

**NATIONAL INSTITUTE OF STANDARDS AND
TECHNOLOGY**

**GAITHERSBURG, MD, BUILDING 215
CLEANROOM REBALANCE
CLIN 0002
19W08375**

Specifications
100% Release For Construction
June 29, 2021
BKM Project No.19146.01

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SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:

- 1. Project information.
 - 2. Work covered by Contract Documents.
 - 3. Work restrictions.
 - 4. Specification and drawing conventions.

- B. Related Section:

- 1. Division 01 Section "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Contracting Officer's facilities.

1.3 PROJECT INFORMATION

- A. Project Identification: BUILDING 215

- 1. Project Location: Entirety of Building 215

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of the Project is defined by the Contract Documents and consists of the following:

- 1. The NIST Gaithersburg Advanced Measurement Laboratory (AML) was completed and occupied in 2005. It is currently one of the most advanced laboratories of its type in the world, showcasing advanced laboratory environmental controls in the areas of temperature and humidity control, vibration isolation, air cleanliness, and electrical power quality in support of NIST's most-demanding laboratory programs.
 - 2. Building 215 is the cleanroom facility within the AML complex, housing an 1800 square meter cleanroom, of which 750 square meters is Class 100.
 - 3. A Contractor will perform a series of task that consists of evaluating and adjusting airflows within the Building 215 cleanroom. The tasks to be performed include:
 - a. Perform Pre-demolition testing of mechanical equipment as indicated in construction documents.

- b. ~~Repair or~~ replace all variable air volume terminal units.
 - i. ~~Base Bid:~~ Replacement of all variable air volume terminal controllers.
 - ii. ~~Alternate 1:~~ Replacement of all variable air volume terminal units.
 - c. Repair and perform diagnostics of existing control systems to confirm operation of existing dampers, valves and sensors.
 - i. An Allowance of \$15,000 shall be provided for additional Controls Contractor labor.
 - d. Replace existing airflow monitors.
 - e. Install new exhaust air valves to control exhaust branch ductwork airflows.
 - f. Repair or modify existing exhaust or supply ductwork as indicated.
 - g. Replace all existing terminal supply HEPA filters, repair supply connections, balance and certification new HEPA filter.
 - h. Rebalance air handling units, exhaust fans, exhaust tools to airflows indicated in construction documents.
 - i. Perform rebalance of cleanroom to maintain proper room pressurization.
 - j. Perform recertification of cleanroom.
 - k. Verify and repair/replace capped ducts as needed.
- 4. A Contractor shall document all work within the Building 215 cleanroom and provide documentation and finals of the following:
 - a. All calibration certificates of equipment and devices
 - b. Final air balance report for various rooms.
 - c. A report listing remedies of all deficiencies.
 - d. Contractor to provide final redline drawings.
 - 5. All work shall be included in base bid unless otherwise noted.
 - 6. Contractor shall provide unit costs as part of bid package for review of COR and contracting officer as indicated in construction documents, which shall include material and labor costs for installation, testing and verification of operation.

1.5 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets and other requirements of authorities having jurisdiction.
- B. Phasing and Mobilization
 - 1. Work within the cleanroom is expected to be completed during a 16-19 month shutdown. Contractor shall coordinate with COR for duration and timing of shutdown.
 - 2. Contractor shall submit preliminary construction schedule including duration of work to be completed in cleanroom to Government or COR for review. COR determine period of performance for this contract.
- C. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet of entrances, operable windows, or outdoor air intakes.

1.6 ACCESS TO SITE

- A. General: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
- B. Use of Site: Limit use of Project site to areas within the contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
 - 1. Limits: Confine construction operations to limits of disturbance as indicated on drawings.
 - 2. Driveways, Walkways, and Entrances: Keep driveways and entrances serving the premises clear and available to the Contracting Officer, Contracting Officer's representatives, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - 3. Parking: Parking will be restricted to the area shown adjacent to the laydown area. Laydown area shall be coordinated with COR. Requests for additional or alternate parking should be made in writing to the COR. Fifteen (15) feet of clearance shall be maintained around all fire hydrants at all times.
 - 4. The Contractor and his employees and subcontractors shall become familiar with and obey all NIST Site Regulations, including fire, traffic, and security regulations. All personnel employed on the site shall keep within the limits of the work (and avenues of ingress and egress), and shall not enter any restricted areas unless required to do so and are cleared for such entry. The Contractor's equipment shall be conspicuously marked for identification.
 - 5. Material Storage: All materials shall be stored in the lay down area. The Contractor shall adequately protect all materials from the weather.

1.7 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on the Drawings are described in detail in the Specifications. One or more of the following are used on the Drawings to identify materials and products:
 - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 - 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.

3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.8 MISCELLANEOUS PROVISIONS

- A. Public Release of Information:
 1. The Contractor shall not publicly release information, photographs, or other documents concerning any aspect of the materials or services relating to this bid, contract, or purchase order without the prior written approval of the Contracting Officer.
 2. Insert the substance of clause “#1” above in each sub-contract and purchase order related to this project.
- B. Permits: In addition to the requirements of the clause entitled “Permits and Responsibilities”, permits are required for but not necessarily limited to welding, and burning,. Prior to commencing these activities, the Contractor shall submit an application for a permit to the COR.
- C. Asbestos Material: No asbestos containing material is expected to be encountered by the Contractor on this project. If material is encountered that looks suspicious but must be disturbed, do not touch the material and immediately notify the COR in writing. Within fourteen (14) calendar days, the Government will perform laboratory tests to determine if there is asbestos. If asbestos is not a danger, the Contracting Officer will direct the Contractor to proceed without change. If the material encountered is asbestos and must handled, the Contracting Officer will direct a change.

1.9 OCCUPATIONAL SAFETY AND HEALTH

- A. NIST, as a Federal government facility in the State of Maryland, is under the jurisdiction of the OSHA Region III regional office, which may assign an OSHA Compliance Safety and Health Officer (CSHO) to conduct safety and health inspections of the Contractor’s operations at the NIST Gaithersburg site. Accordingly, the Contractor is subject to OSHA Citations and Notices of Penalty for noncompliance with OSHA standards. To protect its own interests, NIST may also conduct periodic safety and health inspections to assure that NIST employees/property are not at risk of injury/damage from Contractor operations, and to avoid the risk of OSHA Citations under the OSHA multi-employer worksite provisions.
 1. Pre-work Safety Meeting: Representatives of the Contractor shall meet with the Contracting Officer and his/her safety representative(s) prior to the start of work under this contract for the purpose of reviewing the Contractor’s safety and health programs and discussing implementation of all safety and health provisions pertinent to the work to be performed under the contract. The Contractor shall be prepared to discuss, in detail, the measures he/she intends to take in order to control any unsafe or unhealthy conditions associated with the work to be performed under the contract. If directed by the Contracting Officer, this meeting may be held in conjunction with other meetings which are scheduled to take place prior to start of work under this contract. The level of detail for the safety meeting is dependent upon the nature of the work and the potential inherent hazards. The Contractor’s principal on-site representative(s), the general superintendent, and his/her safety representative(s) shall attend this meeting.
 2. Safety and Health Standards Compliance: The Contractor shall comply (and shall ensure that firms acting as agents or subcontractors to the prime Contractor also comply) with all

applicable OSHA Safety and Health Standards for Construction (29CFR1926) and OSHA General Industry Occupational Safety and Health Standards (29CFR1910). Additionally, the Contractor shall comply with all applicable site safety and health requirements. The NIST Safety Office will provide guidance/consultation regarding specific site requirements.

3. Special Emphasis Standards: While the Contractor is responsible for compliance with all applicable OSHA Safety and Health Standards, special emphasis will be placed upon the following:
 - a. Fall Protection: Fall protection measures shall be implemented as required via use of suitable guardrails/ barricades; safety belts/harnesses/lanyards/ lifelines; safety nets; or other approved means. Particular emphasis is to be focused on the requirements stipulated in Subpart L (Scaffolding), Subpart M (Floor and Wall Openings), Subpart R (Steel Erection) and Subpart X (Stairways and Ladders) of 29CFR1926 (Safety and Health Standards for Construction).
 - b. Excavations and Trenching: With regard to excavations (including trenches), the soil at the NIST Gaithersburg site shall be considered previously excavated and therefore unstable. Accordingly, persons entering excavations five (5) or more feet deep shall be protected from cave-ins by an adequate protective system designed in accordance with the requirements of 29CFR1926.652(b) or (c). All other applicable requirements for excavations as contained in Subpart P (Excavations) of 29CFR1926 shall be implemented.
 - c. Confined Spaces: Entry into permit-required confined spaces must be in accordance with the requirements stipulated in the OSHA Permit-Required Confined Space standard (29CFR1910.146). The Contractor shall be responsible for all confined space entry requirements including personnel training, documented entry permit system, atmospheric contractor funded testing/ monitoring, forced ventilation, personal protective equipment, and emergency procedures/equipment.
 - d. Hazard Communication: As applicable (i.e., when chemicals are used on-site by the Contractor), the Contractor shall develop, implement and maintain at the workplace a written hazard communication program meeting the requirements of 29CFR1926.59 (for construction contracts) or 29CFR1910.1200 (for other than construction contracts). The contractor shall ensure that each container of hazardous chemicals at the worksite is labeled, tagged or otherwise marked with the identity of the hazardous chemical(s) contained therein and that such markings show hazard warnings appropriate for employee protection. The Contractor shall provide employees with information and training on hazardous chemicals in their work area at the time of initial assignment and whenever a new hazardous chemical is introduced into their work area. The Contractor shall also provide employees with information on any operations in their work area where hazardous chemicals are present; and the location and availability of the written hazard communication program, including the required list(s) of hazardous chemicals, and material safety data sheets (MSDS) required by the standard.
 - e. Control of Hazardous Energy (Lockout/Tag out): In accordance with the provisions of OSHA standards 29CFR1910.147 and 29CFR1926.417, the Contractor shall establish and implement a program consisting of energy control procedures, employee training and periodic inspections to ensure that before any employee performs any servicing or maintenance on electrical circuits/equipment, machines or other equipment/systems where the unexpected energizing, start up or release of stored energy could occur and cause injury, the circuit/machine/equipment/system shall be isolated from the energy source and rendered inoperative.

