at the PC workstation.
 3. All digital points shall have user defined two-state status indication (descriptors with minimum of 8 characters allowed per state (i.e. summer/winter).
- B. Control Software Description:
 1. The DDC and HVAC Mechanical Equipment Controllers shall have the ability to perform the following pre tested control algorithms:
 - a. Two position control
 - b. Proportional control
 - c. Proportional plus integral control
 - d. Proportional, integral, plus derivative control
 - e. Automatic tuning of control loops
- C. DDC and HVAC Mechanical Equipment Controllers shall provide the following energy management routines for the purpose of optimizing energy consumption while maintaining occupant comfort.
 1. Start Stop Time Optimization (SSTO) shall automatically be coordinated with event scheduling. The SSTO program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by time of occupancy. The SSTO program shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period, and still maintain desired comfort conditions.
 - a. The SSTO program shall operate in both the heating and cooling seasons. It shall be possible to apply the SSTO program to individual fan systems. The SSTO program shall operate on both outside weather conditions as well as inside zone conditions and empirical factors.
 - b. The SSTO program shall meet the local code requirements for minimum outside air while the building is occupied.
 2. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.
 - a. It shall be possible to individually command a point or group of points.
 - b. For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start or stop within

- that group.
 - c. The operator shall be able to define the following information:
 - 1) Time, day
 - 2) Commands such as on, off, auto, and so forth.
 - 3) Time delays between successive commands.
 - 4) There shall be provisions for manual overriding of each schedule by an appropriate operator.
 - d. It shall be possible to schedule events up to one year in advance.
 - 1) Scheduling shall be calendar based.
 - 2) Holidays shall allow for different schedules.
 - 3. Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.
 - 4. Night setback control: The system shall provide the ability to automatically adjust setpoints for night control.
 - 5. The Peak Demand Limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.
 - a. PDL shall continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.
 - b. PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.
 - c. If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads.
 - d. Once the demand peak has passed, loads that have been shed shall be restored and returned to normal control.
- D. DDC and HVAC Mechanical Equipment Controllers shall be able to execute custom, job specific processes defined by the user, to automatically perform calculations and special control routines.
- 1. A single process shall be able to incorporate measured or calculated data from any and all other DDC and HVAC Mechanical Equipment Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC and HVAC Mechanical Equipment Controllers on the network. Database shall support 30 character, English language point names, structured for searching and logs.
 - 2. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial up connection to a remote device such as a printer or pager.
 - 3. DDC and HVAC Mechanical Equipment Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.
 - 4. DDC and HVAC Mechanical Equipment Controller shall be capable of comment lines for sequence of operation explanation.
- E. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC and HVAC Mechanical Equipment Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC and HVAC Mechanical Equipment Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
- 1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.

2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC and HVAC Mechanical Equipment Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start up. Users shall have the ability to manually inhibit alarm reporting for each point.
 3. Alarm reports and messages will be directed to a user defined list of operator devices or PCs based on time (after hours destinations) or based on priority.
 4. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
 5. In dial up applications, operator selected alarms shall initiate a call to a remote operator device.
- F. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.
1. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC and HVAC Mechanical Equipment Controllers point group. Two methods of collection shall be allowed: either by a pre defined time interval or upon a pre defined change of value. Sample intervals of 1 minute to 7 days shall be provided. Each DDC and HVAC Mechanical Equipment Controller shall have a dedicated RAM based buffer for trend data and shall be capable of storing a minimum of ___ data samples. All trend data shall be available for transfer to a Workstation without manual intervention.
 2. DDC and HVAC Mechanical Equipment Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator initiated automatic and manual loop tuning algorithms shall be provided for operator selected PID control loops as identified in the point I/O summary.
 - a. Loop tuning shall be capable of being initiated either locally at the DDC and HVAC Mechanical Equipment Controller, from a network workstation or remotely using dial in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.
- G. DDC and HVAC Mechanical Equipment Controllers shall be capable of automatically accumulating and storing run time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.
- H. The peer to peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to access any data from or send control commands and alarm reports directly to any other DDC and HVAC Mechanical Equipment Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC and HVAC Mechanical Equipment Controllers shall send alarm reports to multiple workstation without dependence upon a central or intermediate processing device. The peer to peer network shall also allow any DDC and HVAC Mechanical Equipment Controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.
- I. The peer to peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any PC workstation or portable operator

terminal) shall enable the operator to monitor, adjust and control the points that the operator is authorized for. All other points shall not be displayed on the PC workstation or portable terminal (e.g. all base building and all tenant points shall be accessible to any base building operators, but only tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.

2.08 LABORATORY AIRFLOW CONTROL

- A. Description: A laboratory airflow control system shall be furnished and installed to control the airflow into and out of laboratory rooms. This system shall be coordinated with the system as noted in other divisions of this specification. The exhaust flow rate of a laboratory fume hood shall be precisely controlled to maintain a constant average face velocity into the fume hood at either a standard/in-use or standby level based on an operator being present in front of the fume hood. The laboratory control system shall vary the amount of make-up/supply air into the room to operate the laboratories at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates, and maintain laboratory pressurization in relation to adjacent spaces (positive or negative.)
- B. Acceptable Manufacturers:
 - 1. Phoenix
 - 2. In accordance with this specification, alternative laboratory airflow control systems and equipment shall be considered for approval provided that the equipment be equal to the operational characteristics, capacities, and intent of control sequences specified herein. Approval to bid does not relieve the laboratory airflow control system supplier from complying with the minimum requirements or intent of this specification.
- C. Technical Proposal: Any alternate laboratory airflow control system supplier shall submit a detailed technical proposal for the Owner's evaluation. The proposal shall describe the manner of compliance with this minimum performance specification, with particular emphasis on the following areas: diversity and energy analysis; proposed equipment; experience; and performance verification.
- D. Preventive Maintenance: The laboratory airflow control system supplier shall provide at no additional cost to the Owner during and after the warranty period, five years of required preventative maintenance on all airflow sensors (e.g., pitot tube, flow cross, orifice ring, air bar, hot wire, vortex shedder, side wall sensors, etc.) and flow transducers provided under this section. Airflow sensors shall be removed, inspected, and cleaned annually during the first five years period to prevent inaccuracies due to long term buildup from corrosion, lab tissues, wet or sticky particles, or other materials that foul the sensor. If impractical to remove the airflow sensors, the laboratory airflow control system supplier shall include in the proposal the cost of supplying and installing duct access doors, one for each sensor. The transducer shall be checked and recalibrated annually to insure long-term accuracy. Note that auto-zero recalibration of transducers is not acceptable as a substitute for annual recalibration.
- E. Warranty Period: Warranty shall commence upon the date of shipment and extend for a period of thirty-six months whereupon any defects in materials or laboratory airflow control system performance shall be repaired by the supplier at no cost to the Owner.
- F. Laboratory Airflow Control System Description:
 - 1. Each individual laboratory shall have a dedicated laboratory airflow control system with zoning as defined on the drawings.

2. The laboratory airflow control system shall employ individual average face velocity controllers that directly measure the area of the fume hood sash opening and proportionally control the hood's exhaust airflow to maintain a constant face velocity over a minimum range of 20 to 100% of sash travel. The corresponding minimum hood exhaust flow turndown ratio shall be 5 to 1.
3. The hood exhaust airflow control device shall respond to the fume hood sash opening by achieving 90% or its commanded value within one second of the sash reaching 90% of its final position (with no more than 5% overshoot/undershoot) of required airflow. Rate of sash movement shall be between 1.0 to 1.5 feet per second.
4. The hood exhaust airflow control device shall be automatically switched between in-use and standby levels based on operator presence in front of the hood. A presence and motion sensor shall activate the switching. The airflow control device shall achieve the required in-use commanded value in less than one second from moment of detection with no more than a 5% overshoot or undershoot.
5. The laboratory airflow control system shall maintain specific airflow (+/-5% of signal within one second of a change in duct static pressure) regardless of the magnitude of the pressure change (within 0.6" to 3.0" wc,) airflow change or quantity of airflow control devices on the manifold.
6. The laboratory airflow control system shall use volumetric offset control to maintain room pressurization as defined on the air balance sheets in the drawings. The system shall maintain proper room pressurization polarity (negative or positive) regardless of any change in room/system conditions such as the raising and lowering of any or all fume hood sashes or rapid changes in duct static pressure. Systems using differential pressure measurement or velocity measurement to control room pressurization are unacceptable.
7. The laboratory airflow control system shall maintain specific airflow (+/-5% of signal) with a minimum 16 to 1 turndown to insure accurate pressurization at low airflow and guarantee the maximum system diversity and energy efficiency.

G. Airflow Control Sound Specifications:

1. Unless otherwise specified the airflow control device shall not exceed the sound power levels in Table 1, Table 2, or Table 3.
2. If the airflow control device cannot meet the sound power level specification, a properly sized silencer or sound attenuator must be used. All silencers must be of a packless design (constructed of at least 18 gauge 316L stainless steel when used with fume hood exhaust) with a maximum pressure drop at the device's maximum rated flow rate not to exceed 0.20 inches of water.
3. All proposed airflow control devices shall include discharge, exhaust, and radiated sound power level performance.
4. Table 1. Exhaust Airflow Control Device Sound Power Level (Airborne)

	Exhaust Sound Power Level in dB (re: 10 ⁻¹² watts)					
Octave Band Number	2	3	4	5	6	7
Center Frequency in Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
1000-50 cfm Device						
800 cfm @ 0.6" wc	63	55	52	54	50	49
200 cfm @ 0.6" wc	46	42	38	37	32	25
800 cfm @ 3.0" wc	73	70	64	66	65	60

200 cfm @ 3.0" wc	51	52	51	50	52	51
1500-100 cfm Device						
1200 cfm @ 0.6" wc	65	58	53	56	52	52
400 cfm @ 0.6" wc	50	45	38	39	37	31
1200 cfm @ 3.0" wc	72	70	62	65	64	60
400 cfm @ 3.0" wc	55	57	55	53	56	55
3000-200 cfm Device						
2400 cfm @ 0.6" wc	63	56	55	58	54	55
800 cfm @ 0.6" wc	51	45	41	42	39	34
2400 cfm @ 3.0" wc	74	71	65	69	67	63
800 cfm @ 3.0" wc	58	58	56	56	59	58

5. Table 2. Supply Airflow Control Device Sound Power Level (Airborne)

	Discharge Sound Power Level in dB (re: 10^{-12} watts)					
Octave Band Number	2	3	4	5	6	7
Center Frequency in Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
1000-50 cfm Device						
800 cfm @ 0.6" wc	62	57	54	58	54	51
200 cfm @ 0.6" wc	45	46	42	44	40	34
800 cfm @ 3.0" wc	72	71	67	75	72	68
200 cfm @ 3.0" wc	53	56	54	58	56	54
1500-100 cfm Device						
1200 cfm @ 0.6" wc	63	59	55	60	54	53
400 cfm @ 0.6" wc	53	49	44	49	45	39
1200 cfm @ 3.0" wc	72	73	69	77	72	68
400 cfm @ 3.0" wc	58	63	61	63	60	57
3000-200 cfm Device						
2400 cfm @ 0.6" wc	64	60	58	63	56	56
800 cfm @ 0.6" wc	52	48	47	52	46	41
2400 cfm @ 3.0" wc	75	75	72	78	73	70
800 cfm @ 3.0" wc	59	62	62	66	62	60

6. Table 3. Supply Airflow Control Device Sound Power Level (Radiated)

	Radiated Sound Power Level in dB (re: 10^{-12} watts)					
Octave Band Number	2	3	4	5	6	7

Center Frequency in Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
1000-50 cfm Device						
800 cfm @ 0.6" wc	44	41	45	41	36	34
200 cfm @ 0.6" wc	33	28	31	29	26	20
800 cfm @ 3.0" wc	53	53	56	57	55	53
200 cfm @ 3.0" wc	41	38	41	39	39	37
1500-100 cfm Device						
1200 cfm @ 0.6" wc	47	53	40	42	38	36
400 cfm @ 0.6" wc	35	39	31	34	33	26
1200 cfm @ 3.0" wc	52	60	54	60	59	53
400 cfm @ 3.0" wc	42	44	43	46	46	42
3000-200 cfm Device						
2400 cfm @ 0.6" wc	58	56	45	47	43	42
800 cfm @ 0.6" wc	45	43	36	39	37	29
2400 cfm @ 3.0" wc	69	68	60	65	63	57
800 cfm @ 3.0" wc	54	53	48	51	50	48

H. Usage Based Control Equipment:

1. For variable air volume (VAV) systems, a sensor shall be provided to measure the height of each vertically-moving fume hood sash. A sash sensor shall also be provided for horizontal overlapping sashes. Control systems employing sidewall mounted velocity sensors shall be unacceptable.
2. A presence and motion sensor shall be provided to determine an operator's presence in front of a hood by detecting the presence and/or motion of an operator, and to command the laboratory airflow control system from an in-use operating face velocity (e.g., 100 fpm) to a standby face velocity (e.g., 60 fpm) and vice versa.
 - a. The sensor shall define a detection zone that extends approximately 20" (50 cm) from the front of the fume hood. If the sensor does not detect presence and/or motion in its detection zone within five seconds, it shall command the system to the user adjustable standby face velocity. When the sensor detects the presence and/or motion of an operator within the detection zone, it shall command the system to the in-use face velocity within 1.0 second.
 - b. The sensor shall have a control circuit that adapts to its specific surroundings and automatically adjusts for inanimate objects placed within its detection zone. It shall map the area into memory and, after a period of five minutes, nullify the image of the inanimate object and return to a standby mode. Operators shall enter and leave the zone with the unit automatically adjusting between in-use and standby modes. If the inanimate object is moved or taken out of the zone, the unit shall automatically re-map the area.
 - c. Wide area motion detectors (on the hood or room level) shall be unacceptable.
3. The airflow at the fume hood shall vary in a linear manner between two adjustable minimum and maximum flow setpoints to maintain a constant face velocity throughout this range. A minimum volume flow shall be set to assure flow through

the fume hood even with the sash totally closed.