- f. Electrical Installations and Work Practices: The Contractor shall comply with all applicable installation safety requirements, safety-related maintenance and environmental considerations, and safety requirements for special equipment as contained in Subpart K (Electrical) of 29CFR1926.
 - g. Personal Protective and Life Saving Equipment: In accordance with the provisions of Subpart E (Personal Protective and Life Saving Equipment) of 29CFR1926, the Contractor shall ensure that protective equipment (including personal protective equipment for eyes, head, face, head and extremities; protective clothing; respiratory devices; and protective shields and barriers) shall be provided, used and maintained in a sanitary and reliable condition whenever it is necessary by reason of hazards of process or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of the body through absorption, inhalation or physical contact.
 - h. Tools-Hand and Power: The Contractor shall ensure compliance with all applicable safety requirements for tools (hand and power) as outlined in Subpart I (Tools-Hand and Power) of 29CFR1926.
 - i. Welding and Cutting: The Contractor shall ensure compliance with all applicable safety requirements pertaining to welding and cutting operations as outlined in Subpart J (Welding and Cutting) of 29CFR1926.
 - j. Motor Vehicles and Mechanized Equipment: The Contractor shall ensure compliance with the safety requirements pertaining to motor vehicles and mechanized equipment (materials handling equipment and pile driving equipment) as contained in Subpart O (Motor Vehicles, Mechanized Equipment, and Marine Operations) of 29CFR1926.
4. General Site Safety Requirements: For the protection of NIST employees, other agency employees and the general public, the following general worksite safety requirements shall be observed by the Contractor.
- a. Precautions: The Contractor shall take all necessary precautions to prevent injury to the public, building occupants, and damage to property of others. For the purposes of this contract, the public or building occupants shall include all persons not employed by the Contractor or a subcontractor working under his/her direction.
 - b. Housekeeping: Form and scrap lumber with protruding nails/fasteners and all other debris shall be kept clear from all work areas. Combustible scrap and debris shall be removed at regular intervals. Containers shall be provided for collection and separation of all refuse. Covers shall be provided on containers used for flammable or harmful substances. Wastes should be disposed of at frequent intervals.
 - c. Storage: Storing, positioning, and use of equipment, tools, materials, scraps, and trash in a manner likely to present a hazard to the public or building occupants by its accidental shifting, ignition, or other hazardous qualities is prohibited.
 - d. Obstructions: No corridor, aisle, stairway, door, or exit shall be obstructed or used in such a manner as to encroach upon routes or ingress or egress utilized by the public or building occupant, or to present un-safe or unhealthy condition to the public or building occupant.
 - e. Radiation Safety: the Contractor shall not bring to or use at NIST any radioactive materials or radio-graphic devices without explicit prior approval from Health Physics for each use of such devices. Any such use shall be in compliance with

restrictions and procedures prescribed by NIST Health Physics (Bldg. 245, Room C125, x5800). Any work conducted in a NIST Restricted Area (as defined by the Nuclear Regulatory Commission and applied by NIST) shall comply with NIST procedural requirements and, in particular, specific training requirements for all persons entering that area. No area posted with Radioactive Material, Radiation Area, High Radiation Area, or Very High Radiation Area sign shall be entered without prior approval from Health Physics (i.e., all work in such areas requires prior clearance from NIST Health Physics).

- f. Work Area Restrictions: Work shall not be performed in any area occupied by the public or Federal employees unless specifically permitted by the contract or the Contracting Officer and unless adequate steps are taken for the protection of the public or Federal employees.
- g. Fences and Barricades: Wherever practicable, the work area shall be fenced, barricaded, or otherwise blocked off from the public or building occupants to prevent unauthorized entry into the work area.
- h. Alternate Precautions: When the nature of the work prevents isolation of the work area and the public or building occupants may be in or pass through, under, or over the work area, alternate precautions such as the posting of signs, the use of signal persons, the erection of barricades, or similar protection around particularly hazardous operations shall be used as appropriate.
- i. Public Thoroughfare: When work is to be performed over a public thoroughfare, such as a sidewalk, road, lobby, or corridor, the thoroughfare shall be closed, if possible, or other precautions taken such as the installation of screens or barricades.
- j. Removal of Fences and Barricades: Fences and barricades shall be removed upon completion of the project, in accordance with local ordinance and to the satisfaction of the Contracting Officer or his/her representative(s).

1.10 SALVAGE

- A. The Government does not assume responsibility for any loss or damage to materials or structures on the site salvage value of which the Contractor may have reflected in his bid.

1.11 CEREMONIES

- A. Subject to mutually satisfactory agreements between the parties of the contract, the Government may enter the premises during the term of the contract to conduct ceremonies, such as laying the cornerstone or dedication ceremonies, and to occupy temporarily such portions of the premises as may be necessary.

1.12 PUBLIC RELEASE OF INFORMATION

- A. The contractor shall not publicly release information, photographs, or other documents concerning any aspect of the materials or services relating to this bid, contract, or purchase order without the prior written approval of the Contracting Officer.

CLEANROOM REBALANCE
NIST

100% RELEASE FOR CONSTRUCTION
JUNE 29, 2021

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General project coordination procedures.
 - 2. Administrative and supervisory personnel.
 - 3. Coordination drawings.
 - 4. Requests for Information (RFIs).
 - 5. Project meetings.
 - 6. Inspections
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Related Sections:
 - 1. Division 01 Section "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 2. Division 01 Section "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Division 01 Section "Closeout Procedures" for coordinating closeout of the Contract.
 - 4. Division 01 Section "General Commissioning Requirements" for coordinating the Work with Contracting Officer's commissioning authority.

1.3 DEFINITIONS

- A. RFI: Request from Contracting Officer, COR, or Contractor seeking information from each other during construction.

1.4 DOCUMENTATION FOR CONTRACTOR

- A. In addition to one set of reproducible large-scale contract drawings, a set of electronic files of the contract drawings will be furnished to the Contractor without charge. Additional sets will be furnished on request at the cost of reproduction.

- B. Omissions from the drawings or specifications or the mis-description of details of work which are manifestly necessary to carry out the intent of the drawings and specifications, or which are customarily performed, shall not relieve the Contractor from performing such omitted or mis-described details of the work but they shall be performed as if fully and correctly set forth and described in the drawings and specifications.
- C. The Contractor shall check all drawings and specifications furnished him immediately upon their receipt and shall in writing within fourteen (14) calendar days from receipt of award, notify the Contracting Officer of any discrepancies. Figures marked on drawings shall in general be followed in preference to scale measurements. Large-scale drawings shall in general govern small-scale drawings; the Contractor shall compare all drawings and verify the figures before laying out the work and will be responsible for any errors which might have been avoided thereby.

1.5 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Use CSI Form 1.5A. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Prior to 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Any changes to the key personnel shall be submitted for Approval in advance. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
 - 1. Post copies of list in project meeting room, in temporary field office and by each temporary telephone. Keep list current at all times.

1.6 COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.

- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Contracting Officer and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of Contractor's construction schedule.
 - 2. Preparation of the schedule of values.
 - 3. Installation and removal of temporary facilities and controls.
 - 4. Delivery and processing of submittals.
 - 5. Progress meetings.
 - 6. Preinstallation conferences.
 - 7. Project closeout activities.
 - 8. Startup and adjustment of systems.
 - 9. Project closeout activities.
- D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste. The Contractor must also provide manufacturer's Material Data Safety Sheets (MSDS), VOC limits and other material content or manufacturing specification information as required and noted in subsequent Specification sections. Include information on coordinating the following, if part of the LEED submittal:
 - 1. CWM Plan (MRc2)
 - 2. Construction IAQ Plan (EQc3)
 - 3. Commissioning Plan (EAp2)

1.7 AS BUILT DRAWINGS

- A. The Contractor shall maintain at the job site one set of full-size contract drawings marked to show any changes and/or revisions which have been made from the contract drawings, including buried or concealed construction and utility features revealed during the course of construction. The Contractor shall record the horizontal and vertical location of all buried utilities that differ from the contract drawings. These drawings shall be available for review by the COR at all times. Upon completion of the work, the Contractor shall deliver the marked sets of prints to the COR in the original units of measure. Requests for partial payments will not be approved if the marked prints are not current, and request for final payment will not be approved until the marked prints are delivered to the Contracting Officer.

1.8 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings in accordance with requirements in individual Sections, where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is

required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.
 - g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to COR indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show non-structural and structural elements, and mechanical, plumbing, fire protection, fire alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate sub framing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire protection, fire alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.

- b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
 7. Review: COR will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are the Contractor's responsibility. If the COR determines that the coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, the COR will so inform the Contractor, who shall make changes as directed and resubmit.
 8. Coordination Drawing Prints: Prepare coordination drawing prints in accordance with requirements of Division 01 Section "Submittal Procedures."
- C. Coordination Digital Data Files: Prepare coordination digital data files in accordance with the following requirements:
 1. File Preparation Format: Same digital data software program, version, and operating system as the original Drawings.
 2. File Preparation Format: DWG, Version 2018 (or most recent version, conform with COR prior to start of project), operating in Microsoft Windows operating system.
 3. File Submittal Format: Submit or post coordination drawing files using Portable Data File (PDF) format.
 4. COR will furnish Contractor one set of digital data files of the Drawings for use in preparing coordination digital data files.
 - a. COR makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings.
 - b. Digital Data Software Program: The Drawings are available in PDF format
 - c. Contractor shall execute a data licensing agreement in the form of AIA Document C106.

1.9 REQUESTS FOR INFORMATION (RFIs)

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

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

1.10 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
 - 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify COR of scheduled meeting dates and times.
 - 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 - 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Contracting Officer, and COR, within three days of the meeting.
 - 4. Performance of the contract includes the Contractor attending all meetings deemed necessary by the Contracting Officer.
- B. Preconstruction Conference: CO will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Contracting Officer and COR, Revise subparagraphs below if conducting meetings is the responsibility of the Contractor.
 - 1. Conduct the conference to review responsibilities and personnel assignments.
 - 2. Attendees: Authorized representatives of Contracting Officer, COR, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 3. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Revise subparagraphs below to suit Project.
 - b. Tentative construction schedule.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.
 - e. Lines of communications.
 - f. Procedures for processing field decisions and Change Orders.
 - g. Procedures for RFIs.
 - h. Procedures for testing and inspecting.
 - i. Procedures for processing Applications for Payment.
 - j. Distribution of the Contract Documents.
 - k. Submittal procedures.
 - l. Sustainable design requirements.
 - m. Preparation of record documents.
 - n. Use of the premises.
 - o. Work restrictions.
 - p. Working hours.
 - q. Contracting Officer's occupancy requirements.
 - r. Responsibility for temporary facilities and controls.
 - s. Procedures for moisture and mold control.
 - t. Procedures for disruptions and shutdowns.
 - u. Construction waste management and recycling.
 - v. Parking availability.
 - w. Office, work, and storage areas.

- x. Equipment deliveries and priorities.
 - y. First aid.
 - z. Security.
 - aa. Progress cleaning.
 - 4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
- 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advice COR of scheduled meeting dates.
 - 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Revise subparagraphs below to suit Project.
 - b. Contract Documents.
 - c. Options.
 - d. Related RFIs.
 - e. Related Change Orders.
 - f. Purchases.
 - g. Deliveries.
 - h. Submittals.
 - i. Review of mockups.
 - j. Possible conflicts.
 - k. Compatibility requirements.
 - l. Time schedules.
 - m. Weather limitations.
 - n. Manufacturer's written instructions.
 - o. Warranty requirements.
 - p. Compatibility of materials.
 - q. Acceptability of substrates.
 - r. Temporary facilities and controls.
 - s. Space and access limitations.
 - t. Regulations of authorities having jurisdiction.
 - u. Testing and inspecting requirements.
 - v. Installation procedures.
 - w. Coordination with other work.
 - x. Required performance results.
 - y. Protection of adjacent work.
 - z. Protection of construction and personnel.
 - 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Schedule and conduct a Project closeout conference, at a time convenient to Contracting Officer and COR, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Contracting Officer, COR, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Revise subparagraphs below to suit Project.
 - b. Preparation of record documents.
 - c. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - d. Submittal of written warranties.
 - e. Requirements for preparing operations and maintenance data.
 - f. Requirements for delivery of material samples, attic stock, and spare parts.
 - g. Requirements for demonstration and training.
 - h. Preparation of Contractor's punch list.
 - i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - j. Submittal procedures.
 - k. Retain first subparagraph below for projects with separate contracts that may impact Contractor's work and procedures at project closeout.
 - l. Coordination of separate contracts.
 - m. Contracting Officer's partial occupancy requirements.
 - n. Installation of Contracting Officer's furniture, fixtures, and equipment.
 - o. Responsibility for removing temporary facilities and controls.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress Meetings: Conduct progress meetings at biweekly intervals.
1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of Contracting Officer and COR, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

3. Agenda: Review and correct or approve minutes of previous progress meeting; distribute corrected meeting minutes within 48 hours. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - i. Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - i. Interface requirements.
 - ii. Sequence of operations.
 - iii. Status of submittals.
 - iv. Deliveries.
 - v. Off-site fabrication.
 - vi. Access.
 - vii. Site utilization.
 - viii. Temporary facilities and controls.
 - ix. Progress cleaning.
 - x. Quality and work standards.
 - xi. Status of correction of deficient items.
 - xii. Field observations.
 - xiii. Status of RFIs.
 - xiv. Status of proposal requests.
 - xv. Pending changes.
 - xvi. Status of Change Orders.
 - xvii. Pending claims and disputes.
 - xviii. Documentation of information for payment requests.
 4. Minutes: Contractor shall be responsible for conducting the meeting, will record, and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- F. Coordination Meetings: Conduct Project coordination meetings at regular intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and pre-installation conferences.
1. Attendees: In addition to representatives of Contracting Officer and COR, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - i. Interface requirements.
 - ii. Sequence of operations.
 - iii. Status of submittals.
 - iv. Deliveries.
 - v. Off-site fabrication.
 - vi. Access.
 - vii. Site utilization.
 - viii. Temporary facilities and controls.
 - ix. Work hours.
 - x. Hazards and risks.
 - xi. Progress cleaning.
 - xii. Quality and work standards.
 - xiii. Change Orders.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.11 SCHEDULING OF INSPECTIONS

- A. When specified inspections or tests are required by the Contract Documents, the work involved shall not proceed beyond the point until such inspections or tests have been approved by the COR. The Contractor shall inform the COR of progress of the work and shall give the COR a minimum of three (3) working days written notice of appropriate times for specified inspections and tests. The Contractor shall insure that the portion of work to be inspected is safe and accessible.
- B. The Contractor and COR shall jointly develop agendas subject to the COR's approval for all inspections/tests. All required labor, materials, equipment, instruments, lubricants and incidentals necessary to perform these inspections/tests shall be furnished by the Contractor. All discrepancies and deficiencies observed during each inspection/test shall be noted and corrected and, if directed by the COR, the inspection/test of equipment and systems previously found deficient shall be rescheduled and performed at no additional cost to the Government.

1.12 FIELD INVESTIGATIONS

- A. Contractors shall adhere to the requirements of the “Guidelines for Contractors and A/E Firms Performing Site Investigations and Field Work at NIST” when they are performing site investigations and fieldwork.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Start-up construction schedule.
 - 2. Contractor's construction schedule.
 - 3. Daily construction reports.
 - 4. Material location reports.
 - 5. Field condition reports.
 - 6. Special reports.
- B. Related Sections:
 - 1. Division 01 Section "Submittal Procedures" for submitting schedules and reports.
 - 2. Division 01 Section "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum, unless otherwise approved by COR.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of the Project.

- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time belongs to Contracting Officer.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. PDF electronic file.
 - 2. Two paper copies.
- B. Start-up construction schedule.
 - 1. Approval of cost-loaded start-up construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Start-up Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
- D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 - 1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
- E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
 - 1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 - 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 - 3. Total Float Report: List of all activities sorted in ascending order of total float.
 - 4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work until most recent Application for Payment.

- F. Daily Construction Reports: Submit at weekly intervals.
- G. Material Location Reports: Submit at weekly intervals.
- H. Field Condition Reports: Submit at weekly intervals.
- I. On Site Equipment Report: Submit at daily intervals.
- J. Special Reports: Submit at time of unusual event.
- K. Qualification Data: For scheduling consultant.

1.5 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of COR's request.
- B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's construction schedule, including, but not limited to, the following:
 - 1. Review software limitations and content and format for reports.
 - 2. Verify availability of qualified personnel needed to develop and update schedule.
 - 3. Discuss constraints, including work stages and interim milestones.
 - 4. Review delivery dates for Contracting Officer-furnished products.
 - 5. Review schedule for work of Contracting Officer's separate contracts.
 - 6. Review time required for review of submittals and resubmittals.
 - 7. Review requirements for tests and inspections by independent testing and inspecting agencies.
 - 8. Review time required for completion and startup procedures.
 - 9. Review and finalize list of construction activities to be included in schedule.
 - 10. Review submittal requirements and procedures.
 - 11. Review procedures for updating schedule.

1.6 COORDINATION

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

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established for commencement of the Work to date of Substantial Completion.
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- B. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
 - 1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by COR.
 - 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - 3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
 - 4. Startup and Testing Time: Include not less than 15 days for startup and testing.
 - 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for COR's administrative procedures necessary for certification of Substantial Completion.
 - 6. Punch List and Final Completion: Include not more than 30 days for punch list and final completion.
- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
 - 1. Work under More Than One Contract: Include a separate activity for each contract.
 - 2. Work by Contracting Officer: Include a separate activity for each portion of the Work performed by Contracting Officer.
 - 3. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 - 4. Contracting Officer-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 - 5. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Limitations of continued occupancies.
 - b. Uninterruptible services.
 - c. Use of premises restrictions.
 - d. Provisions for future construction.
 - e. Seasonal variations.
 - f. Environmental control.

6. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Startup and placement into final use and operation.
 7. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Revise list below to suit Project.
 - b. Structural completion.
 - c. Permanent space enclosure.
 - d. Completion of mechanical installation.
 - e. Completion of electrical installation.
 - f. Substantial Completion.
- D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.
- E. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.
- F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
1. Unresolved issues.
 2. Unanswered RFIs.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
- G. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

- H. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

- 1. Utilize Microsoft Project, for Windows operating system.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

- A. General: Prepare network diagrams using cost loaded format.

- B. Start-up Network Diagram: Prepare a fully developed network analysis of the project. The network shall be of the type generally referred to as the Critical Path Method (CPM), Critical Path Schedule (CPS), and Critical Path Analysis (CPA). Submit within 15 days of the date established for "Notice to Proceed".

- 1. The network analysis shall include as a minimum a graphic representation of all activities and events included in the construction of the project. The network shall show the major subdivisions of the work, the activities involved in each part, the relations of activities to each other as to dependency, concurrency, etc., the duration of each activity, and the critical path of activities for the overall job showing a total job duration equal to the contract time. A written statement of explanation is to be submitted with the network designation.
 - 2. An initial schedule, generated by the network design shall be submitted showing the following for each activity.
 - a. The earliest activity starting time, the latest activity starting time, the earliest activity finishing time, the latest activity finishing time, total float time (slack time), free float (of slack). These times are to be given in calendar dates.
 - b. Status reports for the approved network diagram will be required monthly throughout the life of the contract or at other times if unusual conditions exist, at the direction of the Contracting Officer. These reports will indicate actual completion dates of completed activities and expected completion dates of other activities.
 - c. Any changes in the original network plan desired by the Contractor must be approved by the Contracting Officer.
 - d. Allow 21 calendar days for NIST to process and review major submittal packages submitted to NIST for review and approval.
 - e. Clearly indicate the critical path for the project. Highlight NIST actions that are on the critical path.
 - f. Phasing: Provide notations on the schedule to show how the sequence of the Work is affected by requirements for phased completion to permit Work by separate Contractors and partial occupancy by the Government prior to Substantial Completion.
 - g. Work Stages: Indicate important stages of construction for each major portion of the Work, including contractor funded testing and installation.
 - h. Area Separations: Provide a separate time bar to identify each major construction area for each major portion of the Work. Indicate where each element in an area must be sequenced or integrated with other activities.
 - i. Cost Correlation: At the head of the schedule, provide a two item cost correlation line, indicating "pre-calculated" and "actual" costs. On the line show dollar-volume of Work performed as of the dates used for preparation of payment requests.

- C. CPM Schedule: Prepare Contractor's construction schedule using a cost loaded CPM network analysis diagram for the Work.
1. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of COR's approval of the schedule.
 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to correlate with Contract Time.
 5. All costs applicable to the requirements for network analysis, reports, etc. shall be included in the lump sum offer.
 6. Update the equipment delivery schedule at monthly intervals or as directed by the COR; reflect any changes occurring since the last updating. Submit copies of purchase orders and confirmation of delivery dates as directed. Update the equipment schedule with each invoice for progress payment.
- D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the start-up network diagram, prepare a skeleton network to identify probable critical paths.
1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Revise list below to suit Project.
 - b. Preparation and processing of submittals.
 - c. Mobilization and demobilization.
 - d. Purchase of materials.
 - e. Delivery.
 - f. Fabrication.
 - g. Utility interruptions.
 - h. Installation.
 - i. Work by Contracting Officer that may affect or be affected by Contractor's activities.
 - j. Testing and commissioning.
 - k. Punch list and final completion.
 - l. Activities occurring following final completion.
 2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
 3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

5. Cost-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain COR's approval prior to assigning costs to fabrication and delivery activities. Assign costs under principal subcontracts for contractor funded testing and commissioning activities, operation and maintenance manuals, punch list activities, Project record documents, LEED documentation, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
 - a. Each activity cost shall reflect an appropriate value subject to approval by COR.
 - b. Total cost assigned to activities shall equal the total Contract Sum.
 - c. All costs applicable to the requirements for network analysis, reports, etc. shall be included in the lump sum offer.
- E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.
- F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
 1. Contractor or subcontractor and the Work or activity.
 2. Description of activity.
 3. Principal events of activity.
 4. Immediate preceding and succeeding activities.
 5. Early and late start dates.
 6. Early and late finish dates.
 7. Activity duration in workdays.
 8. Total float or slack time.
 9. Average size of workforce.
 10. Dollar value of activity (coordinated with the schedule of values).
- G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following: Update the equipment delivery schedule at monthly intervals or as directed by the COR; reflect any changes occurring since the last updating. Submit copies of purchase orders and confirmation of delivery dates as directed. Update the equipment schedule with each invoice for progress payment.
 1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in total float or slack time.
 7. Changes in the Contract Time.
- H. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
 1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.