4. A fume hood monitor shall be provided to receive the sash sensor output and presence and/or motion signal. This same monitor shall generate an exhaust airflow control signal for the appropriate airflow control device in order to provide a constant average face velocity. Audible and separate visual alarms shall be provided for both flow alarm and emergency exhaust conditions.

I. Airflow Control Device – General:

1. The airflow control device shall be a venturi valve.
2. The airflow control device shall be pressure independent over its specified differential static pressure operating range. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifold system.
3. The airflow control device shall maintain accuracy within $\pm 5\%$ of signal over an airflow turndown range of no less than 16 to 1. No minimum entrance or exit duct diameters shall be required to ensure accuracy and/or pressure independence.
4. The airflow control device shall be constructed as follows:
 - a. The airflow control device for laboratories and corrosive airstreams such as fume hoods shall be 316 stainless steel with a baked on phenolic coating. The device's shaft shall be made of 316 stainless steel with a Teflon coating. The shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of 316 or 303 stainless steel. The pressure independent springs shall be a spring grade stainless steel. The internal nuts, bolts, and rivets shall be stainless steel. All shaft bearing surfaces shall be made of a Teflon or PPS (polyphenylene sulfide) composite.
5. Actuation:
 - a. Electrically-actuated VAV operation, UL 916 listed electronic actuator shall be factory mounted to the valve. Loss of main power shall cause the valve to position itself in an appropriate failsafe state. Options for these failsafe states include: normally open-maximum position, normally closed-minimum position, or last position. This position shall be maintained constantly without external influence, regardless of external conditions on the valve (within product specifications.)
6. Certification:
 - a. Each airflow control device shall be factory calibrated to the job specific airflows as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of no more than $\pm 1\%$ of signal over the entire range of measurement. Electronic airflow control devices shall be further calibrated and their accuracy verified to $\pm 5\%$ of signal at a minimum of eight different airflows across the full operating range of the device.
 - b. All airflow control devices shall be individually marked with device specific and factory characterization data. As a minimum, it should include: tag number, serial number, model number, characterization information (for electronic devices,) and quality control inspection numbers. All information shall be stored by the manufacturer. Job related information, such as tag number, serial number, and model number, shall be stored by the manufacturer for use with as-built documentation.
 - c. Airflow control devices that are not venturi valves, and airflow measuring devices (e.g., pitot tube, flow cross, air bar, orifice ring, vortex shedder, etc.) shall only be acceptable provided they meet all the performance and construction characteristics as stated throughout this specification and:
 - 1) The airflow control device employs transducers manufactured by

Rosemount, Bailey, Bristol, or Foxboro. Accuracy shall be no less than $\pm 0.15\%$ of span (to equal $\pm 5\%$ of signal with a 15 to 1 turndown) over the appropriate full-scale range including the combined effects of nonlinearity, hysteresis, repeatability, drift over a one year period, and temperature effect. 316L stainless steel materials shall be provided for all exhaust applications. The use of 304 stainless steel materials shall be provided for all make-up air applications

- 2) Airflow sensors shall be of a multi-point averaging type, 304 stainless steel for all supply and general exhaust applications, 316L stainless steel for all fume hood, canopy, snorkel, and biosafety cabinet applications. Single point sensors are not acceptable.
 - 3) Suppliers of airflow control devices or airflow measuring devices requiring minimum duct diameters shall provide revised duct layouts showing the required duct runs upstream and downstream of these devices. Coordination drawings reflecting these changes shall be submitted by the supplier of the laboratory airflow control system. In addition, suppliers shall include static pressure loss calculations as part of their submittals. All costs to modify the ductwork, increase the fan sizes and horsepower, and all associated electrical changes shall be borne by the laboratory airflow control supplier.
7. Exhaust and Supply Airflow Control Device: The airflow control device shall use closed loop control to linearly regulate airflow based on a 0 to 10 volt control signal. The device shall generate a 0 to 10 volt feedback signal that is linearly proportional to its airflow.
8. Laboratory Office Supply and General Purpose Airflow Control Device: The control device shall regulate flow based on a varying 0 to 10 volt electronic signal. The office supply or general purpose devices requiring flow feedback shall generate a 0 to 10 volt feedback signal that is linearly proportional to its airflow.
- J. Closed Loop Variable Frequency Drive:
1. The drive shall be a high performance pulse width modulated design which generates a sine-coded, adjustable voltage/frequency, three phase output for complete speed control of any conventional squirrel cage induction motor.
 2. The device shall not induce any voltage line notching distortion back to the utility line. The device shall maintain a displacement power factor of not less than .95 throughout its speed range. Synchronism between drive frequency and motor speed shall be maintained under all conditions.
 3. The drive shall automatically restart a coasting motor after a power outage of any duration without tripping or shutting down. The drive shall apply rated power to accelerate the motor to the commanded speed within 0.5 second of the reapplication of drive power or the removal of a motor fault condition.
 4. The drive shall accelerate the motor rapidly, limited only by the motor's rated torque and load.
 5. An alarm circuit indicating low face velocity shall be included to electronically sense a loss of airflow via a drop in actual (not calculated) motor power or a difference between the actual and commanded motor speed. The alarm shall be enunciated through audible and visual means at the fume hood monitor.
- K. Laboratory Control Unit:
1. A laboratory control unit shall control the supply and/or general exhaust airflow control devices to maintain proper room pressurization polarity (positive or negative.) Each individual laboratory shall have a dedicated laboratory control unit.
 2. The control unit shall be electronic. The inputs shall accept linear feedback signals from fume hood, equipment room, laboratory and office supply airflow control

- devices. The output signals shall control supply, general exhaust/return airflow control devices and/or variable frequency drives with signals that are linearly proportional to the desired supply or exhaust airflows.
3. The control unit shall maintain a constant design offset between the sum of the room's total exhaust and make-up/supply airflows. This offset shall be field adjustable and represents the volume of air which will enter (or exit) the room from the corridor or adjacent spaces.
 4. The control unit shall provide linear signals that are proportional to all airflow sources, sash sensors, and flow alarms. The signals shall be available for hard wired connection to the facility's direct digital control (DDC) system, or through an integrated control unit that interfaces directly into the facility's DDC system.
 5. The laboratory control unit may be either panel or valve mounted.
 6. Refer to the DDC Control specification for the required input/output summary for the necessary points to be monitored and/or controlled.
 7. Each laboratory shall have a dedicated 120 vac line connection to power the laboratory's airflow control system power supply.
- L. Reheat Coils: Terminal unit shall be provided with a hot water reheat coil. The control of the reheat coil shall be in conjunction with the terminal unit control. The terminal unit controller shall be responsible for the control of the reheat coil.
- M. Installation: The automatic temperature controls (ATC) contractor shall install the sash sensors, interface boxes, presence and motion sensor, and fume hood monitor on the fume hood under initial supervision of the laboratory airflow control system supplier. Reel-type sash sensors and their stainless steel cables shall be hidden from view. Bar-type sash sensors shall be affixed to the individual sash panels. Sash interface boxes with interface cards shall be mounted in an accessible location.
1. The ATC contractor shall install the laboratory control unit (if panel-mounted) and wall-mounted power supply (as required) in an accessible location in the designated laboratory room.
 2. The ATC contractor shall install 20 psi clean, dry, pneumatic supply air to all airflow control devices, except for constant volume devices.
 3. The ATC contractor shall terminate and connect all cables as required. In addition, integrated laboratory control unit connectors shall be furnished by the ATC.
 4. The mechanical contractor shall install all airflow control devices in the ductwork and shall connect all airflow control valve linkages.
 5. The mechanical contractor shall provide and install all reheat coils and transitions.
 6. The mechanical contractor shall provide and install insulation as required.
 7. The electrical contractor shall wire a dedicated, single phase 120 vac power circuit to the laboratory control unit or power supply.
- N. System Start-Up and Training:
1. System start-up shall be provided by a factory-authorized representative of the laboratory airflow control system manufacturer. Start-up shall include calibrating the fume hood monitor and any combination sash sensing equipment as required. Start-up shall also provide electronic verification of airflow (fume hood exhaust, supply, make-up, general exhaust, or return.)
 2. The balancing contractor shall be responsible for final verification and reporting of all airflows.
 3. The laboratory airflow control system supplier shall furnish a minimum of eight hours of Owner training, by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves, and general troubleshooting procedures.
 4. Operation and Maintenance manuals, including as-built wiring diagrams and component lists shall be provided for each training attendee.

2.09 FLOOR LEVEL NETWORK APPLICATION SPECIFIC CONTROLLERS (ASC)

- A. Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (ASCs) through Floor Level LAN Device Networks.
- B. Each ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor based, multi tasking, real time digital control processor. Each ASC shall be capable of control of the terminal device independent of the manufacturer of the terminal device.
- C. Terminal Equipment Controllers:
 - 1. Provide for control of each piece of equipment, including, but not limited to, the following:
 - a. Variable Air Volume (VAV) terminal units
 - b. Constant Air Volume (CAV) terminal units
 - c. Split System Air Conditioning Units
 - d. Fan Coil Units
 - e. Unit Heaters
 - 2. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, 3-15 psi pneumatic, 0-10v, allowing for interface to a variety of modulating actuators.
 - 3. All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the FLN, BLN or MLN is not acceptable.

2.10 PERSONAL COMPUTER OPERATOR WORKSTATION HARDWARE (EXISTING)

- A. All new system software, graphics, point database information, and programming shall be added to the existing Personal computer operator workstation.

2.11 WORKSTATION OPERATOR INTERFACE (EXISTING)

- A. Basic Interface Description
 - 1. Operator workstation interface software shall minimize operator training through the use of English language prompting, 30 character English language point identification, on-line help, and industry standard PC application software. The software shall provide, as a minimum, the following functionality:
 - a. Real-time graphical viewing and control of environment.
 - b. Scheduling and override of building operations.
 - c. Collection and analysis of historical data.
 - d. Point database editing, storage and downloading of controller databases.
 - e. Alarm reporting, routing, messaging, and acknowledgment.
- B. Dynamic Color Graphic Displays
 - 1. Color graphic floor plan displays and system schematics for each piece of mechanical equipment shall be installed under this contract. Graphics to be created include:
 - a. Building floor plan with area temperatures displayed.
 - b. Each air handling unit.
 - c. Each air terminal unit.
 - d. Chilled water system, including components and temperatures
 - e. Hot water system, including components and temperatures

2.12 FIELD DEVICES

- A. Provide instrumentation as required for monitoring, control or optimization functions.
- B. Room Temperature Sensors
1. Digital room sensors shall have LCD display, day / night override button, and setpoint slide adjustment override options. The setpoint slide adjustment can be software limited by the automation system to limit the amount of room adjustment.