2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
 - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
 - b. Submit value summary printouts one week before each regularly scheduled progress meeting.

2.3 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
 1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. Equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 7. Accidents.
 8. Meetings and significant decisions.
 9. Unusual events (refer to special reports).
 10. Stoppages, delays, shortages, and losses.
 11. Meter readings and similar recordings.
 12. Emergency procedures.
 13. Orders and requests of authorities having jurisdiction.
 14. Change Orders received and implemented.
 15. Construction Change Directives received and implemented.
 16. Services connected and disconnected.
 17. Equipment or system tests and startups.
 18. Partial completions and occupancies.
 19. Substantial Completions authorized.
- B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.
- C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.4 SPECIAL REPORTS

- A. General: Submit special reports directly to Contracting Officer within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, and response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Contracting Officer in advance when these events are known or predictable.
- C. Equipment Delivery Schedule:
 - 1. Within ten (10) calendar days after Notice of Award, submit to the COR for approval, a schedule shown in the procurement plans for materials, plans and equipment. The submittal shall be in the format prescribed by the Contracting Officer and include as a minimum the following information.
 - a. Description
 - b. Date of purchase order
 - c. Promised shipping date
 - d. Name of manufacturer or supplier
 - e. Date delivery is expected
 - f. Date material or equipment is required, according to current progress schedule or network.
 - 2. The Contractor shall update the equipment delivery schedule at monthly intervals or as directed by the COR. This delivery schedule shall reflect any changes occurring since the last update. The Contractor shall submit copies of purchase orders and confirmation of delivery dates as directed by the COR and update the equipment schedule with each invoice for progress payment.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Scheduling: Contractor to provide planning, evaluation, and reporting using CPM scheduling.
- B. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
 - 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 - 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 - 3. As the Work progresses, indicate final completion percentage for each activity.

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

END OF SECTION 013200

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Sections:
 - 1. Division 01 Section "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 2. Division 01 Section "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 3. Division 01 Section "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
 - 4. Division 01 Section "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Contracting Officer's personnel.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require COR's responsive action. Action submittals are those submittals indicated in individual Specification Sections as action submittals.
- B. Informational Submittals: Written and graphic information and physical samples that do not require COR's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as informational submittals.
- C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.
- E. Base Manufacturer:

1. The term “base manufacturer” as used in the Specifications refers to a manufacturer of equipment, materials, articles, or patented processes, designated by trade name, make, or catalog number, that have been used as the basis of design.
2. Base manufacturer’s products shall be regarded as establishing a standard of quality and shall not be construed as limiting competition.

F. Optional Manufacturer:

1. Subject to the limitations set out in Sections 016000, the term “optional manufacturer” as used in the Specifications refers to a manufacturer of equipment, materials, articles, or patented processes that may provide the same functions and meet the same performance standards as the base manufacturer’s product but may require different structural support or different utility hookups or other adjustments. Optional manufacturer’s products are acceptable for performance but the Contractor is responsible for the costs for any dimensional, operational, structural, or utility adjustments to make the products fit the Project. If the Contractor intends to supply an optional manufacturer’s product, the “or equal” terms and conditions of Construction Contract Clauses title “Materials and Workmanship” shall apply, except as otherwise specifically provided in Sections 016000
2. Listing of an optional manufacturer as a supplier of the product, but only if the optional manufacturer’s product complies or can be successfully made to comply with the specified requirements, including the salient qualities included but are not necessarily limited to the following:
 - a. Purpose and function.
 - b. Materials and finish.
 - c. Strength, durability and other applicable physical properties.
 - d. Compatibility and performance attributes for the indicated application.
 - e. Capacity and operating characteristics, where applicable.
 - f. Size and configuration to the extent required for fit with adjoining and adjacent conditions and within spatial limitations.
 - g. Appearance, including exposed dimensions, profile, texture, pattern, and color, where visible to personnel in finished spaces or from the exterior.

1.4 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or modifications to submittals noted by the COR and additional time for handling and reviewing submittals required by those corrections.
1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 2. All product submittals shall be submitted within 15 days of notice to proceed.
 3. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal category: Action, informational.
 - d. Name of subcontractor.

- e. Description of the Work covered.
- f. Scheduled date for COR's final release or approval.
- g. Scheduled dates for purchasing.
- h. Scheduled dates for installation.
- i. Activity or event number.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. COR's Digital Data Files: Electronic copies of CAD Drawings of the Contract Drawings will be provided by COR for Contractor's use in preparing submittals.
 - 1. COR and Architect make no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 - 2. Digital Drawing Software Files: The Contract Drawings are available in AutoCAD 2014.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, contractor funded testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 - 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 - 4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. COR reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on COR's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 - 1. Initial Review: Allow 21 calendar days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. COR will advise Contractor when a submittal being processed must be delayed for coordination.
 - 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 - 3. Reprocessing: Allow 14 calendar days for reprocessing each submittal.
 - 4. Re-submittal Review: Allow 21 calendar days for review of each resubmittal.
 - 5. Sequential Review: Where sequential review of submittals by COR's consultants, Contracting Officer, or other parties is indicated, allow 28 calendar days for initial review of each submittal.
 - 6. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to COR and to COR's consultants, allow 21 calendar

days for review of each submittal. Submittal will be returned to COR before being returned to Contractor.

7. No extension of Contract Time will be authorized because of failure by the Contractor to transmit submittals to the Government sufficiently in advance of the Work to permit processing.

D. Identification and Information: Place a permanent label or title block on each paper copy submittal item for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space approximately 4 by 5 inches on label or beside title block to record Contractor's review and approval markings and action taken by COR.
3. Include the following information for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name and Address of Engineer
 - d. Name and Address of Contractor
 - e. Name and Address of Sub-Contractor.
 - f. Name and Address of Supplier.
 - g. Name of manufacturer.
 - h. Revise first subparagraph below to suit Project and office practice.
 - i. Submittal number or other unique identifier, including revision identifier.
 - i) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
 - j. Number and title of appropriate Specification Section.
 - k. Drawing number and detail references, as appropriate.
 - l. Location(s) where product is to be installed, as appropriate.
 - m. Other necessary identification.

E. Identification and Information: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by COR.
4. Include the following information on an inserted cover sheet:
 - a. Project name.
 - b. Date.
 - c. Name and Address of Engineer

- d. Name and Address of Contractor
 - e. Name and Address of Sub-Contractor.
 - f. Name and Address of Supplier.
 - g. Name of manufacturer.
 - h. Number and title of appropriate Specification Section.
 - i. Drawing number and detail references, as appropriate.
 - j. Location(s) where product is to be installed, as appropriate.
 - k. Related physical samples submitted directly.
 - l. Other necessary identification.
5. Include the following information as keywords in the electronic file metadata:
- a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- F. Options: Identify options requiring selection by the COR.
- G. Deviations: Identify deviations from the Contract Documents on submittals.
- H. Additional Paper Copies: Unless additional copies are required for final submittal, and unless COR observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to COR.
- I. Transmittal: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal from Contractor to NIST using a transmittal form. COTR will return submittals, without review, received from sources other than Contractor. Transmittal form: Use format agreeable to COR
1. Transmittal Form: Provide locations on form for the following information:
- a. Project name.
 - b. Date.
 - c. Destination (To :).
 - d. Source (From :).
 - e. Names of subcontractor, manufacturer, and supplier.
 - f. Category and type of submittal.
 - g. Submittal purpose and description.
 - h. Specification Section number and title.
 - i. Indication of full or partial submittal.
 - j. Drawing number and detail references, as appropriate.
 - k. Transmittal number.
 - l. Submittal and transmittal distribution record.
 - m. Remarks.
 - n. Signature of transmitter.

2. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by COR on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- J. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked with approval notation from COR's action stamp.
- K. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- L. Use for Construction: Use only final submittals that are marked with approval notation from COR's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Submit submittals via mail or other delivery service to COR for review.
 - a. COR will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 2. Submittals: The Contractor shall prepare submittals in accordance with the Special Contract Requirements and the Technical Specifications and submit to the COR for approval. Each submittal shall be accompanied with a cover letter signed by the Contractor. The Contractor shall clearly mark each item proposed to be incorporated into the contract and identify in the submittals, with cross-references to the contract drawings and specifications so as to identify clearly the use for which it is intended. Stamp each sheet of submittal with the Contractor's certification stamp. Data submitted in a bound volume or on one sheet printed on two sides, may be stamped on the front of the first sheet only. The Contractor's certification stamp shall be worded as follows
 - a. "It is hereby certified that the (equipment) (material) shown and marked in this submittal is that proposed to be incorporated into Contract Number _____, is in compliance with the Contract drawings and specifications, can be installed in the allocated spaces, and is submitted for Government approval.
 - b. Certified by _____ Date _____"

- c. The person signing the certification shall be one designated in writing by the Contractor as having that authority. The signature shall be in original ink. Stamp signatures are not acceptable.
3. Action Submittals: Submit Six (6) paper copies of each submittal, unless otherwise indicated. COR will return two copies.
4. Informational Submittals: Submit Six (6) paper copies of each submittal, unless otherwise indicated. COR will return Two (2) copies.
5. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Division 01 Section "Closeout Procedures."
6. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
 - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.
7. Test and Inspection Reports Submittals: Comply with requirements specified in Division 01 Section "Quality Requirements."
8. Submittal Status Logs: The Contractor shall utilize the submittal log provided by the COR of Construction. The Contractor shall verify the log for accuracy and completeness, and shall notify the COR, in writing, within seven (7) calendar days with regards to the same. The Contractor is required to maintain at the job-site an up-to-date log showing the status of all submittals required by the Contract. Use of a numbering system is required.
9. Shop Drawings: These submittals shall be in accordance with the requirements of the clause entitled "Shop Drawings"
10. Manufacturer's Data: Catalogue cuts, technical data sheets, descriptive literature, and samples shall be submitted in accordance with the clause entitled, "Submittal Procedures"
11. Certified Test Reports: Before delivery of materials and equipment, five (5) certified copies of the reports of all test listed in the technical sections shall be submitted and approved. The contractor funded testing shall have been performed in a laboratory meeting the requirements specified herein. The tests shall have been performed within three (3) years of submittal of the reports for approval. Test reports shall be accompanied by the certificates from the manufacturers certifying that the material and equipment proposed to be supplied is of the same type, quality, manufacture, and make as that tested
12. Manufacturer's Certificates of Conformance: Before delivery, manufacturer's certifications shall be furnished by the Contractor as required on items of materials and equipment indicated in the technical sections. Pre-printed certifications will not be acceptable. All certifications shall be in the original. The original of all manufacturers' certifications shall name the appropriate item of equipment or material, specification, standard, or other document specified as controlling the quality of that item and shall have attached thereto certified copies of test data upon which the certifications are based. All certificates shall be signed by the manufacturer's official authorized to sign certificates of conformance.
13. Tabulation of Tests: Prior to final payment, the Contractor shall obtain from each laboratory a tabulation of all tests it has performed in connection with the construction contract. Conforming, nonconforming, and contractor funded testing shall be tabulated.