Temperature monitoring range	+20°F to 120°F
Output signal	Changing resistance
Accuracy at Calibration point	+0.5°F
Set Point and Display Range	55° to 95° F
 2. Liquid immersion temperature:

Temperature monitoring range	+30°F to 250°F
Output signal	Changing resistance
Accuracy at Calibration point	+0.5°F
 3. Duct (single point) temperature:

Temperature monitoring range	+20°F to 120°F
Output signal	Changing resistance
Accuracy at Calibration point	+0.5°F
 4. Duct Average temperature:

Temperature monitoring range	+20°F to 120°F
Output signal	4 – 20 mA DC
Accuracy at Calibration point	+0.5°F
Sensor Probe Length	25 feet long
 5. Outside air temperature:

Temperature monitoring range	-58°F to 122°F
Output signal	4 – 20 mA DC
Accuracy at Calibration point	+0.5°F
- C. Liquid Differential Pressure Transmitter
- | | |
|-------------------------------|---|
| Ranges | 0-5/30 inches H ₂ O
0-25/150 inches H ₂ O
0-125/750 inches H ₂ O |
| Output signal | 4 – 20 mA DC |
| Accuracy at Calibration point | Zero and span |
| Accuracy | ± 0.2% of span |
| Linearity | ±0.1% of span |
| Hysteresis | ±0.05% of span |
- D. Differential pressure:
1. Unit for fluid flow proof:

Range	8 to 70 psi
Differential	3 psi

- | | | |
|--|-------------------------------|---------|
| | Maximum differential pressure | 200 psi |
| | Maximum pressure | 325 psi |
2. Unit for air flow:.
- | | |
|-------------------|---|
| Set point ranges: | 0.5" WG to 1.0" WG
1.0" WG to 12.0" WG |
|-------------------|---|
- E. Static Pressure Sensor:
- | | |
|-----------------------|---|
| Range | 0 to 0.5" WG
0 to 1" WG
0 to 2" WG
0 to 5" WG
0 to 10" WG |
| Output Signal | 4 – 20 mA VDC |
| Combined static error | 0.5% full range |
| Operating Temperature | -40°F to 175°F |
- F. Air Pressure Sensor:
- | | |
|---------------|--|
| Range | 0 to 0.1 " WG
0 to 0.25" WG
0 to 0.5 " WG
0 to 1" WG
0 to 2" WG
0 to 5" WG
0 to 10" WG |
| Output Signal | 4 – 20 mA VDC |
| Accuracy | ±1.0% of full scale |
- G. Humidity Sensors:
- | | |
|-----------------|----------------|
| Range | 0 to 100% RH |
| Sensing Element | Bulk Polymer |
| Output Signal | 4 – 20 mA VDC |
| Accuracy | ± 2%RH at 77°F |
- H. Insertion Flow Meters (Equal to Onicon Series F-1200 or FB-1200)
- | | |
|----------------------------|--|
| Type: | Dual turbine. Provide bi-directional where required. |
| Sensing Method | Impedance Sensing |
| Accuracy | ± 2% of Actual Reading |
| Maximum Operating Pressure | 400 PSI |
| Output Signal | 4 – 20 mA |
- I. Pressure to Current Transducer
- | | |
|---------------|---------------------------------|
| Range | 3 to 15 psig or 3 to 30 psig |
| Output Signal | 4 – 20 mA VDC |
| Accuracy | ± 1% of full scale (± 0.3 psig) |
- J. Carbon Dioxide:
1. Sensor shall be remote mounted non dispersive infrared carbon dioxide optical diffusion gas cell type with pulsed source and non-free air optical path. Sensing

cell shall be provided with thirty (30) inch cable for duct mounting. Sensor shall produce linear analog 0-1 Volt DC, 4-20 MA, and binary adjustable switch point form C outputs. Range shall be 0-2000 parts per million with accuracy of three (3) percent. Sensor shall be mounted in weather tight enclosure with forty-one (41) degree Fahrenheit to 104 degree Fahrenheit operating temperature.

K. Control Valves (all control valves shall have electric actuators)

Rangeability	40:1
Flow Characteristics	Modified. Equal percentage
Control Action	Normal open or closed as selected
Medium	Steam, water, glycol
Body Type	Valves 2" and smaller- screwed ends Valves 2½" and larger – flanged
Body Material	Bronze
Body Trim	Bronze
Stem	Stainless Steel
Actuator	0-10 VDC Floating or 2 position 24 VAC/120VAC

L. Damper Actuators

1. Electric control shall be direct coupled actuators.
2. Damper actuators shall be Brushless DC Motor Technology with stall protection, bi-directional, fail safe spring return, all metal housing, manual override, independently adjustable dual auxiliary switch.
 - a. The actuator assembly shall include the necessary hardware and proper mounting and connection to a standard ½" diameter shaft or damper blade.
3. Actuators shall be designed for mounting directly to the damper shaft without the need for connecting linkages.
4. All actuators having more than 100 lb-in torque output shall have a self-centering damper shaft clamp that guarantees concentric alignment of the actuator's output coupling with the damper shaft. The self-centering clamp shall have a pair of opposed "v" shaped toothed cradles; each having two rows of teeth to maximize holding strength. A single clamping bolt shall simultaneously drive both cradles into contact with the damper shaft.
5. All actuators having more than a 100 lb-in torque output shall accept a 1" diameter shaft directly, without the need for auxiliary adapters.
6. All actuators shall be designed and manufactured using ISO9000 registered procedures, and shall be Listed under Standards UL873 and CSA22.2 No. 24-93 I.

2.13 MISCELLANEOUS DEVICES

A. Thermostats

1. Room thermostats shall be of the gradual acting type with adjustable sensitivity.
2. They shall have a bi-metal sensing element capable of responding to a temperature change of one-tenth of one degree. (Provide all thermostats with limit stops to limit adjustments as required.)
3. Thermostats shall be arranged for either horizontal or vertical mounting.
4. In the vertical position thermostat shall fit on a mullion of movable partitions without overlap.
5. Mount the thermostat covers with tamper-proof socket head screws.

B. Firestats:

1. Provide manual reset, fixed temperature line voltage type with a bi-metal actuated switch.
 - a. Switch shall have adequate rating for required load.

- C. Electronic Airflow Measurement Stations and Transmitters (At Duct Locations).
 - 1. Each insertion station shall contain an array of velocity sensing elements and straightening vanes. The velocity sensing elements shall be of the RTD or thermistor type. The sensing elements shall be distributed across the duct cross section in a quality to provide accurate readings. The resistance to airflow through the airflow measurement station shall not exceed 0.08 inches water gage at an airflow of 2,000 fpm. Station construction shall be suitable for operation at airflow of up to 5,000 fpm over a temperature range of 40 to 120 degrees F, and accuracy shall be plus or minus 3 percent over a range of 125 to 2,500 fpm scaled to air volume. Each transmitter shall produce a linear, temperature compensated 4 to 40 mA DC, output corresponding to the required velocity pressure measurement.
- D. Current Sensing Relay:
 - 1. Provide solid-state, adjustable, current operated relay. Provide a relay which changes switch contact state in response to an adjustable set point value of current in the monitored A/C circuit.
 - 2. Adjust the relay switch point so that the relay responds to motor operation under load as an "on" state and so that the relay responds to an unloaded running motor as an "off" state. A motor with a broken belt is considered an unloaded motor.
 - 3. Provide for status device for all fans and pumps.
- E. Fire and Smoke Control Devices
 - 1. Provide all smoke detection devices as required by NFPA Standard 90A and the International Building Code.

PART 3 - EXECUTION

3.01 PROJECT MANAGEMENT

- A. Provide a designated project manager who will be responsible for the following:
 - 1. Construct and maintain project schedule
 - 2. On-site coordination with all applicable trades, subcontractors, and other integration vendors
 - 3. Authorized to accept and execute orders or instructions from owner/architect
 - 4. Attend project meetings as necessary to avoid conflicts and delays
 - 5. Make necessary field decisions relating to this scope of work
 - 6. Coordination/Single point of contact

3.02 INSTALLATION

- A. Provide control/power wiring and conduit to connect the automatic temperature control system and all HVAC system components for a complete operational system.
 - 1. Provide wiring in accordance with the NFPA 70.
 - 2. Do not bury or conceal wiring beneath insulation.
 - 3. Locate wiring clear of access doors, accessible ceilings, lighting fixtures, walkways, or any location subject to damage or abrasion.
- B. Label or code each field wire at each end, and each controller and controlled device.
 - 1. Identification shall be permanent, not subject to fading, flameproof, and approved by the Architect.
 - 2. Permanently mark terminal blocks at wire termination points.
 - 3. Identify each control device with an engraved laminated phenolic nameplate, white on black, lettering not less than 1/8 inch high, on 1 1/2 inch by 1 inch tag and brass interlocked chain secured to the control device. Name shall correspond with identification on the shop drawings.

4. Identify sensors, controllers, relays, either mounted in local or central control panels, or remote mounted with a similar name tag as specified above. Attach to or adjacent to controllers with stainless steel or brass screws or rivets. Adhesives will not be acceptable. Do not attach to removable controller covers.
- C. Mount strap on sensors using helical screw stainless steel band clamps install strap on thermostats, aquastats and other temperature sensors on new piping only after the pipe surface is cleaned to bright metal. Strap on sensor may be used on piping up to 2 1/2 inch diameter. On pipe three (3) inches and larger pipe wells shall be used.
- D. Install valves in piping with stems as vertical as possible but in no case less than forty-five (45) degrees from vertical. For soldered or welded connections, remove valve internals before installation.
- E. Wire electric valves in accordance with NFPA 70 with not less than two (2) feet of flexible liquidtight connector with watertight bushings at the valve actuator and conduit termination. Brace conduit to the building structure to prevent movement and damage.
- F. Install pressure and temperature sensors as follows.
 1. Locate pressure and temperature sensing points sufficiently downstream from the control device to increase control loop time constant and minimize hunting.
 2. Locate shut off valves and three (3) valve bypasses as specified and as required to service sensors.
 3. Locate sensors where accessible for maintenance and replacement.
 4. Do not cover or conceal sensors with insulation.
- G. Locate each controller inside local field cabinets with instrumentation, pressure gauges, voltmeters or milliammeters to show, at the controller location, the condition of input power supply, input controller signal, and branch line signal. Indicators shall be permanently mounted.
- H. Provide wells for all sensors and indicators measuring temperatures in pressure vessels and piping.
 1. Wells shall be stainless steel or bronze to match media requirements.
 2. Verify working pressure of each sensor well installed.
 3. Do not install wells in extension couplings.
 4. Where pipe diameters are smaller than the well length, provide wells at piping elbow or tees to affect flow across the entire well area.
 5. Wells may face upstream or downstream.
 6. Install pipe wells above the horizontal to retain liquid heat transfer fluid in the well during assembly and maintenance
 7. If pipe wells restrict cross sectional pipe area to less than seventy (70) percent free area, provide pipe increases at the well not less than 150 percent pipe diameter.
- I. Dampers
 1. Mount dampers with the pivot rods in a horizontal position, except where suitable thrust bearings are provided, damper blade pivot rods may be a position other than horizontal.
 2. Mount operators outside of the duct or casing, on support plates that are completely outside the insulation and lagging. On casings or ducts handling cold air, install support plates in a manner that will prevent condensation on damper operator or on supports.

3.03 START-UP AND COMMISSIONING

- A. When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the manufacturer. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power.
- B. Provide any recommendation for system modification in writing to owner. Do not make any system modification, including operating parameters and control settings, without prior approval of owner.
- C. After manufacturer has completed system start-up and commissioning. Joint commissioning of integrated system segments shall be completed.
- D. A total of 80 man-hours shall be included in the project for the purpose of project commissioning.

3.04 ELECTRICAL WIRING AND MATERIALS

- A. Install, connect and wire the items included under this Section. This work includes providing required conduit, wire, fittings, and related wiring accessories. All wiring shall be installed in conduit.
- B. Electrical work required for the control system shall be performed by and under the direction of the control manufacturer. All electrical work shall be performed in accordance with the requirements of Division 16, ELECTRICAL of this specification. Use materials specified in Division 16, ELECTRICAL for comparable application.
- C. Provide 120 volt, single phase, 60 hertz power to every BAS DDC Controller panel, HVAC/Mechanical Equipment Controller, PC console, power supply, transformer, annunciator, modems, printers and to other devices as required. The power supplies are to be extended in conduit and wire from normal power circuit breakers.
- D. Provide status function conduit and wiring for equipment covered under this Section.
- E. Provide conduit and wiring between the BAS panels and the temperature, humidity, or pressure sensing elements, including low voltage control wiring in conduit.
- F. Provide conduit and signal wiring between motor starters in motor control centers and high and/or low temperature relay contacts and remote relays in BAS panels located in the vicinity of motor control centers.
- G. Provide conduit and wiring between the PC workstation, electrical panels, metering instrumentation, indicating devices, miscellaneous alarm points, remotely operated contractors, and BAS panels, as shown on the drawings or as specified.
- H. All wiring to be compliant to local building code and the NEC.
- I. Provide electrical wall box and conduit sleeve for all wall mounted devices.

3.05 PERFORMANCE

- A. Unless stated otherwise, control temperatures within plus or minus 2°F, and humidity

within plus or minus 2% of the set point and static pressure within 10% of set point.

3.06 COMMISSIONING, TESTING AND ACCEPTANCE

- A. Perform a three-phase commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets which shall be submitted prior to acceptance testing. Commissioning work which requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required. The commissioning must be coordinated with the owner and construction manager to ensure systems are available when needed. Notify the operating personal in writing of the testing schedule so that authorized personnel from the owner and construction manager are present throughout the commissioning procedure.
 - 1. Prior to system program commissioning, verify that each control panel has been installed according to plans, specifications and approved shop drawings. Test, calibrate and bring on line each control sensor and device. Commissioning to include, but not be limited to:
 - a. Sensor accuracy at 10, 50 and 90% of range.
 - b. Sensor range.
 - c. Verify analog limit and binary alarm reporting.
 - d. Point value reporting.
 - e. Binary alarm and switch settings.
 - f. Actuator ranges.
 - g. Fail safe operation on loss of control signal, electric power, network communications.
- B. After control devices have been commissioned (i.e. calibrated, tested and signed off), each BMS program shall be put on line and commissioned. The contractor shall, in the presence of the owner and construction manager, demonstrate each programmed sequence of operation and compare the results in writing. In addition, each control loop shall be tested to verify proper response and stable control, within specified accuracy's. System program test results shall be recorded on commissioning data sheets and submitted for record. Any discrepancies between the specification and the actual performance will be immediately rectified and retested.
- C. After all BMS programs have been commissioned, the contractor shall verify the overall system performance as specified. Tests shall include, but not be limited to:
 - 1. Data communication, both normal and failure modes.
 - 2. Fully loaded system response time.
 - 3. Impact of component failures on system performance and system operation.
 - 4. Time/Date changes.
 - 5. End of month/ end of year operation.
 - 6. Season changeover.
 - 7. Global application programs and point sharing.
 - 8. System backup and reloading.
 - 9. System status displays.
 - 10. Diagnostic functions.
 - 11. Power failure routines.
 - 12. Battery backup.
 - 13. Smoke Control, stair pressurization, stair, vents, in concert with Fire Alarm System testing.
 - 14. Testing of all electrical and HVAC systems with other division of work.
- D. Submit for approval, a detailed acceptance test procedure designed to demonstrate compliance with contractual requirements. This Acceptance test procedure will take place

after the commissioning procedure but before final acceptance, to verify that sensors and control devices maintain specified accuracy's and the system performance does not degrade over time.

- E. Using the commissioning test data sheets, the contractor shall demonstrate each point. The contractor shall also demonstrate all system functions. The contractor shall demonstrate all points and system functions until all devices and functions meet specification.
- F. The contractor shall supply all instruments for testing and turn over same to the owner after acceptance testing.
 - 1. All test instruments shall be submitted for approval.
 - 2. Test Instrument Accuracy:

Temperature:	1/4 °F or 1/2% full scale, whichever is less.
High Pressure:	1/2 psi or 1/2% full scale, whichever is less.
Low Pressure	1/2% full scale
Humidity:	2% RH
Electrical:	1/4% full scale

- G. After the above tests are complete and the system is demonstrated to be functioning as specified, a thirty day performance test period shall begin. If the system performs as specified throughout the test period, requiring only routine maintenance, the system shall be accepted. If the system fails during the test, and cannot be fully corrected within eight hours, the owner may request that performance tests be repeated.

3.07 TRAINING

- A. The manufacturer shall provide factory trained instructor to give full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The manufacturer shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 am to 4:30 PM weekdays.
- B. Provide 8 hours of training for Owner's designated operating personnel. Training shall include:
 - 1. Explanation of drawings, operations and maintenance manuals
 - 2. Walk-through of the job to locate control components
 - 3. Operator workstation and peripherals
 - 4. DDC controller and ASC operation/function
 - 5. Operator control functions including graphic generation and field panel programming
 - 6. Explanation of adjustment, calibration and replacement procedures
 - 7. Student binder with training modules
- C. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Manufacturer. If such training is required by the Owner, it will be contracted at a later date.

3.08 TEMPERATURE CONTROL

- A. The sequences on the drawings describe the general intent of the control systems. Provide all devices, equipment, and wiring as required to perform the sequences described.

- B. Unless otherwise noted, size all automatic control valves for maximum ten (10) feet water pressure drop at maximum design flow rate.
- C. See plans for locations of all room thermostats, panels, dampers, valves, and equipment; where such devices are not indicated, however required by the sequences they shall be provided and located in the field by the Architect.
- D. Division 16 shall provide all detection devices (heat/smoke) as required by NFPA Standard 90A and the International Building and Mechanical Codes. The installation of detection devices and all control/power wiring for smoke detection devices and smoke dampers shall be provided under this section. Detection devices shall provide automatic shutdown of the HVAC systems in accordance with NFPA 90A.
- E. All fans shall be provided with a current sensors installed around the fan. Sensors shall provide status for pump and fan operation.
- F. All temperature, humidity, pressure, and time set points shall be fully adjustable from the BAS.
- G. Where used to control both comfort heating and cooling, zone thermostatic controls shall be capable of providing a temperature range or dead band of at least 5°F within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum. Variable air volume (VAV) terminal units shall be programmed to operate at the minimum airflow setting without addition of reheat when the zone temperature is within the set deadband.
- H. Provide all hardware, software, devices, equipment, and wiring as required to interface with the BAS.
- I. All two (2) position dampers shall be proven open by the use of end switches.
- J. Refer to input/output summary schedule for additional control items not described in the sequences. Input/output summary are minimum requirements, provide all required points for complete operation of system.
- K. All variable frequency drives for fan shall be soft started at minimum speed and increased to operating speed by the BAS.

END OF SECTION 15850

SECTION 15990
TESTING AND BALANCING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, General Requirements and all other Specification Sections apply to the work specified in this section.

1.02 SUMMARY

- A. This Section includes TAB to produce design objectives for the following:
 - 1. Air Systems:
 - a. Variable-air-volume systems.
 - 2. Hydronic Piping Systems:
 - a. Variable-flow systems.
 - 3. HVAC equipment quantitative-performance settings.
 - 4. Laboratory fume hood airflow balancing.
 - 5. Space pressurization testing and balancing
 - 6. Verifying that automatic control devices are functioning properly.
 - 7. Reporting results of activities and procedures specified in this Section.

1.03 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.
- C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- E. NC: Noise criteria.
- F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- G. RC: Room criteria.
- H. Report Forms: Test data sheets for recording test data in logical order.

- I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- M. TAB: Testing, adjusting, and balancing.
- N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- O. Test: A procedure to determine quantitative performance of a system or equipment.
- P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.04 QUALIFICATIONS

- A. Work included in this section must be performed by an independent testing and balancing agency, certified by either AABC or NEBB, who shall provide a complete and comprehensive total system balance process to test, adjust, and balance the air and water systems for this project. Submit the name of the air balance firm for approval within thirty (30) days after award of contract.
- B. If the Contractor fails to submit the name of an acceptable agency within the specified time, the Architect will select a firm to accomplish the work, and the selection shall be binding at no additional cost to the Owner.
- C. All work shall be performed under direct supervision of a qualified engineer. All instruments used shall be accurately calibrated and maintained in good working order. If requested, calibration tests of equipment to be used shall be performed in the presence of the Architect.
- D. Submit for review and approval the names of the personnel who will be responsible for the work and those who will actually perform the testing and balancing and their qualification, which shall demonstrate that they have balanced and tested systems of comparable size and complexity.

1.05 SUBMITTALS

- A. Qualification Data: Within 45 days from Contractor's Notice to Proceed, submit 6 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

- B. Contract Documents Examination Report: Within 60 days from Contractor's Notice to Proceed, submit 6 copies of the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 90 days from Contractor's Notice to Proceed, submit 6 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
- D. Certified TAB Reports: Submit six copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- E. Warranties specified in this Section.

1.06 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.
- B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items: Include at least the following:
 - a. Submittal distribution requirements.
 - b. The Contract Documents examination report.
 - c. TAB plan.
 - d. Work schedule and Project-site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.
- C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
- E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" and NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
- F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by the instrument manufacturer.
 - 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.07 PROJECT CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.08 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.09 WARRANTY

- A. National Project Performance Guarantee: If AABC standards are used, provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
- B. Special Guarantee: If NEBB standards are used, provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents.
- C. Guarantee includes the following provisions:
 - 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

1.10 TEST PROCEDURE

- A. System may be tested in sections when approved by the Architect.
- B. When testing and balancing involve the building temperature control systems, cooperate with the temperature control subcontractor to achieve the desired results.
- C. At the time of final inspection, recheck in the presence and at the request of the Architect not to exceed ten (10) percent of the previously recorded readings from the certified report selected at random from the log by the Architect.
- D. Permanently mark the settings of valves, dampers, and other adjustment devices so that adjustment can be restored if disturbed at any time. Do not permanently mark devices before final acceptance.

- E. Perform all tests in accordance with AABC standard procedures. Any deviation from same must be approved by the Architect.
- F. Should the basic system or any of its components fail to meet contract requirements, and thereby make the testing and balancing work invalid, notify the Architect and stop all tests until such time that the failure is corrected.

PART 2 - PRODUCTS

2.01 TEST INSTRUMENTS

- A. Use instruments of equal or better quality than those described in the technical portions of Associated Air Balance Council--"National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems, Fifth Edition 1989.
- B. Instruments used for balancing air and water systems must have been calibrated within a period of six (6) months prior to balancing.
- C. List in the report types, serial numbers, and dates of calibration of all instruments used in the final air and water balance tests.
- D. Instrumentation shall include, as a minimum, the following items of equipment:
 - 1. Pressure gauges and fittings.
 - 2. Dry bulb and wet bulb thermostats.
 - 3. Contact pyrometer.
 - 4. Portable flow meter and, if required, orifice plates.
 - 5. Pitot tube and manometers.
 - 6. Anor Velometer with attachments.
 - 7. Amprobe.
 - 8. Tachometer.
 - 9. Special wrenches and tools.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
 - 1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
 - 2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.

- C. Examine project record documents described in Division 1 Section "Project Record Documents."
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
- G. Examine system and equipment test reports.
- H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- K. Examine supply and exhaust air terminal units to verify that they are accessible and their controls are connected and functioning.
- L. Examine strainers for clean screens and proper perforations.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine equipment for installation and for properly operating safety interlocks and controls.
- O. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions.

4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 6. Sensors are located to sense only the intended conditions.
 7. Sequence of operation for control modes is according to the Contract Documents.
 8. Controller set points are set at design values.
 9. Interlocked systems are operating.
 10. Changeover from heating to cooling mode occurs according to indicated values.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
1. Permanent electrical power wiring is complete.
 2. Hydronic systems are filled, clean, and free of air.
 3. Automatic temperature-control systems are operational.
 4. Equipment and duct access doors are securely closed.
 5. Balance, smoke, and fire dampers are open.
 6. Isolating and balancing valves are open and control valves are operational.
 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 8. Windows and doors can be closed so indicated design conditions for system operations can be met.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. All air distribution systems including supply, return and exhaust ductwork shall be tested and balanced.
- B. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- C. Prepare schematic diagrams of systems' "as-built" duct layouts.
- D. For variable-air-volume systems, develop a plan to simulate diversity.
- E. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- F. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- G. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- H. Verify that motor starters are equipped with properly sized thermal protection.
- I. Check dampers for proper position to achieve desired airflow path.
- J. Check for airflow blockages.
- K. Check condensate drains for proper connections and functioning.
- L. Check for proper sealing of air-handling unit components.
- M. Check for proper sealing of air duct system.
- N. Where the system cannot be properly balanced or equipment tested due to system deficiencies such as inability to properly adjust fan speeds, improperly sized motors, excessively noisy equipment, malfunctioning controls, excessively out of balance air distribution system branch runs, and similar items, furnish to the Architect in writing a list of the deficiencies prior to the submission of the test report.
- O. Verify operation of each room thermostat serving variable air volume terminal units over full range of heating and cooling to insure proper sequence of control of the variable air volume operator and reheat coil valve.
- P. Field test maximum and minimum air volumes of all variable air volume terminal units and record final settings. Check factory settings of regulators and controllers before tests. Reset to the scheduled air volumes if required.
- Q. Work in conjunction with the Automatic Temperature Control Contractor and Architect to establish maximum and minimum settings on all variable air volume fans.