The tabulation(s) shall be certified as complete, and signed by the authorized representative of the laboratory, and shall be delivered to the Contracting Officer.

14. Deviations: Deviations from contract requirements are discouraged. In the event the Contractor determines that a deviation is necessary, the Contractor shall state specifically what portion varies, why a deviation is necessary, and includes a complete breakdown of the difference in cost, either additive or deductive, in compliance with Section, Paragraph , entitled "Changes". Without such documentation, deviations will not be considered by the Contracting Officer.
15. Warrants for Deviations: If the Contractor determines that a deviation is necessary, the Contractor shall warrant.
 - a. That the entire contract has been reviewed in order to establish that the deviation, when incorporated, will be compatible with all other elements of construction.
 - b. That any action shall be taken and any additional expense borne which may arise by reason of incorporating the proposed deviation, including, but not limited to, change in this or other elements of construction resulting from the incompatibility of the proposed deviation with any other element of construction.

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

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

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches
 3. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
 - b. Six copies (bond). COR will return two copies.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Contracting Officer's property, are the property of Contractor.
 4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. COR will return submittal with options selected.
 5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent contractor funded testing and inspection.

- a. Number of Samples: Submit Four (4) sets of Samples. COR will return one set.
 - i) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - ii) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 1. Type of product. Include unique identifier for each product indicated in the Contract Documents.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
 5. Submit product schedule in the following format:
 - a. PDF electronic file.
 - b. Three paper copies of product schedule or list, unless otherwise indicated. COR will return two copies.
- F. Spare Parts Data:
 1. As soon as practicable after approval of the list of equipment, the Contractor shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies with current unit price and source of supply; a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment, or specified hereinafter to be furnished as part of the Contract and a list of additional items recommended by the manufacturer to assure efficient operation. The foregoing shall not relieve the Contractor of any responsibilities under the guarantee specified hereinafter
- G. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."
- H. Application for Payment: Comply with requirements specified in Division 01 Section "Payment Procedures."
- I. Schedule of Values: Comply with requirements specified in Division 01 Section "Payment Procedures."
- J. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 2. Number and title of related Specification Section(s) covered by subcontract.

3. Drawing number and detail references, as appropriate, covered by subcontract.
4. Submit subcontract list in the following format:
 - a. Number of Copies: Five (5) paper copies of subcontractor list, unless otherwise indicated. COR will return two copies.
- K. Coordination Drawings: Comply with requirements specified in Division 01 Section "Project Management and Coordination."
- L. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of COR and Contracting Officer, and other information specified.
- M. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on American Welding Society (AWS) forms. Include names of firms and personnel certified.
- N. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- O. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- P. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- Q. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- R. Material Test Reports: Submit reports written by a qualified contractor funded testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- S. Product Test Reports: Submit written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified contractor funded testing agency, or on comprehensive tests performed by a qualified contractor funded testing agency.
- T. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 1. Name of evaluation organization.
 2. Date of evaluation.
 3. Time period when report is in effect.
 4. Product and manufacturers' names.
 5. Description of product.

6. Test procedures and results.
7. Limitations of use.
- U. Schedule of Tests and Inspections: Comply with requirements specified in Division 01 Section "Quality Requirements."
- V. Preconstruction Test Reports: Submit reports written by a qualified contractor funded testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- W. Compatibility Test Reports: Submit reports written by a qualified contractor funded testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- X. Field Test Reports: Submit reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- Y. Maintenance Data: Comply with requirements specified in Division 01 Section "Operation and Maintenance Data."
- Z. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

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

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to COR.
- B. Project Closeout and Maintenance/Material Submittals: Refer to requirements in Division 01 Section "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 COR'S ACTION

- A. General: COR will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: COR will review each submittal, make marks to indicate corrections or modifications required, and return it. COR will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
- C. Informational Submittals: COR will review each submittal and will not return it, or will return it if it does not comply with requirements. COR will forward each submittal to appropriate party.
- D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from COR.
- E. Incomplete submittals are not acceptable, will be considered nonresponsive, and will be returned without review.
- F. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Contractor funded testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and -control services required by COR, Contracting Officer, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Sections:
 - 1. Division 01 Section "Construction Progress Documentation" for developing a schedule of required tests and inspections.
 - 2. Divisions 02 through 49 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by COR.

- C. Mockups: Full size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, Contractor funded testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
 - 1. Installation Mockups: Mockups of typical mechanical equipment installation for HEPA devices, air flow measuring stations and exhaust air terminal units shall be provided at the request of COR.
- D. Preconstruction Contractor funded testing: Tests and inspections performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.
- E. Product Contractor funded testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a Contractor funded testing agency qualified to conduct product Contractor funded testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Certified Test Reports: Test reports signed by an authorized official stating that tests were performed in accordance with the test method specified, that the results reported are accurate, and that items tested either meet or fail to meet the stated minimum requirements. These test reports include those performed by Factory Mutual, Underwriters Laboratories, Inc., and others.
- G. Certified Inspection Reports: Reports signed by approved inspectors at Contractor funded testing that the items inspected meet the specification requirements other than any exception included in the report.
- H. Manufacturer's Certificate of Conformance: A certificate signed by an authorized manufacturer's official at Contractor funded testing that the material or equipment delivered meets the specification requirements.
- I. Source Quality-Control Contractor funded testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
- J. Field Quality-Control Contractor funded testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- K. Factory Tests: Tests made on various products and component parts prior to shipment to the job site, including but not limited to such items as transformers, boilers, air conditioning equipment, electrical equipment, and precast concrete.
- L. Field Tests: Tests or analyses made at, or in the vicinity of, the job site in connection with the actual construction.
- M. Person: The term "person" means associations, companies, corporations, educational institutions, firms, government agencies at the Federal, State, and local level, partnerships, and societies, as well as divisions thereof, and individuals.

- N. Product: The term “product” includes the plural thereof and means a type or a category of manufactured goods, constructions, installations, and natural and processed materials or those associated services whose characterization, classification, or functional performance determination is specified by standards.
- O. Contractor funded testing Agency: The term “Contractor funded testing laboratory” means any “person”, as defined above, whose functions include Contractor funded testing, analyzing, or inspecting “products”, as defined above, evaluating the designs or specifications of such “products” according to the requirements of applicable standards.
- P. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade or trades.
- Q. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of **five** previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

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

1.5 ACTION SUBMITTALS

- A. Shop Drawings: For mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.
 - 1. Indicate manufacturer and model number of individual components.
 - 2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.
- B. Contractor funded testing Agency Qualifications: For Contractor funded testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the Contractor funded testing agency by a recognized authority.

C. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

1.6 THREE PHASES OF CONTROL

A. The QC Manager shall perform and document the three phases of control to ensure that work complies with Contract requirements. The three phases of control shall adequately cover both onsite and offsite work, and shall include the following for each definable feature of work: a definable feature of work is a task, which is separate and distinct from other tasks and requires separate control requirements.

1. Preparatory Phase: Notify the Contracting Officer at least 48 hours in advance of each preparatory phase. Conduct the preparatory phase with the QC Specialists, the Superintendent, and the Foreman responsible for the definable feature. Document the results of the preparatory phase actions in the daily Contractor Quality Control Report. Perform the following prior to beginning work on each definable feature of work.
 - a. Review each paragraph of the applicable specification sections.
 - b. Review the Contract drawings.
 - c. Verify that appropriate shop drawings and submittals for materials and equipment have been submitted and approved. Verify receipt of approved factory test results, when required.
 - d. Review the Contractor funded testing plan and ensure that provisions have been made to provide the required QC Contractor funded testing.
 - e. Examine the work area to ensure that the required preliminary work has been completed.
 - f. A physical examination of required materials, equipment, and sample work to ensure that they are on hand and conform to the approved shop drawings and submitted data.
 - g. Review the safety plan and appropriate activity hazard analysis to ensure that applicable safety requirements are met, and that required Material Safety Data Sheets (MSDS) are submitted.
 - h. Discussion of procedures for controlling quality of the work, including repetitive deficiencies. Document construction tolerances and workmanship standards for that feature of work.
 - i. A check to ensure that the Contracting Officer has accepted the portion of the plan for the work to be performed.
2. Initial Phase: Notify the Contracting Officer at least 48 hours in advance of each initial phase. When construction crews are ready to start work on a definable feature of work, conduct the initial phase with the QC Specialists, the Superintendent, and the Foreman responsible for that feature of work. Observe the initial segment of the definable feature of work to ensure that the work complies with the Contract requirements. Document the results of the initial phase in the daily Contractor Quality Control Report. Repeat the initial phase for each new crew to work onsite, or when acceptable levels of specified quality are not being met. Perform the following for each definable feature of work.

- a. Establish the quality of workmanship required.
 - b. Resolve conflicts.
 - c. Review the Safety Plan, and the appropriate activity hazard analysis to ensure that applicable safety requirements are met.
 - d. Ensure that Contractor funded testing is performed, by the approved laboratory.
 - e. Review minutes of the preparatory meeting.
 - f. Verify adequacy of controls to ensure full contract compliance, verify required control inspection, and Contractor funded testing.
 - g. The initial phase should be repeated for new crew to work onsite, or anytime that acceptable specified quality standards are not being met.
3. Follow-up Phase: Daily checks shall be performed to assure control activities, including control Contractor funded testing, are providing compliance with contract requirements, until completion of the particular feature of work. The checks shall be made a matter of record in the QC documentation. Perform the following for ongoing work daily, or more frequently, as necessary until the completion of each definable feature of work and document in the daily Contractor Quality Control Report.
 - a. Ensure the work is in compliance with Contract requirements.
 - b. Maintain the quality of workmanship required.
 - c. Ensure that Contractor funded testing is performed by the approved laboratory; and ensure that rework items are being corrected.
4. Notification of Three Phases of Control for Offsite Work: Notify the Contracting Officer at least 14 calendar days prior to the start of the preparatory and initial phases.