3.05 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
 - 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge duct losses.
 - 3. Measure total system airflow. Adjust to within indicated airflow.
 - 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 - 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
 - 6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
 - 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure adequate static pressure is maintained at the most critical unit.
 - 8. Record the final fan performance data.

3.06 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check expansion tank liquid level and tank pressure.
 - 3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
 - 4. Check flow-control valves for specified sequence of operation and set at indicated flow.

5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type, unless several terminal valves are kept open.
 6. Set system controls so automatic valves are wide open to heat exchangers.
 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.
- D. Where liquid flow balancing cannot be accomplished due to system deficiencies such as excessive or lack of pumping head, inadequately sized motors, pressure drops not determinable or similar problems, prepare a list of such deficiencies and the suggested system modifications and furnish to the Architect in writing and prior to submission of test report for necessary action.

3.07 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark the pump manufacturer's head-capacity curve. Adjust pump discharge valve until design water flow is achieved.
 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on the pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than design flow.
- E. Adjust balancing stations to within specified tolerances of design flow rate as follows:
1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.
- F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures, including outdoor-air temperature.

- G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.08 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.09 GENERAL PROCEDURES FOR EQUIPMENT

- A. Conduct performance tests only after the air and water systems have been balanced and the proper flow rates established.
- B. Test and record capacity of heat transfer equipment including all coils. Air side and water side capacities must agree within five (5) percent of each other. Include the manufacturer's rated capacity at the test operating conditions with the report. Perform tests where possible at design conditions. If tests are not performed under design conditions, interpolate results to determine capacity at full load operating conditions.
- C. Calculate efficiency of fans by recognized methods using test data.

3.10 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer, model, and serial numbers.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.11 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Water Coils: Measure the following data for each coil:
 - 1. Entering- and leaving-water temperatures.
 - 2. Water flow rate.
 - 3. Water pressure drop.
 - 4. Dry-bulb temperatures of entering and leaving air.
 - 5. Wet-bulb temperatures of entering and leaving air for cooling coils.
 - 6. Airflow.
 - 7. Air pressure drop.

3.12 PROCEDURES TEMPERATURE TESTING

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

3.13 PROCEDURES FOR LABORATORY FUME HOODS

- A. Before performing laboratory fume hood testing, measure, adjust and record the supply airflow and airflow patterns of each supply air outlet that is located in the same room as the hood. Adjust the air outlet flow pattern to minimize turbulence and to achieve the desired airflow patterns at the face and inside the hood. Verify that adequate makeup air is available to achieve the indicated flow of the hood.
- B. Measure, adjust, and record the airflow of each laboratory fume hood by duct Pitot-tube traverse with the laboratory fume hood sash in the design open position.
 - 1. For laboratory fume hoods installed in variable exhaust systems, measure, adjust, and record the hood exhaust airflow at maximum and at minimum airflow conditions.
 - 2. For laboratory fume hoods designed with integral makeup air, measure, adjust, and record the exhaust and makeup airflow.
- C. For laboratory fume hoods that are connected to centralized exhaust systems using automatic dampers, adjust the damper controller to obtain the indicated exhaust airflow.
- D. After balancing is complete, do the following:
 - 1. Measure and record the static pressure at the hood duct connection with the hood operating at indicated airflow.
 - 2. Measure and record the face velocity across the open sash face area. Measure the face velocity at each point in a grid pattern. Perform measurements at a maximum of 12 inches between points and between any point and the perimeter of the opening.
 - a. For laboratory fume hoods designed to maintain a constant face velocity at varying sash positions, also measure and record the face velocity at 50 and 25 percent of the design open sash position.
 - b. Calculate and report the average face velocity by averaging all velocity measurements.
 - c. Calculate and report the exhaust airflow by multiplying the calculated average face velocity by the sash open area. Compare this quantity with the exhaust airflow measured by duct Pitot-tube traverse. Report differences.
 - d. If the average face velocity is less than the indicated face velocity, retest the average face velocity and adjust hood baffles, fan drives, and other parts of the system to provide the indicated average face velocity.
 - 3. Check each laboratory fume hood for the capture and containment of smoke by using a hand-held emitting device. Observe the capture and containment of smoke flow pattern across the open face and inside the hood. Make adjustments necessary to achieve the desired results.

- E. With the room and laboratory fume hoods operating at indicated conditions, perform an "as-installed" performance test of the laboratory fume hood according to ASHRAE 110. Test each laboratory fume hood(s) and document the test results.

3.14 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS AND ADJUSTMENTS

- A. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.
- B. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions.
- C. Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.
 - 1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
 - 2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
 - 3. Test room pressurization first, then zones, and finish with building pressurization.
- D. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.
- E. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.
 - 1. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
 - 2. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test overpressurization and underpressurization, and observe and report on the system's ability to revert to the set point.
 - 3. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.
- F. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.
- G. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

3.15 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.

- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Check free travel and proper operation of control devices such as damper and valve operators.
- F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.
- G. Check the interaction of electrically operated switch transducers.
- H. Check the interaction of interlock and lockout systems.
- I. Check main control supply-air pressure and observe compressor and dryer operations.
- J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
- K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.16 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.17 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of the instruments used for procedures, along with proof of calibration.

- C. Final Report Contents: In addition to the certified field report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

- D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of TAB firm.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB firm who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents, including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer, type size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports varies from indicated values.
 - 15. Test conditions for fans and pump performance forms, including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings, including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.

- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outside, supply, return, and exhaust airflows.
 - 2. Water and steam flow rates.
 - 3. Duct, outlet, and inlet sizes.
 - 4. Pipe and valve sizes and locations.
 - 5. Terminal units.
 - 6. Balancing stations.
 - 7. Position of balancing devices.

- F. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.

- c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Sheave dimensions, center-to-center and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center and amount of adjustments in inches.
 - g. Number of belts, make, and size.
 - 3. Test Data: (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- G. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- H. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Test apparatus used.
 - d. Area served.
 - e. Air-terminal-device make.
 - f. Air-terminal-device number from system diagram.
 - g. Air-terminal-device type and model number.
 - h. Air-terminal-device size.
 - i. Air-terminal-device effective area in sq. ft.
 - 2. Test Data: (Indicated and actual values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.

- I. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 - 2. Test Data: (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- J. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.18 INSPECTIONS

- A. Initial Inspection:
 - 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
 - 2. Randomly check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Measure sound levels at two locations.
 - e. Measure space pressure of at least 10 percent of locations.
 - f. Verify that balancing devices are marked with final balance position.
 - g. Note deviations to the Contract Documents in the Final Report.
- B. Final Inspection:
 - 1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
 - 2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
 - 3. Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
 - 4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 - 5. If the number of "FAILED" measurements is greater than 10 percent of the total

- measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
 7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

END OF SECTION 15990

SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Supporting devices for electrical components.
 - 2. Electrical identification.
 - 3. Electrical demolition.
 - 4. Cutting and patching for electrical construction.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.04 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- D. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

PART 2 - PRODUCTS

2.01 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch-diameter slotted holes at a maximum of 2 inches o.c., in webs.
 - 1. Channel Thickness: Selected to suit structural loading.
 - 2. Fittings and Accessories: Products of the same manufacturer as channel supports.
- D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- E. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- F. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- G. Expansion Anchors: Carbon-steel wedge or sleeve type.
- H. Toggle Bolts: All-steel springhead type.

2.02 ELECTRICAL IDENTIFICATION

- A. Identification Devices: A single type of identification product for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Raceway and Cable Labels: Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway and cable size.
 - 1. Type: Pretensioned, wraparound plastic sleeves. Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the item it identifies.
 - 2. Type: Preprinted, flexible, self-adhesive, vinyl. Legend is overlaminated with a clear, weather- and chemical-resistant coating.
 - 3. Color:
 - a. Match existing.
 - 4. Legend: Indicates voltage.
- C. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick.
- D. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

- E. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
- F. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch minimum thickness for signs up to 20 sq. in. and 1/8-inch minimum thickness for larger sizes. Engraved legend in black letters on white background.
- G. Interior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Preprinted, aluminum, baked-enamel-finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.
- H. Exterior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch, galvanized-steel backing, with colors, legend, and size appropriate to the application. 1/4-inch grommets in corners for mounting.
- I. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria is not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.02 WIRING INSTALLATION

- A. Install splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- B. Install wiring at outlets with at least 12 inches of slack conductor at each outlet.
- C. Connect outlet and component connections to wiring systems and to ground. Tighten electrical connectors and terminals, according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.03 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.
- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.04 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch- diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Simultaneously install vertical conductor supports with conductors.
- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

- K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
 - 1. Wood: Fasten with wood screws or screw-type nails.
 - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 - 3. New Concrete: Concrete inserts with machine screws and bolts.
 - 4. Existing Concrete: Expansion bolts.
 - 5. Steel: Welded threaded studs or spring-tension clamps on steel.
 - a. Field Welding: Comply with AWS D1.1.
 - 6. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
 - 7. Light Steel: Sheet-metal screws.
 - 8. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.05 IDENTIFICATION MATERIALS AND DEVICES

- A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.
- C. Self-Adhesive Identification Products: Clean surfaces before applying.
- D. Identify raceways and cables with color banding as follows:
 - 1. Bands: Pretensioned, snap-around, colored plastic sleeves or colored adhesive marking tape. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 - 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
 - 3. Colors: Match existing.
 - a. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.
- E. Install warning, caution, and instruction signs where required to comply with 29 CFR, Chapter XVII, Part 1910.145, and where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

- F. Install engraved-laminated emergency-operating signs with white letters on red background with minimum 3/8-inch- high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

3.06 DEMOLITION

- A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- D. Remove demolished material from Project site.
- E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.07 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.08 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
 - 1. Supporting devices for electrical components.
 - 2. Electrical identification.
 - 3. Electrical demolition.
 - 4. Cutting and patching for electrical construction.

3.09 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."

3.010 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 16050

SECTION 16060
GROUNDING AND BONDING

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: Grounding systems and equipment.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.01 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.02 CONNECTORS

- C. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

PART 3 - EXECUTION

3.01 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

3.02 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- C. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

3.03 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

3.04 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
- B. Prepare test and inspection reports.
- C. Report measured ground resistances that exceed the following values:
3. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
- D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 16071
SEISMIC PROTECTION FOR ELECTRICAL WORK

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Provide seismic supports and anchors for electrical equipment, and seismic bracing for raceway systems, in conformance with the requirements in this Section and Division 16 Section "Electrical General Provisions".

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Seismic protection requirements for factory-manufactured electrical equipment components inside electrical enclosures are described in individual Division 16 equipment Sections.

1.03 SUMMARY

- A. This Section includes seismic design criteria to serve as the basis of design for seismic restraint calculations for the Contractor's equipment and raceway installation.
- B. Seismic restraint calculations shall be performed by a registered professional Structural Engineer retained by the Contractor. Seismic restraints shall be provided in conformance with Building Code requirements.

1.04 DEFINITIONS

- A. IBC: International Building Code
- B. ICBO: International Conference of Building Officials
- C. ICSSC: Interagency Committee on Seismic Safety in Construction
- D. NEHRP: National Earthquake Hazards Reduction Program
- E. UL: Underwriter's Laboratories, Inc.
- F. Seismic Restraint: A fixed device (a seismic brace, an anchor bolt or stud, or a fastening assembly) used to prevent vertical or horizontal movement, or both vertical and horizontal movement, of an electrical system component during an earthquake.

1.05 QUALIFICATIONS

- A. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer. The manufacturing company shall be listed in a published NRTL directory of companies

offering NRTL-listed and labeled products.

- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing seismic engineering services, including the design of seismic restraints, that are similar to those indicated for this Project.
- C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated.

1.06 REFERENCE STANDARDS

- A. Comply with the following standards in effect at the time of bid submittal (unless otherwise noted in Division 1):
 - 1. IBC 2006

1.07 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions:
 - 1. Equipment specified in this Section shall be suitable for the temperature range, humidity range, and altitude specified in Division 16 Section "Electrical – General Provisions".

1.08 SUBMITTALS

- A. Product Data: Submit technical data sheets indicating types, styles, materials, strength, fastening provisions, and finish for each type and size of seismic restraint component used.
 - 1. Anchor Bolts and Studs: Types and sizes, complete with test report numbers and rated strength in tension and shear.
 - 2. Steel Channel Type Bracing Assemblies and Hanger Rod Stiffeners: Component types and sizes, complete with test report numbers and rated strength in tension, compression, bending, and shear.
 - 3. Steel Cable Type Bracing Assemblies: Component types and sizes, complete with test report numbers and rated strength in tension.
- B. Shop Drawings: Furnish anchorage and bracing details in isometric diagram format with complete bill of materials listing manufacturer and catalog number for each component. .
Furnish calculations signed and sealed by a registered professional Structural Engineer.
 - 1. Design Analysis: To support selection and arrangement of seismic restraints. Include graphical analysis in the form of vector diagrams with calculations of combined tensile and shear loads. Indicate direction and value of forces transmitted to structural components during specified seismic events.
 - 2. Details: Detail fabrication and arrangement. Detail attachment of restraints to both structural and restrained items. Show attachment locations, methods, and spacing, identifying components and listing their strengths
 - 3. Preapproval and Evaluation Documentation: By a NRTL or agency acceptable to the AHJ, showing maximum ratings of restraints and the basis for approval (tests or calculations).
 - 4. Include a list of items not requiring seismic bracing under the specified Codes and Standards.

- C. Coordination Drawings: Include seismic bracing for electrical components with other systems and equipment, including other seismic restraints in the vicinity, on the Coordination Drawings described in Division 16 Section "Electrical General Provisions".
- D. Product Certificates: Signed by manufacturers of seismic restraints certifying that products furnished comply with specified requirements.
- E. Qualification Data: For firms and persons as described in "Qualifications" and "Quality Assurance" portions of this Section.
- F. Material Test Reports: From a qualified testing agency indicating and interpreting test results of seismic control devices for compliance with specified requirements.

1.09 PROJECT CONDITIONS (IBC)

- A. Building Code: IBC 2008.
- B. Seismic Design Category as Defined in IBC: D.
- C. Seismic Use Group as Defined in IBC: III.

1.10 COORDINATION

- A. Coordinate layout and installation of seismic bracing with building structural system and architectural features, and with mechanical, fire-protection, electrical, and other installations in the vicinity. Show seismic bracing on layout and coordination drawings.
- B. Coordinate seismic design for anchor bolts with building structural design.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with specified requirements, provide products by one of the following manufacturers:
 - 1. Amber/Booth Company, Inc.
 - 2. B-Line Systems, Inc.
 - 3. Erico, Inc.
 - 4. GS Metals Corp.
 - 5. Loos & Company, Inc.
 - 6. Mason Industries, Inc.
 - 7. Powerstrut.
 - 8. Thomas & Betts Corp.
 - 9. Unistrut Corporation.

2.02 MATERIALS OF CONSTRUCTION

- A. Restraints shall be manufactured of the following materials:
 - 1. Indoor Dry Locations: Zinc plated steel. Hot dip galvanized or stainless steel materials are required for direct contact with concrete.

2. Indoor Damp Locations: Hot dip galvanized or stainless steel.
3. Corrosive Locations: Stainless steel of suitable corrosion-resistant grade, or hot dip galvanized steel with corrosion-resistant coating, approved by the Engineer for the corrosive environment.
4. In the event of an apparent conflict with Code-specified materials, notify the Engineer.

2.03 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

- A. Strength: Defined in reports by a NRTL or agency acceptable to the AHJ.
 1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
- B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type or epoxy stud type, recommended in the manufacturer's published technical literature as suitable for seismic loading.
- C. Concrete Inserts: Steel channel type.
- D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
- E. Welding Lugs: Comply with MSS SP-69, Type 57. Welding shall be designed and inspected by a registered professional Structural Engineer.
- F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.
- G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
- H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.04 SEISMIC BRACING COMPONENTS

- A. Steel Channel Type Bracing Assemblies: cold rolled steel channel, nominal 1-1/2 inch width.
 1. Materials for Channel, Fittings, and Accessories: match conduit support channel materials described in Division 16 Section "Raceways, Boxes, and Fittings".
- B. Steel Cable-Type Bracing Assemblies: High-strength steel wire rope cable attached to steel thimbles, brackets, and bolts designed for cable service.
 1. Arrange units for attachment to the braced component at one end and to the structure at the other end.
 2. Wire Rope Cable: Comply ASTM wire rope standards applicable to the materials of construction. Use 49- or 133-strand cable with a minimum strength of 2 times the calculated maximum seismic force to be resisted.
- C. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install seismic restraints according to applicable codes and regulations and as approved by authorities having jurisdiction, unless more stringent requirements are indicated.

3.02 STRUCTURAL ATTACHMENTS

- A. Use bolted connections with steel brackets, slotted channel, and slotted-channel fittings to spread structural loads and reduce stresses.
- B. Attachments to New Concrete: Bolt to channel-type concrete inserts or use expansion anchors or epoxy studs.
- C. Attachments to Existing Concrete: Use expansion anchors or epoxy studs.
- D. Holes for Expansion Anchors and Epoxy Studs in Concrete: Drill at locations and to depths that avoid reinforcing bars.
- E. Attachments to Solid Concrete Masonry Unit Walls: Use expansion anchors.
- F. Attachments to Hollow Walls: Bolt to slotted steel channels fastened to wall with hollow wall anchors.
- G. Attachments to Wood Structural Members: Install bolts through members.
- H. Attachments to Steel: Bolt to clamps on flanges of beams or on upper truss chords of bar joists.

3.03 ELECTRICAL EQUIPMENT ANCHORAGE

- A. Anchor rigidly to a single structural element or to a concrete base that is structurally tied to a single structural element.
- B. Anchor transformers, switchboards, distribution panels, motor controllers, fused power-circuit devices, panelboards, transfer switches, battery racks, and cable trays, and electronic signal processing, control, and distribution units as follows:
 - 1. Size concrete bases so anchor bolts and studs will be located at least the anchor manufacturer's recommended minimum distance from the edge of the concrete base.
 - 2. Retain first subparagraph below if Owner or designer prefers floor-mounted equipment anchorage that permits sliding the equipment into place after anchors are installed.
 - 3. Floor-Mounted Equipment on Concrete Bases: Use female expansion anchors and install studs and nuts after equipment is positioned.
 - 4. Bushings for Floor-Mounted Equipment Anchors: Provide where resilient media are required between anchor bolt or stud and mounting hole in concrete.
 - 5. Anchor Bolt Bushing Assemblies for Wall-Mounted Equipment: Provide where resilient media are required between anchor bolt or stud and wall.
 - 6. Torque bolts and nuts on studs to values recommended by equipment manufacturer.

3.04 SEISMIC BRACING INSTALLATION

- A. Install bracing according to spacings and strengths indicated by approved analysis.
- B. Expansion and Contraction: Install to allow for thermal movement of braced components.
- C. Cable Braces: Install with amount of cable slack recommended by manufacturer.
- D. Attachment to Structure: Anchor bracing to the structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

3.05 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Make flexible connections in raceways, cables, wireways, cable trays, and busways where they cross expansion and seismic control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate at electrical equipment anchored to a different structural element from the one supporting them.

3.06 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform the following field quality-control testing:
- B. Testing: Test pull-out resistance of seismic anchorage devices.
 - 1. Provide necessary test equipment required for reliable testing.
 - 2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 3. Retain subparagraphs below with any paragraph selected above.
 - 4. Schedule test with Owner, through Engineer, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
 - 5. Obtain Engineer's approval before transmitting test loads to the structure. Provide temporary load-spreading members.
 - 6. Edit sampling frequency in subparagraph below to suit Project.
 - 7. Test at least four of each type and size of installed anchors and fasteners selected by the Engineer.
 - 8. Test to 90 percent of rated proof load of device.
 - 9. If a device fails the test, modify all installations of same type and retest until satisfactory results are achieved.
 - 10. Record test results.

END OF SECTION 16071

SECTION 16120
CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.03 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alcan Products Corporation; Alcan Cable Division.
 - 2. American Insulated Wire Corp.; a Leviton Company.
 - 3. General Cable Corporation.
 - 4. Senator Wire & Cable Company.
 - 5. Southwire Company.
- B. Copper Conductors: Comply with NEMA WC 70.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

- D. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC with ground wire.

2.02 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Tyco Electronics Corp.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- F. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- G. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Section 16073 "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Section 16050 "Basic Electrical Materials and Methods."

3.04 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 16130.

3.06 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07841 "Through-Penetration Firestop Systems."

3.07 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Test Reports: Prepare a written report to record the following:
 - 3. Test procedures used.

4. Test results that comply with requirements.
 5. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 16120

SECTION 16130
RACEWAYS, BOXES, AND FITTINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Provide a complete system of raceways, including conduit, fittings, pull boxes, junction boxes, outlet boxes, hangers, supports, and accessories, as shown on the Drawings and in conformance with the requirements in this Section and Division 16 Section "Basic Electrical Materials and Methods".

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Raceways, boxes, and fittings components and related requirements are also specified in the following Sections:
 - 1. Division 7 Section "Firestopping" for fire-stopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
 - 2. Division 16 Section "Interior Lighting" for special application lighting fixture outlet boxes, including lighting plug-in outlets and ball hanger fittings for fixture stems.
 - 3. Division 16 Section "Basic Electrical Materials and Methods" for supports, anchors, and identification products.
 - 4. Division 16 Section "Seismic Controls for Electrical Work" for seismic restraints and bracing of raceways, boxes, enclosures, and cabinets.
 - 5. Division 16 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.
 - 6. Division 16 Section "Grounding and Bonding".

1.03 DEFINITIONS

- A. In addition to the definitions in Division 16 Section "Electrical General Provisions", the following definitions apply to this Section:
 - 1. Clamp-back: spacer used with conduit one-hole strap to provide air gap between surface and conduit
 - 2. EMT: Electrical metallic tubing (NEC definition)
 - 3. Equipment bonding jumper: suitable for connecting sections of conduit used for equipment grounding conductor (see NEC definition)
 - 4. FMC: Flexible metal conduit (NEC definition)
 - 5. ID: inside diameter
 - 6. IMC: Intermediate metal conduit (NEC definition)
 - 7. LFMC: Liquidtight flexible metal conduit (NEC definition)
 - 8. Lighting fixture whips: NEC maximum length of flexible conduit run from junction boxes in fixed raceways to lighting fixtures, to allow movement of the lighting fixtures for initial installation and for maintenance
 - 9. NPT: National pipe thread
 - 10. OD: outside diameter
 - 11. PVC: Polyvinyl chloride
 - 12. RAC: Rigid aluminum conduit
 - 13. RGS: Rigid galvanized steel conduit
 - 14. RMC: Rigid metal conduit (NEC definition)

15. RNC: Rigid nonmetallic conduit (NEC definition) includes PVC and RTRC
16. RTRC: Reinforced thermosetting resin conduit (fiberglass conduit - NEC definition)

1.04 REFERENCE STANDARDS

- A. Comply with the following standards in effect at the time of bid submittal:
1. NEMA Standards applicable to raceways, boxes, and fittings.
 2. UL Standards applicable to raceways, boxes, and fittings. Each raceway, box, and fitting shall be NRTL-listed and labeled.
 3. ANSI and ASTM standards mentioned in this Section and included in the UL and NEMA Standards applicable to raceways, boxes, and fittings.

1.05 ENVIRONMENTAL CONDITIONS

- A. Provide raceways, boxes, and fittings fabricated from materials resistant to corrosion and suitable for the application in the locations where installed, including NEC requirements for installation in "damp", "wet", and hazardous classified areas.

1.06 SUBMITTALS

- A. Product Data: For all raceways, boxes, and fittings proposed to be installed for this project. Mark out inapplicable catalog data.
- B. Detail Drawings for raceway trapeze hangers and bracing: Sealed and signed by a qualified professional engineer.
1. Design Calculations: Calculate requirements for selecting seismic restraints. Structural calculations for worst case loading of each type of proposed channel assembly, including description of design criteria and industry standard safety factors, stress and deflection analysis with vector diagrams, and bill of materials indicating manufacturer's part numbers with brief description of part name and materials of construction.
 2. Detail assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Manufacturer Seismic Qualification Certification: Submit certification that enclosures, cabinets, accessories, and components will withstand seismic forces defined in Division 16 Section "Seismic Controls for Electrical Work." Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.07 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.08 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, fittings, hangers, enclosures, cabinets, and supports with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists of manufacturers, provide products in conformance with this Section produced by the listed manufacturers.