1.7 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice of Award, and not less than five days prior to preconstruction conference. Submit in format acceptable to COR. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
 1. Project quality-control manager may also serve as Project superintendent.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Contractor funded testing and Inspection: Include in quality-control plan a comprehensive schedule of Work requiring Contractor funded testing or inspection, including the following:
 1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.

2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
 3. Contracting Officer-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by the Commissioning Authority.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to Contractor funded testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain Contractor funded testing and inspection reports including log of approved and rejected results. Include work COR has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.8 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
 2. Project title and number.
 3. Name, address, and telephone number of Contractor funded testing agency.
 4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making tests and inspections.
 6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample taking and Contractor funded testing and inspecting.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on Contractor funded testing and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.

6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.
- D. Permits, Licenses, and Certificates: For Contracting Officer's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.9 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

- G. Contractor funded testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct Contractor funded testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized Contractor funded testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A Contractor funded testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. Preconstruction Contractor funded testing: Where Contractor funded testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for Contractor funded testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - e. Build laboratory mockups at Contractor funded testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - f. When Contractor funded testing is complete, remove test specimens, assemblies, mockups; do not reuse products on Project.
 - 2. Contractor funded testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to COR, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups in location and of size indicated or, if not indicated, as directed by COR.
 - 2. Notify COR seven days in advance of dates and times when mockups will be constructed.

3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at the Project.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Obtain COR's approval of mockups before starting work, fabrication, or construction.
 - a. Allow 15 calendar days for initial review and each re-review of each mockup.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed, unless otherwise indicated.

1.10 QUALITY CONTROL

- A. Contractor Responsibilities: Tests and inspections not explicitly assigned to Contracting Officer are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Where services are indicated as Contractor's responsibility, engage a qualified Contractor funded testing agency to perform these quality-control services.
 - a. Contractor shall not employ same entity engaged by Contracting Officer, unless agreed to in writing by Contracting Officer.
 3. Notify Contractor funded testing agencies at least 24 hours in advance of time when Work that requires Contractor funded testing or inspecting will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Contractor funded testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- B. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section "Submittal Procedures."
- C. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- D. Contractor funded testing/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including Contractor funded testing and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

- E. Contractor funded testing Agency Responsibilities: Cooperate with COR and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - 1. Notify COR and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 - 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 - 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 - 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 - 6. Do not perform any duties of Contractor.
- F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - 1. Access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Adequate quantities of representative samples of materials that require Contractor funded testing and inspecting. Assist agency in obtaining samples.
 - 4. Facilities for storage and field curing of test samples.
 - 5. Delivery of samples to Contractor funded testing agencies.
 - 6. Preliminary design mix proposed for use for material mixes that require control by Contractor funded testing agency.
 - 7. Security and protection for samples and for Contractor funded testing and inspecting equipment at Project site.
- G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate Contractor funded testing and inspecting.
 - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- H. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses. .
 - 1. Distribution: Distribute schedule to Contracting Officer, COR Contractor funded testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.11 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Engage a qualified Contractor funded testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Contracting Officer, and as follows:

- B. Special Tests and Inspections: Conducted by a qualified Contractor funded testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
 2. Notifying COR and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 3. Submitting a certified written report of each test, inspection, and similar quality-control service to COR with copy to Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 6. Contractor funded testing and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

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

3.2 QUALITY CONTROL REQUIREMENTS

1. The Contractor shall inspect and test all work under the contract and maintain records of the inspections and tests. Approvals, except those required for field installation, field applications, and field tests, shall be obtained before delivery of materials and equipment to the project site. Surveillance of the inspection system will be performed by the Contracting Officer.
 - a. Factory Tests: Unless otherwise specified, the Contractor shall arrange for factory tests when they are required under the contract.
 - b. Factory Inspections by the Contractor: Unless otherwise specified, the Contractor shall arrange and perform all factory inspections specifically required in the technical specifications. These inspections shall be reported in the Contractor's Daily Report.
 - c. Field Inspections and Tests by the Contractor: The Contractor shall furnish all equipment, instruments, qualified personnel, and facilities necessary to inspect all work and perform

all tests required by the contract. All inspections and tests performed and test results received each day shall be included in the Contract's Daily Report.

- d. Field Inspections and Tests by the Government: If deemed necessary by the Contracting Officer, field inspections and tests will be made in accordance with the clause entitled "Scheduling of Inspections".
- e. Repeated Tests and Inspections: The Contractor shall repeat tests and inspections after each correction made to nonconforming materials and workmanship until tests and inspections indicate the materials, equipment, and workmanship conform to the contract requirements. The Contractor funded testing and reinspections shall be performed at no additional cost to the Government.

3.3 INTERRUPTION TO OPERATIONS AND SERVICES

- A. The Contractor shall schedule his work as to cause the least amount of interference with site operations. Work schedules shall be subject to the approval of the COR. Permission to interrupt any site road and/or utility service shall be requested in writing a minimum of fourteen (14) calendar days prior to the desired date of interruption.
- B. The Contractor shall ensure that new utility lines are complete, except for the connection, before interrupting existing service.
- C. Outages and Closures: The Contractor shall not close or partially block any roads or cause utility outages (electrical, steam, chilled water, water, compressed air, gas, sewer, telephone, fire alarm, and signal systems) without the written authorization from the COR. Authorization shall be requested not less than 14 days in advance and not before all material necessary for the work to be done during the road blockage or utility outage is on the site. The request for authorization shall include in writing the following information: Contractor's name, contract number, project title, description and drawings of roads and utilities to be shut down, times, dates and reasons for shut downs, and any pertinent suggestions or comments. All outages and closures shall be limited to the minimum time and shall not exceed the authorized time. The Contractor shall provide cautionary and directional signs as needed. Work which necessitates an outage affecting the areas beyond the work site shall be performed on Saturday, Sunday or after the normal working day.

3.4 MEASUREMENTS

- A. Actual dimensions and physical obstructions shall be obtained by the Contractor from on-site investigation. The Contractor shall furnish and install, at no cost to the Government, all necessary fittings, off-sets, supports, accessories, etc., as required, whether shown or not, to prevent conflict with new or existing work and to provide a complete and usable facility.

3.5 REPAIR AND PROTECTION

- A. General: On completion of Contractor funded testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

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

END OF SECTION 014000

SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": The term "approved," where used in conjunction with the COTR's action on the Contractor's submittals, applications, and requests, is limited to the duties and responsibilities of the COTR as stated in General and Supplementary Conditions. Such approval shall not release the Contractor from responsibility to fulfill Contract requirements unless otherwise provided in the Contract Documents.
- C. "Directed": Terms such as "directed", "requested", "authorized", "selected", "approved", "required", and "permitted" mean "directed by the COTR", "requested by the COTR", and similar phrases. However, no implied meaning shall be interpreted to extend the COTR's responsibility into the Contractor's area of construction supervision."
- D. "Indicated": Refers to graphic representations, notes or schedules on the Drawings, or other Paragraphs or Schedules in Specifications, and similar requirements in Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help locate the reference; no limitation on location is intended except as specifically noted."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": The term "furnish" is used to mean "supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": The term "install" is used to describe operations at project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. "Installer": An "Installer" is the Contractor or an entity engaged by the Contractor, either as an employee, subcontractor, or sub-subcontractor for performance of a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.
 - 1. The term "experienced," when used with the term "Installer" means having a minimum of 5 previous Projects similar in size and scope to this Project, being familiar with the

precautions required, and having complied with requirements of the authority having jurisdiction

- I. "Provide": The term "provide" means "to furnish and install, complete and ready for the intended use.
- J. "Project Site": Project Site is the space available to the Contractor for performance of construction activities, either exclusively or in conjunction with others performing other construction activities as part of the Project.
- K. "Recycled Content Materials": Building materials that contain, in aggregate, a minimum weighted average of post-consumer or post-industrial recycled content material.
- L. "Regulation": The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work, whether lawfully imposed by authorities having jurisdiction or not
- M. "Post-Consumer Recycled Content": Building material generated by collection after use by consumers, installed in a project.
- N. "Manufacturing": Refers to the final assembly of components into the building product.
- O. "Salvage or Re-used Materials": Materials recovered from existing buildings and reprocessed for reuse in other buildings.
- P. "Testing Laboratory": A "testing laboratory" is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.
- Q. "Volatile Organic Compounds (VOC)": Carbon compounds that [participate in atmospheric photochemical reactions and contribute to smog and air pollution.
- R. "Ozone Depleting Substances": Materials and chemical compounds that are destructive to the ozone layer. CFCs and HCHCs, aerosol sprays and other similar substances are considered 'ozone depleting'.

1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

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

1.4 SPECIFICATION FORMAT AND CONTENT EXPLANATION

- A. Specification Format: These Specifications are organized into Divisions and Sections based on the Construction Specifications Institute's 50-Division format and numbering system.
- B. Specification Content: This Specification uses certain conventions in the use of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions are explained as follows:
 1. Abbreviated Language: Language used in the Specifications and other Contract Documents is the abbreviated type. Implied words and meanings will be appropriately interpreted. Singular words will be interpreted as plural and plural words interpreted as singular where applicable and where the full context of the Contract Documents so indicates.
 2. Abbreviated Language: Language used in the Specifications and other Contract Documents is the abbreviated type. Implied words and meanings will be appropriately interpreted. Singular words will be interpreted as plural and plural words interpreted as singular where applicable and where the full context of the Contract Documents so indicates.
 - a. The words "shall be" shall be included by inference wherever a colon (:) is used within a sentence or phrase.
 3. Assignment of Specialists: The Specification requires that certain specific construction activities shall be performed by specialists who are recognized experts in the operations to be performed. The specialists must be engaged for those activities, and assignments are requirements over which the Contractor has no choice or option. Nevertheless, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.
 - a. This requirement shall not be interpreted to conflict with enforcement of building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.
 - b. Trades: Use of titles such as "carpentry" is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to trade persons of the corresponding generic name.
- C. Drawing Symbols:
 1. Graphic symbols: Where not otherwise noted, symbols are defined by "Architectural Graphic Standards," published by John Wiley & Sons, Inc., eighth edition.
 2. Mechanical/Electrical Drawings: Graphic symbols used on mechanical and electrical Drawings are generally aligned with symbols recommended by ASHRAE. Where appropriate, they are supplemented by more specific symbols recommended by technical associations including ASME, ASPE, IEEE, and similar organizations. The Contractor shall refer instances of uncertainty to the COTR for clarification before proceeding.
 3. Fire Safety Symbols: The contractor shall use the NFPA 170 Standard for Fire Safety Symbols.

D. Industry Standards:

1. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents. Such standards are made a part of the Contract Documents by reference. Individual Sections indicate which codes and standards the Contractor must keep available at the Project Site for reference.
2. Publication Dates: Where the date of issue of a referenced standard is not specified, the Contractor shall comply with the standard in effect as of date of Contract Documents.
 - a. Updated Standards: At the request of the COTR, Contractor, or authority having jurisdiction, the Contractor shall submit a Change Order proposal where an applicable code or standard has been revised and reissued after the date of the Contract Documents and before performance of Work affected. The COTR will decide whether to issue a Change Order to proceed with the updated standard.
3. Conflicting Requirements: Where compliance with two or more standards is specified, and they establish different or conflicting requirements for minimum quantities or quality levels, the most stringent requirement will be enforced, unless the Contract Documents indicate otherwise. The Contractor shall refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent to the COTR for a decision before proceeding.
 - a. Minimum Quantity or Quality Levels: In every instance the quantity or quality level shown or specified shall be the minimum to be provided or performed. The actual installation may comply exactly, within specified tolerances, with the minimum quantity or quality specified, or it may exceed that minimum within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum values, as noted, or appropriate for the context of the requirements. The Contractor shall refer instances of uncertainty to the COTR for a decision before proceeding.
4. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents.
 - a. Where copies of standards are needed for performance of a required construction activity, the Contractor shall obtain copies directly from the publication source.

E. Submittals:

1. Permits, Licenses, and Certificates: For the Government's records, the Contractor shall submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence, and records established in conjunction with compliance with standards and regulations bearing upon performance of the Work.

1.5 ABBREVIATIONS AND ACRONYMS

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

- B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents. Also, the Contractor shall refer to the *“Encyclopedia of Associations,”* published by Gale Research Co., available in most libraries if abbreviations and acronyms must be verified.

PRIVATE tbl1

AABC	Associated Air Balance Council www.aabchq.com	(202) 737-0202
ABAA	Air Barrier Association of America www.airbarrier.org	(866) 956-5888
ABMA	American Bearing Manufacturers Association www.abma-dc.org	(202) 367-1155
AGA	American Gas Association www.aga.org	(202) 824-7000
AGC	Associated General Contractors of America (The) www.agc.org	(703) 548-3118
AHRI	Air-Conditioning, Heating, and Refrigeration Institute www.ahrinet.org	(703) 524-8800
AIA	American Institute of Architects (The) www.aia.org	(800) 242-3837 (202) 626-7300
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
AMCA	Air Movement and Control Association International, Inc. www.amca.org	(847) 394-0150
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
ARI	Air-Conditioning & Refrigeration Institute (Now AHRI)	
ASHRAE	American Society of Heating, Refrigerating and Air- Conditioning Engineers www.ashrae.org	(800) 527-4723 (404) 636-8400
ASHRAE/IESN A 90.1-2004	Energy Standard for Buildings www.ashrae.org	(404) 636-8400
ASME	ASME International (American Society of Mechanical Engineers International) www.asme.org	(800) 843-2763 (973) 882-1170

ASSE	American Society of Safety Engineers www.asse.org	(847) 699-2929
ASTM	ASTM International (American Society for Testing and Materials International) www.astm.org	(610) 832-9500
AWS	American Welding Society www.aws.org www.carpetcushion.org	(800) 443-9353 (305) 443-9353
CDA	Copper Development Association www.copper.org	(212) 251-7200
CGA	Compressed Gas Association www.cganet.com www.pbmdf.com	(703) 788-2700
CSA	Canadian Standards Association	(800) 463-6727 (416) 747-4000
CSA	CSA International (Formerly: IAS - International Approval Services) www.csa-international.org	(866) 797-4272 (416) 747-4000
CSI	Construction Specifications Institute (The) www.csinet.org	(800) 689-2900 (703) 684-0300
FM Approvals	FM Approvals LLC www.fmglobal.com	(781) 762-4300
FM Global	FM Global (Formerly: FMG - FM Global) www.fmglobal.com	(401) 275-3000
HI	Hydraulic Institute www.pumps.org	(973) 267-9700
HI	Hydronics Institute www.gamanet.org	(908) 464-8200

ISO	International Organization for Standardization www.iso.ch	41 22 749 01 11
	Available from ANSI www.ansi.org	(202) 293-8020
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. www.mss-hq.com	(703) 281-6613
NADCA	National Air Duct Cleaners Association www.nadca.com	(202) 737-2926
NAIMA	North American Insulation Manufacturers Association www.naima.org	(703) 684-0084
NEBB	National Environmental Balancing Bureau www.nebb.org	(301) 977-3698
NECA	National Electrical Contractors Association www.necanet.org	(301) 657-3110
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200
NFPA	NFPA (National Fire Protection Association) www.nfpa.org	(800) 344-3555 (617) 770-3000
NSF	NSF International (National Sanitation Foundation International) www.nsf.org	(800) 673-6275 (734) 769-8010
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association www.smacna.org	(703) 803-2980
UL	Underwriters Laboratories Inc. www.ul.com	(877) 854-3577 (847) 272-8800
USGBC	U.S. Green Building Council www.usgbc.org	(800) 795-1747

- C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

PRIVATE tbl2

DIN	Deutsches Institut für Normung e.V. www.din.de	49 30 2601-0
IAPMO	International Association of Plumbing and Mechanical Officials www.iapmo.org	(909) 472-4100
ICC	International Code Council www.iccsafe.org	(888) 422-7233
ICC-ES	ICC Evaluation Service, Inc. www.icc-es.org	(800) 423-6587 (562) 699-0543
UBC	Uniform Building Code (See ICC)	

- D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

PRIVATE tbl3

CE	Army Corps of Engineers www.usace.army.mil	(202) 761-0011
CPSC	Consumer Product Safety Commission www.cpsc.gov	(800) 638-2772 (301) 504-7923
DOC	Department of Commerce www.commerce.gov	(202) 482-2000
DOE	Department of Energy www.energy.gov	(202) 586-9220
EPA	Environmental Protection Agency www.epa.gov	(202) 272-0167
NIST	National Institute of Standards and Technology www.nist.gov	(301) 975-6478
OSHA	Occupational Safety & Health Administration www.osha.gov	(800) 321-6742 (202) 693-1999
PHS	Office of Public Health and Science www.hhs.gov/ophs	(202) 690-7694

- E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

PRIVATE tbl4

ADAAG	Americans with Disabilities Act (ADA)	(800) 872-
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	Architectural Barriers Act (ABA)	2253 (202) 272-0080
	Accessibility Guidelines for Buildings and Facilities Available from U.S. Access Board www.access-board.gov	
CFR	Code of Federal Regulations Available from Government Printing Office www.gpoaccess.gov/cfr/index.html	(866) 512-1800 (202) 512-1800
FED-STD	Federal Standard (See FS)	
FS	Federal Specification Available from Department of Defense Single Stock Point http://dodssp.daps.dla.mil Available from Defense Standardization Program www.dps.dla.mil Available from General Services Administration www.gsa.gov Available from National Institute of Building Sciences www.wbdg.org/ccb	(215) 697-2664 (202) 619-8925 (202) 289-7800
FTMS	Federal Test Method Standard (See FS)	
UFAS	Uniform Federal Accessibility Standards Available from Access Board www.access-board.gov	(800) 872-2253 (202) 272-0080

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, COR, contractor funded testing agencies, and authorities having jurisdiction.
- B. Water and Sewer Service from Existing System: Water from Contracting Officer's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- C. Electric Power Service from Existing System: Electric power from Contracting Officer's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- D. Communications Systems: Contractor shall provide and pay for all phone and data services. All communication services shall be through outside phone lines.
 - 1. The Contractor shall arrange with the local phone service provider to have telephone lines installed in the Contractor's General Foreman's Office trailer when a trailer is required by the contract.

1.4 INFORMATIONAL SUBMITTALS

- A. Disposal of Refuse: The Contractor is totally responsible for the removal of all refuse associated with this project. The Contractor shall remove all refuse associated with the construction

operations from the site and dispose of it in accordance with the requirements of the local jurisdiction.

- B. Disposal of Hazardous Wastes: Any hazardous wastes generated by the Contractor shall be properly controlled and disposed by the Contractor in accordance with applicable RCRA (40CFR) and COMAR (Title 26) regulations.
- C. Dust-Control and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust-control and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
 - 1. Locations of dust-control partitions at each phase of the work.
 - 2. HVAC system isolation schematic drawing.
 - 3. Location of proposed air filtration system discharge.
 - 4. Other dust-control measures.
 - 5. Waste management plan.

1.5 QUALITY ASSURANCE

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

1.6 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized steel, chain-link fabric fencing; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch- OD corner and pull posts
- B. Dust Control Adhesive-Surface Walk-off Mats: Provide mats minimum 36 by 60 inches.

2.2 CONSTRUCTION FENCE

1. The Contractor shall furnish and install at his own expense, retain contracting ownership of and remove when no longer required or as directed by the COR, a construction fence following the contract limit lines. The layout must be approved by the COR prior to installation by the Contractor.
2. Variations in location of the fence as shown will be considered where construction fence can also serve as a protection for wooded areas, trees and shrubs which are to remain, as described elsewhere in the Technical Specifications.

2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Contracting Officer authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 2. Heating Units: Listed and labeled for type of fuel being consumed, by a contractor funded testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 3. Permanent HVAC System: If Contracting Officer authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return air grille in system and remove at end of construction.
- C. Air Filtration Units: HEPA primary and secondary filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.
- D. Construction Site Maintenance:
 1. The Contractor shall store all supplies and equipment on project site so as to preclude mechanical and climatic damage. Maintain site in a neat and orderly manner.
 2. Contractor shall be responsible for maintaining any temporary structures in good repair and visually pleasant.
- E. Noise Control:
 1. The Contractor shall comply with all applicable local laws, ordinances, and regulations relative to noise control. Equipment to be employed on this site shall not produce a noise level exceeding the following limits in dB(A) at a distance of 50 feet from the equipment under test.
 - a. Equipment:
 - i. Stationary
 - a) generators 78
 - b) compressors 81
 - ii. Impact

	a)		
	b)	pneumatic tools	86
iii.	Other		
	a)	saws	78
	b)	vibrators	76

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 - 1. Locate facilities to limit site disturbance as specified in Division 01 Section "Summary."
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with NIST COR & Contracting Officer for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
 - 1. Connect temporary sewers to private system indicated as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Water Service: Connect to Contracting Officer's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Contracting Officer. At Substantial Completion, restore these facilities to condition existing before initial use.
- E. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Contractor shall provide portable toilet accommodations for construction personnel. The toilet units shall be kept in sanitary condition, regularly maintained, and, on completion of the contract, shall be removed leaving the premises clean. Location of portable toilet facilities must be approved by the COR.

- F. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- G. Waste Disposal Facilities: Provide waste collection and recycling containers in sizes adequate to handle waste from construction operations. Containerize and clearly label hazardous, dangerous or unsanitary waste materials separately from salvageable and recycled materials. Comply with Division 1, Section 'Execution Requirements' for progress cleaning requirements and Section 01592 'Construction Waste Management' for procedures.
- H. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
- I. Electric Power Service: Connect to Contracting Officer's existing electric power service. Maintain equipment in a condition acceptable to Contracting Officer.
- J. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
 - 1. Install electric power service underground, unless otherwise indicated.
 - 2. Connect temporary service to Contracting Officer's existing power source, as directed by Contracting Officer.
- K. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
 - 2. Install lighting for Project identification sign.