2.02 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube and Conduit, a Division of TYCO International.
 - 2. LTV Steel Tubular Products Company
 - 3. VAW of America, Inc.
 - 4. Western Tube & Conduit Corp
 - 5. Wheatland Tube Co.
- B. EMT: galvanized steel interior and exterior to ANSI C80.3, for use in accordance with NEC Article "Electrical Metallic Tubing, Type EMT", NRTL-listed and labeled under UL 797
- C. Provide couplings and connectors, locknuts, bushings, fittings, conduit bodies, junction boxes, pull boxes, and outlet boxes as follows:
 - 1. Zinc coated steel compression type couplings and connectors, ANSI C80.3, UL 514B, suitable for use as grounding fittings. Cast zinc fittings are not acceptable.
 - 2. Locknuts: galvanized steel
 - 3. Bushings: galvanized steel or malleable iron, insulated throat grounding type, with thermoset plastic insulation insert, complete with mechanical ground lug for connection to ground wire
 - 4. Fittings: ANSI 80.4, hot-dip galvanized cast steel or cast aluminum.
 - 5. Expansion and deflection couplings: UL 467 and UL 514B. Suitable for the anticipated amount of movement and direction(s) of movement. Couplings shall have flexible metal braid for ground continuity, sized for use as NEC equipment grounding conductors.
 - 6. Conduit bodies: aluminum with oil-resistant gasket and galvanized sheet steel cover.
 - 7. Junction boxes: NEMA enclosure type in accordance with Part 3 of this Section
 - 8. Pull boxes: NEMA enclosure type in accordance with Part 3 of this Section
 - 9. Outlet boxes: cast metal for exposed locations in non-hazardous areas, NEMA enclosure type in accordance with Part 3 of this Section

2.03 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflec Inc.

3. Anamet Electrical, Inc.; Anaconda Metal Hose.
 4. Electri-Flex Co.
- B. Flexible Metal Conduit (FMC): Galvanized steel, for use in accordance with NEC Article "Flexible Metal Conduit, Type FMC", NRTL-listed and labeled under UL 1
- C. Fittings: screw-in connectors, NEMA FB 1, same material as conduit, and suitable for use as grounding fittings, UL 514B

2.04 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
1. AFC Cable Systems, Inc.
 2. Alflec Inc.
 3. Anamet Electrical, Inc.; Anaconda Metal Hose.
 4. Electri-Flex Co.
- B. Liquidtight flexible metal conduit (LFMC): Flexible steel type UA conduit with PVC jacket, for use in accordance with NEC Article "Liquidtight Flexible Metal Conduit: Type LFMC", NRTL-listed and labeled under UL 360. Non-UL listed LFMC is not acceptable.
- C. Fittings: Insulated-throat screw-in connectors, NEMA FB 1, UL 514B, galvanized malleable iron or steel. Connectors shall be suitable for use as grounding fittings. Provide fittings with bonding jumper connections for exterior bonding jumpers at motors.

2.05 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.
 2. Hoffman; a Pentair company.
 3. Mono-Systems, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.06 BOXES

- A. Manufacturers:
1. Adalet / A Scott Fetzer Company
 2. Appleton
 3. Bell
 4. Cooper / B-Line
 5. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 6. Emerson/General Signal; Appleton Electric Company.

7. Erickson Electrical Equipment Co.
 8. Hoffman.
 9. Hubbell, Inc. / RACO
 10. Hubbell, Inc./ Killark Electric Manufacturing Co.
 11. Lew Electric Fittings Co.
 12. Myers
 13. O-Z Gedney; Unit of General Signal
 14. RACO; Division of Hubbell, Inc.
 15. Robroy Industries, Inc.; Enclosure Division.
 16. Scott Fetzer Co.; Adalet-PLM Division.
 17. Spring City Electrical Manufacturing Co.
 18. Thomas & Betts Corporation.
 19. Walker Systems, Inc.; Wiremold Company (The).
 20. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. Sheet Metal Outlet and Device Boxes: Stamped galvanized steel, NEMA OS 1, UL 50, UL 514A.
- C. Small Sheet Metal Pull and Junction Boxes: zinc coated steel, NEMA OS 1, UL 50, UL 514A.
- D. Sheet Metal Pull and Junction Boxes: NEMA 250, Type 1 galvanized or painted steel, with continuous hinged cover and flush latch.
- E. Surface-Mounted Enclosures for terminal blocks and electrical equipment and components: NEMA 250, Type 1 painted steel, with continuous hinged cover and flush latch.

2.07 SURFACE METAL RACEWAY

- A. See section 16140.

2.08 CONDUIT SLEEVES AND SEALING FITTINGS

- A. Manufacturers:
1. Appleton
 2. Crouse-Hinds
 3. Spring City Electric
 4. Thomas & Betts
 5. O.Z. Gedney
- B. Wall and Floor Sleeves:
1. Hot-dip galvanized steel pre-fabricated conduit sleeves with welded water-stop ring.
 2. Galvanized steel, PVC, and polyethylene sleeves that are part of a manufacturer's standard wall seal assembly are also acceptable, subject to compliance with the fire resistant rating of the related walls and floors.
- C. Conduit-to-Sleeve Sealing Fittings:
1. Synthetic elastomeric gland with galvanized steel compression plates sized for the conduit OD and sleeve ID, or a manufactured assembly of hot-dip galvanized pressure plates, neoprene sealing grommets, and cast or malleable iron sealing bodies with zinc-rich epoxy coating, with factory-assembled galvanized steel, PVC, or polyethylene pipe sleeve. Segmented seals are also acceptable for conduits 4

- inch trade size and larger.
2. Sealing fittings for wall penetrations with water or soil on one side shall have seals installed at both ends of the conduit sleeve or core-drilled hole.
3. Where single conductors pass through a single sleeve, select materials to mitigate the effects of inductive heating.
4. Provide ground wire attachment bolts for manufactured sleeve assemblies.
5. Seals shall have fire ratings equal to the fire-resistant rating of the wall.

2.09 CONDUIT INTERIOR SEALING FITTINGS

A. Manufacturers:

1. Crouse-Hinds
2. O.Z. Gedney
3. Thomas & Betts

B. Conduit-to-Cable Sealing Fittings:

1. For exposed conduit ends without pull and junction boxes: Conduit fitting with synthetic elastomeric sealing gland with galvanized steel compression plates drilled for the conduit ID and cable(s) OD, retained by threaded collar at the end of the conduit.
2. For exposed conduit ends entering pull or junction box: Conduit fitting suitable for installation of locknuts at conduit entry to sheet metal box, and bushing with synthetic elastomeric sealing gland with galvanized steel compression plates drilled for the conduit ID and cable(s) OD, retained by threaded collar at the end of the conduit.
3. Seal shall be watertight at 50 feet of water pressure.
4. Where single conductors pass through a seal, select materials to mitigate the effects of inductive heating.
5. Where bare stranded copper conductors pass through sealing fittings, place an exothermic weld in the stranded cable to prevent water from leaking through the strands.

2.010 CONDUIT EXPANSION AND DEFLECTION FITTINGS

A. Manufacturers:

1. Crouse-Hinds
2. Spring City Electric
3. O.Z. Gedney
4. Thomas & Betts

B. Conduit expansion and deflection fittings:

1. Suitable for the anticipated expansion joint elongation and deflection at each expansion joint.
2. Materials of construction: Hot dip galvanized ductile iron body, neoprene sealing sleeve, stainless steel clamps, tinned flexible copper equipment bonding jumper.

2.011 FACTORY FINISHES

- ### **A. Finish:** For painted steel enclosures, provide manufacturer's standard commercial and industrial coating in ANSI 61 light grey color, or different color when required by the NEC.

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

- A. Deliver raceways, boxes, and fittings to jobsite in factory packaging.
- B. Store in clean, dry, weatherproof locations.
- C. Handle in accordance with manufacturer's recommendations.

3.02 RACEWAY APPLICATIONS

- A. Indoor raceways, boxes, and fittings:
 - 1. Below floor slab in slab-on-grade construction: electrical metallic tubing.
 - 2. Exposed: electrical metallic tubing.
 - 3. Exposed in areas designated "Corrosive Area" on the Drawings: PVC-coated rigid galvanized steel conduit.
 - 4. Concealed: electrical metallic tubing.
 - 5. Connections to transformers, motor-driven equipment, vibrating equipment, and equipment requiring position adjustment, e.g., rail-mounted motors: liquidtight flexible metal conduit.
 - 6. Lighting fixture whips: flexible galvanized steel conduit.
 - 7. Damp or Wet Locations: rigid galvanized steel conduit
 - 8. Boxes and fittings: as described in each raceway sub-section, and recommended as suitable for the particular application by the manufacturer.
 - 9. Enclosures: NEMA 250, Type 1, unless otherwise specified in Division 16 Section "Electrical General Provisions".
- B. Minimum Raceway Size: 3/4-inch trade size.

3.03 INSTALLATION – GENERAL

- A. Install raceways, boxes, and fittings in accordance with manufacturer's installation instructions and NEC requirements as a minimum, and comply with the additional requirements described in this Section.
- B. Conduits shall be electrically and mechanically continuous, and suitable for use as an equipment grounding conductor. Make up threaded joints wrench tight.
- C. When coordination drawing submittals are specified in Part 1 of this Section, do not commence work until coordination drawings for the entire building are approved.
- D. Install and route emergency system raceways independently of other raceways systems, except where specific exceptions are permitted by the NEC.
- E. Fasten boxes in wet and damp areas using external mounting feet. Do not drill through boxes.
- F. Comply with NEC requirements for sizing outlet and junction boxes to accommodate wires, splices, and devices.
- G. Bends and offsets between pull points shall not exceed a cumulative total of 270 degrees unless otherwise approved by the Engineer. Maximum distance between pull points in conduit systems inside buildings shall be 100 feet unless otherwise approved by the En-

- H. Raceways shall be routed in accordance with the following guidelines:
1. Run conduits exposed, concealed, and underground as indicated on the Drawings.
 2. The preferred location for horizontal conduit runs is just below the ceiling structural supports.
 3. Do not obstruct access to equipment for operation and maintenance. Coordinate conduit runs with the work of other trades. Plan conduit runs to avoid lighting fixtures, and leave space for easy access to HVAC equipment, motors, and duct access hatches and doors.
 4. Route conduits around doors, windows, hatches, louvers, and other building openings, and around range and fume hoods.
 5. Group conduits on horizontal trapeze hangers or on wall-mounted steel channel where long horizontal runs are required.
 6. Do not run conduits through stairwells unless required for connection to equipment located in the stairwell.
 7. Maintain eight feet minimum clearance above finished floor wherever it is physically possible to do so. Comply with OSHA requirements for minimum headroom.
 8. Comply with raceway, boxes, and fittings details shown on the Drawings.
 9. Where conduits enter the top of electrical equipment enclosures and control panels, install conduit interior sealing fittings to prevent entry of water and condensation from conduit.
- I. Cut conduits square with roller-wheel pipe cutter. Hacksaw cuts are acceptable only if the entire conduit is swabbed clean after cutting and threading is completed. Conduits cut in the field shall be threaded with sharp, standard NPT dies to achieve a fully cut tapered thread with a minimum of five full tapered threads at the end of the conduit. Running threads are not acceptable. Over- and under-threading are not acceptable. After threading, ream conduit ends, remove cuttings and debris from inside and outside of conduit, degrease, and apply cold spray-on zinc-rich paint.
- J. Conduit bends shall be made with conduit bending tools manufactured for the purpose. Comply with conduit and bending tool manufacturers' instructions. Use specially sized shoes in bending tools for PVC-coated rigid galvanized steel conduits.
- K. Do not cut or drill holes in structural beams and columns, or other structural members. Do not weld raceway supports to structural steel.
- L. Join raceways with fittings designed and approved for that purpose and make joints wrench tight. Comply with NEC requirements for minimum thread engagement in Hazardous Classified areas.
- M. Provide expansion, deflection, or expansion & deflection couplings at building expansion joints. Expansion and deflection fittings shall comply with UL 467 and UL 514B, and shall be suitable for the anticipated amount of movement and direction(s) of movement.
- N. Provide drain fittings at the first junction or pull box where conduits enter the building from outdoor and underground locations. Locate drains to permit observation of leakage without damage to electrical and mechanical equipment.
- O. Three-piece (Erickson) couplings shall be used where it is not possible to turn conduits to make up threaded joints. Threadless fittings are not generally acceptable. Application for permission to use threadless fittings at particular locations shall be made in writing to the Engineer, and threadless fittings shall not be used unless approved.

- P. Complete raceway installation before starting conductor installation.
- Q. Support raceways as specified in Division 16 Section "Basic Electrical Materials and Methods."
- R. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Firestopping".
- S. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- T. Terminations:
 - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box. Install bushings wrench-tight.
 - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
 - 3. Install temporary closures to prevent foreign matter from entering raceways.
- U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lbtensile strength. Leave at least 12 inches of slack at each end of pull wire.
- V. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
- W. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate equipment bonding jumper across flexible connections.
- X. Seismic Areas: Brace conduit supports to the building structure where required to provide seismic protection.

3.04 INSTALLATION – EXPOSED RACEWAYS, BOXES AND FITTINGS

- A. Install raceways, boxes, and fittings exposed as indicated on the Drawings.
- B. Install exposed raceways parallel or at right angles to nearby surfaces or structural members.
 - 1. Run raceways together in groups on common supports wherever possible.
 - 2. Do not use mechanical piping or ceiling supports to support conduit runs.
- C. Make concentric bends in parallel exposed conduit runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- D. Surface-mounted channel supports shall be 1-1/2 inch x 1-1/2 inch channel bolted to wall

or ceiling with expansion anchors.

- E. Suspended (trapeze) channel supports shall be 1-1/2 inch x 1-1/2 inch channel suspended from minimum 3/8 inch threaded rod. Fasten rods to structural steel with beam clamps or channel assemblies designed specifically for each application. Fasten threaded rods to concrete with expansion bolts and threaded rod hanger, or concrete channel inserts
- F. Keep raceways at least 6 inches away from parallel runs of flues and mechanical piping (including insulation). Install horizontal raceway runs above water and steam piping.
- G. Install electrical enclosures and cabinets plumb. Support at each corner.
- H. At building interior floor and roof penetrations, provide floor sleeves 2 inches above finished floor level with fire-rated conduit sealing fittings. Provide flashing at roof penetrations in accordance with roofing system manufacturer's recommendations.

3.05 INSTALLATION – CONCEALED RACEWAYS, BOXES AND FITTINGS

- A. Install raceways, boxes, and fittings concealed, including above suspended ceilings, in partitions, and within or below floor slabs, as indicated on the Drawings.
- B. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- C. Raceways embedded in slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete. Maintain 4 inch minimum spacing between conduit exterior surfaces.
 - 3. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
- D. Stub-up connections: Extend conduits through concrete floor for connection to freestanding equipment. Install PVC-coated rigid steel conduit elbows with a flush-plugged coupling set flush with finished floor. Plugs shall be plastic, shall have slots for screwdrivers, and shall be within 1/8 inch of the finished floor surface. Extend conductors to equipment with rigid steel conduit. LFMC may be used above 12 inches above finished floor.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab. Use conduit expansion & deflection fittings in in-slab conduit runs when crossing structural joints at concrete equipment isolation pads.
- F. Set floor boxes level and flush with finished floor surface. Complete installation to match fire-resistant rating of floor.

3.06 PROTECTION DURING CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure coatings and finishes without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.07 CLEANING & PAINTING

- A. Swab conduits clean after installation and plug ends until conductors are installed.
- B. Remove dust, construction debris, plaster and paint spatters from raceways, boxes, and fittings after all trades have completed their work, and prior to painting.
- C. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes, touch up damage, and prepare for finish painting in accordance with Division 9 Section "Painting and Finishing".

END OF SECTION

SECTION 16140
WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Single and duplex receptacles and ground-fault circuit interrupters.
 - 2. Single- and double-pole switches and dimmer switches.
 - 3. Device wall plates.
 - 4. Multioutlet assemblies.

1.03 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand (Pass & Seymour).
 - 5. Wiremold Company (The).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

2.03 STRAIGHT-BLADE RECEPTACLES

- A. Straight-Blade-Type Receptacles: Heavy duty, wide body design, one piece triple wipe brass power contacts, grounding type, one piece mounting strap without the use of rivets and with integral ground contacts, back and side wired, enclosed in composition, or nylon case, impact resistant nylon face. Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498.
- B. Straight-Blade and Locking Receptacles: Heavy-Duty grade.

2.04 GFCI RECEPTACLES

- A. GFCI Receptacles: Straight blade, feed-through type, Heavy-Duty grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch-deep outlet box without an adapter.

2.05 TOGGLE SWITCHES

- A. Single- and Double-Pole Switches: Heavy duty, toggle, quiet type, back and side wired fully enclosed in composition case with ground lug. Comply with DSCC W-C-896F and UL 20.
- B. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
 - 1. Control: Continuously adjustable slider; with single-pole or three-way switching to suit connections.
 - 2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle switch, or slider; single pole with soft tap or other quiet switch; EMI/RFI filter to eliminate interference; and 5-inch wire connecting leads.
 - 3. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 1 percent of full brightness.

2.06 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 - 1. 600 W; dimmers shall require no derating when ganged with other devices

2.07 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.035-inch-thick, satin-finished, Type 302 stainless steel.

2.08 MULTIOUTLET ASSEMBLIES

- A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- B. Provide 1 and 2 cell surface raceway, Wiremold 3000 and 4000, or approved equal, complete with elbows, fittings, base and covers, wireclips and bushed openings for lab tables and elsewhere as shown on drawings, and as described herein.
- C. Raceway Material: Steel, with manufacturer's standard finish.
- D. Raceway Color: Provide grey color, or approved equal, complete with all required fittings.
 - 1. 4046/4048-OL Series with an overlapping steel coverplate.
- E. Provide Wiremold 4050 Series coverplate, or approved equal.
- F. Telephone/Data outlets shall be as specified elsewhere. Provide 50% blank modular covers for communications outlets.
- G. Provide the number and type receptacles indicated. Receptacles shall be as specified under "Wiring Devices". Provide ground conductor for each circuit in the raceway. Ground each device.

2.09 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: Gray unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Gray.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- F. Dimmers:
 - 1. Install dimmers within terms of their listing.
 - 2. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.02 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.03 IDENTIFICATION

- A. Comply with Section 16075 "Electrical Identification."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black(normal) and red(emergency)-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
 - 2. Test Instruments: Use instruments that comply with UL 1436.
 - 3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 16140

SECTION 16410
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Shunt trip switches.
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Enclosures.

1.03 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.04 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to IBC.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.06 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01782 "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.08 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

1.09 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.01 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses,

lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2.02 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2.03 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussmann, Inc.
2. Ferraz Shawmut, Inc.
3. Littelfuse, Inc.

B. General Requirements: Comply with UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; with a control power transformer of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

E. Accessories:

1. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
2. Form C alarm contacts that change state when switch is tripped.

2.04 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 4. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.05 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1
 - 2. Outdoor Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Section 16074 "Vibration and Seismic Controls for Electrical Systems."
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.03 IDENTIFICATION

- A. Comply with requirements in Section 16050 "Basic Electrical Materials and Methods."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- C. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

SECTION 16511
INTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures with lamps and ballasts.
 - 2. Indoor Occupancy Sensors
- B. Related Sections include the following:
 - 1. Division 16 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.03 DEFINITIONS

- A. BF: Ballast factor. Ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.
- B. CRI: Color rendering index.
- C. CU: Coefficient of utilization.
- D. LER: Luminaire efficiency rating, which is calculated according to NEMA LE 5. This value can be estimated from photometric data using the following formula:
 - 1. LER is equal to the product of total rated lamp lumens times BF times luminaire efficiency, divided by input watts.
- E. RCR: Room cavity ratio.

1.04 SUBMITTALS

- A. Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of fixture, including dimensions and verification of indicated parameters.
 - 2. Fixture photometric performance data.
 - 3. Emergency battery ballasts.
 - 4. Fluorescent ballasts.
- B. Wiring Diagrams: Power, signal, and control wiring.
- C. Product Certificates: For each type of ballast for dimmer-controlled fixtures, signed by product manufacturer.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Catalog data for each fixture. Include the diffuser, ballast, and lamps installed in that fixture.
- G. Warranties: Special warranties specified in this Section.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in

NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. Comply with NFPA 70.
- C. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.06 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.07 WARRANTY

- A. Special Warranty for Emergency Lighting Unit Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 2 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining one year.
- B. Special Warranty for Fluorescent Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Electronic Ballasts: two years from date of Substantial Completion.
- C. Manufacturer's Special Warranty for T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- 1. Products: Subject to compliance with requirements, provide one of the products specified.

2.02 FIXTURES AND COMPONENTS, GENERAL

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- G. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.
 4. Laminated Silver Metallized Film: 90 percent.
 - H. Plastic Diffusers, Covers, and Globes:
 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - I. Lens Thickness: At least 0.125 inch minimum unless different thickness is scheduled.
 - a. UV stabilized.
 2. Glass: Annealed crystal glass, unless otherwise indicated.
- 2.03 LIGHTING FIXTURES**
- A. Fixtures shall be as indicated in "LIGHTING FIXTURE SCHEDULE" on drawings.
- 2.04 FLUORESCENT LAMP BALLASTS**
- A. Description: Include the following features, unless otherwise indicated:
 1. Designed for type and quantity of lamps indicated at full light output except for emergency lamps powered by in-fixture battery-packs.
 - B. Electronic ballasts for linear lamps shall include the following features, unless otherwise indicated:
 1. Comply with NEMA C82.11.
 2. Ballast Type: Instant start, unless otherwise indicated.
 3. Programmed Start: Ballasts with two-step lamp starting to extend life of frequently started lamps.
 4. Sound Rating: A.
 5. Total harmonic distortion rating of less than 10 percent according to NEMA C82.11.
 6. Transient Voltage Protection: IEEE C62.41, Category A.
 7. Operating Frequency: 20 kHz or higher.
 8. Lamp Current Crest Factor: Less than 1.7.
 9. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.
 - C. Electronic ballasts for compact fluorescent lamps shall include the following features, unless otherwise indicated:
 1. Description: Electronic-programmed instant start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
 2. Lamp end-of-life detection and shutdown circuit.
 3. Automatic lamp starting after lamp replacement.
 4. Sound Rating: Class A.
 5. Total Harmonic Distortion Rating: Less than 20 percent.
 6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 7. Operating Frequency: 20 kHz or higher.
 8. Lamp Current Crest Factor: 1.7 or less.
 9. BF: 0.95 or higher unless otherwise indicated.
 10. Power Factor: 0.95 or higher.
- 2.05 EXIT SIGNS**

General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

Internally Lighted Signs:

Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2.06 FLUORESCENT LAMPS

- A. Low-Mercury Lamps: Comply with Federal toxic characteristic leaching procedure test, and yield less than 0.2 mg of mercury per liter, when tested according to NEMA LL 1.
- B. T8 rapid-start low-mercury lamps, rated 32 W maximum, 2800 initial lumens (minimum), CRI of 75 (minimum), color temperature of 4000 K, and average rated life of 20,000 hours, unless otherwise indicated.
- C. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500K, average rated life of 10,000 hours at three hours operation per start unless otherwise indicated.
 - 1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
 - 2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
 - 3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
 - 4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
 - 5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).

2.07 FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 16 Section "Basic Electrical Materials and Methods" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, 12 gage.
- E. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.
- F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- G. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.08 FINISHES

- A. Fixtures: Manufacturers' standard, unless otherwise indicated.
 - 1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
 - 2. Metallic Finish: Corrosion resistant.

2.09 LIGHTING CONTROL DEVICES

- A. Dimming Ballast Controls: Sliding-handle type with on/off control; compatible with ballast and having light output and energy input over the full dimming range.

2.010 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Bryant Electric; a Hubbell company.
 - 2. Cooper Industries, Inc.
 - 3. Hubbell Building Automation, Inc.
 - 4. Leviton Mfg. Company Inc.
 - 5. Lightolier Controls.
 - 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 7. Lutron Electronics Co., Inc.
 - 8. NSI Industries LLC; TORK Products.
 - 9. RAB Lighting.
 - 10. Sensor Switch, Inc.

11. Square D; a brand of Schneider Electric.
12. Watt Stopper.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
 4. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft..
 5. Sensing Technology: PIR.
 6. Voltage: 277 V.
 7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.
 2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- C. Suspended Fixture Support: As follows:
 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

3.02 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.03 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Verify normal operation of each fixture after installation.
- C. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal.
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
- E. Corroded Fixtures: During warranty period, replace fixtures that show any signs of

University of South Carolina
PHRC Laboratory 305 Renovation
Columbia, South Carolina
corrosion.

State Project # H27-1937

END OF SECTION