3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
 - 1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
 - 2. Maintain support facilities until COR schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Contracting Officer.
- B. Traffic Controls: Comply with requirements of authorities having jurisdiction.
 - 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 - 2. Maintain access for fire-fighting equipment and access to fire hydrants.

3. Provide personnel "flagger(s)" to control and direct construction vehicular traffic.
- C. Parking: Coordinate with COR for location of temporary parking.
- D. Waste Disposal Facilities: Comply with requirements specified in Division 01 Section "Construction Waste Management and Disposal."
- E. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with Division 01 Section "Construction Waste Management and Disposal" for progress cleaning requirements.
- F. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- G. Temporary Offices:
 1. Services and Connections: Connect water, sanitary, and other required services to the existing site utilities adequately sized and correctly placed to perform their function without damage or interruption of service.
 2. Maintenance Service: Provide all maintenance including light, heat, water, sanitary, and janitorial service during the contract period or until removal as directed by the COR. Keep in neat and clean condition and wash windows periodically.
 3. Removal and Clean Up: Remove temporary facilities promptly upon written direction from the COR. All services shall be disconnected, capped, or removed as appropriate and the area left free of any features resulting from the installation.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
 1. Comply with work restrictions specified in Division 01 Section "Summary."
- B. Security Enclosure: Install temporary enclosure around partially completed areas of construction.
- C. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- D. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- E. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.
- F. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
1. Prohibit smoking in construction areas.
 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.5 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture-Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.
- B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
1. Protect porous materials from water damage.
 2. Protect stored and installed material from flowing or standing water.
 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 4. Remove standing water from decks.
 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Keep interior spaces reasonably clean and protected from water damage.
 2. Periodically collect and remove waste containing cellulose or other organic matter.
 3. Discard or replace water-damaged material.
 4. Do not install material that is wet.
 5. Discard, replace or clean stored or installed material that begins to grow mold.
 6. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.
- D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use permanent HVAC system to control humidity.
 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

- a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective.
- b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record daily readings over a forty-eight hour period. Identify materials containing moisture levels higher than allowed. Report findings in writing to COR.
- c. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.6 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 1. Materials and facilities that constitute temporary facilities are property of Contractor. Contracting Officer reserves right to take possession of Project identification signs.
 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 01 Section "Closeout Procedures."

END OF SECTION 015000

SECTION 015100 - PROJECT CONSTRUCTION SIGNAGE

PART 1 – GENERAL

1.1 SECTION INCLUDES:

- A. National Institute of Standards and Technology Project Information Signs.
- B. Provide signs and maintain

1.2 SUBMITTAL:

- A. Submit layout of signs (see the signs at the end of this section).

PART 2 – PRODUCTS

2.1 MATERIALS:

- A. Sign substrate – 48H”x 72L” x 3/4-inch exterior type high density overlaid plywood type AC or equal.
- B. Sign material – 48H” x 72L” x 1/8” Dibond aluminum composite panel with polyethylene core. Front and back sides, platinum white or black lacquered with digital print. Secure aluminum panel sign to plywood substrate.
- C. Boundary Strips-1-inch by 4-inch fir or equal
- D. Sign vertical supports-pressure treated 4-inch by 4-inch pine
- E. Support bracing-pressure treated pine or fir.

PART 3 – EXECUTION

- A. The Contractor shall display no signs or advertisements except as noted herein.
- B. The Contractor shall furnish, erect and maintain for his own people, such signs as may be required by safety regulations, as necessary to safeguard life and property, or as required by local authorities or the Construction Manager and the Owner.
- C. Erect signs at a location as ordered by the Project COTR. Coordinate mounting height above grade with Project COTR.
- D. Erect 48-inch by 72-inch signs at a proper distance above grading for public viewing
- E. Adequately support signs as site conditions may require.
- F. Extend vertical support a minimum of 3 feet into the ground
- G. Bound edge of plywood with a 1-inch by 4-inch wood furring strip fastened flat to the edge of the sign at middle of the width of the strip.

- H. Coordinate with COR for construction sign template.

END OF SECTION 015100

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Sections:
 - 1. Division 01 Section "Alternates" for products selected under an alternate.
 - 2. Division 01 Section "Submittal Procedures" for products selected as specified.
 - 3. Division 01 Section "Substitutions Prior to Offering and Product Options and Substitutions after Execution of Contract" for requests for substitutions.
 - 4. Division 01 Section "References" for applicable industry standards for products specified.

1.3 DEFINITIONS

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

characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 - 2. COTR's Action: If necessary, COTR will request additional information or documentation for evaluation within one week of receipt of a comparable product request. COTR will notify Contractor of approval or rejection of proposed comparable product request within **15** days of receipt of request, or **seven** days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: As specified in Division 01 Section "Submittal Procedures."
 - b. Use product specified if COTR does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

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

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

C. Storage:

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

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Contracting Officer.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Contracting Officer.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 3. Refer to Divisions 02 through 49. Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.

3. Contracting Officer reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," COTR will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures:

1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
3. Products:
 - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered.
 - b. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Substitutions Prior to Offering" Article for consideration of an unnamed product.
4. Manufacturers:
 - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered.
 - b. Nonrestricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Substitutions Prior to Offering" Article for consideration of an unnamed manufacturer's product.
5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

- C. Visual Matching Specification: Where Specifications require "match COTR's sample", provide a product that complies with requirements and matches COTR's sample. COTR's decision will be final on whether a proposed product matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Division 01 Section "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by COTR from manufacturer's full range" or similar phrase, select a product that complies with requirements. COTR will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

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

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Installation of the Work.
 - 3. Coordination of Contracting Officer-installed products.
 - 4. Progress cleaning.
 - 5. Starting and adjusting.
 - 6. Protection of installed construction.
 - 7. Correction of the Work.
- B. Related Sections:
 - 1. Division 01 Section "Submittal Procedures" for submitting surveys.
 - 2. Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Contracting Officer-accepted deviations from indicated lines and levels, and final cleaning.

1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 INFORMATIONAL SUBMITTALS

- A. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning site work, investigate and verify the existence and location of mechanical and electrical systems, and other construction affecting the Work.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - a. Description of the Work.
 - b. List of detrimental conditions, including substrates.
 - c. List of unacceptable installation tolerances.
 - d. Recommended corrections.
 - 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - 3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to Contracting Officer that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility

appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of the Contractor, submit a request for information to COR according to requirements in Division 01 Section "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to existing benchmarks. If discrepancies are discovered, notify COR promptly.

3.4 FIRE PREVENTION AND PROTECTION

- 1. The Contractor shall comply with all fire prevention recommendations of the National Fire Protection Association (NFPA) Regulations which are incorporated herein by reference. A written fire permit shall be obtained from the FPE for use of open flame devices, such as blow torches, portable furnaces, tar kettles or gas and electric welding and cutting equipment in or within fifteen feet of buildings. The Contractor shall be liable for any fire loss to Government property attributable to negligence on the part of the Contractor or sub-Contractor, included in part, failure to comply with fire prevention measures prescribed by terms of this Contract. Gasoline-driven equipment will not be allowed within the building.
- 2. Fire hydrant service shall be maintained during all construction activities, in accordance with National Fire Protection Association Standard No. 241 (NFPA 241), standard for Safeguarding Construction Alteration, and Demolition Operations. Should the relocation of hydrants or the use of temporary hydrants be required during major renovation or construction activities, the location of such hydrants shall be suitable to the Fire Protection Services Division, as directed by the Contracting Officer. Installation shall be in accordance with Division 15 of the Technical Specifications.

3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.

2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
 4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produces harmful noise levels.
- F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- G. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by COR.
 2. Allow for building movement, including thermal expansion and contraction.
 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 CONTRACTING OFFICER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project site for Contracting Officer's construction personnel.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Contracting Officer's construction personnel.
1. Construction Schedule: Inform Contracting Officer of Contractor's preferred construction schedule for Contracting Officer's portion of the Work. Adjust construction

schedule based on a mutually agreeable timetable. Notify Contracting Officer if changes to schedule are required due to differences in actual construction progress.

2. Preinstallation Conferences: Include Contracting Officer's construction personnel at preinstallation conferences covering portions of the Work that are to receive Contracting Officer's work. Attend preinstallation conferences conducted by Contracting Officer's construction personnel if portions of the Work depend on Contracting Officer's construction.

3.7 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Utilize containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where more than one installer has worked.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Division 01.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

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

3.8 STARTING AND ADJUSTING

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

3.9 PROTECTION OF INSTALLED CONSTRUCTION

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

3.10 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

CLEANROOM REBALANCE
NIST

100% RELEASE FOR CONSTRUCTION
JUNE 29, 2021

END OF SECTION 017300

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.
- B. Related Sections:
 - 1. Division 01 Section "Execution" for progress cleaning of Project site.
 - 2. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 3. Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 4. Divisions 13 & 23 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.3 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete with request.
 - 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 - 2. Advise Contracting Officer of pending insurance changeover requirements.
 - 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Obtain and submit releases permitting Contracting Officer unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 5. Prepare and submit Project Record Documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.

6. Deliver tools, spare parts, extra materials, and similar items to location designated by Contracting Officer. Label with manufacturer's name and model number where applicable.
 7. Make final changeover of permanent locks and deliver keys to Contracting Officer. Advise Contracting Officer's personnel of changeover in security provisions.
 8. Complete startup testing of systems.
 9. Submit test/adjust/balance records.
 10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 11. Advise Contracting Officer of changeover in heat and other utilities.
 12. Submit changeover information related to Contracting Officer's occupancy, use, operation, and maintenance.
 13. Complete final cleaning requirements, including touchup painting.
 14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- B. Request for Inspection: Submit a written request for inspection for Substantial Completion to the Contracting Officer at least 14 calendar days prior to the requested date of inspection . On receipt of request and verifying that all required testing has been completed, COR will either proceed with inspection or notify Contractor of unfulfilled requirements. COR will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by COR that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for final completion.

1.4 FINAL COMPLETION

- A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:
1. Submit a final Application for Payment according to Division 01.
 2. Submit certified copy of COR's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by COR. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Instruct Contracting Officer's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
 5. Prior to completion of the contract, the Contractor shall furnish an "as-built" record of materials used in the construction. Submission of this data is a condition for final payment under the contract. Where several manufacturers' brands, types, or classes of the item listed have been used in the project, the specific areas where each item was used shall be designated. Designations shall be keyed to the areas and spaces depicted on the contract drawings.

- B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, COR will either proceed with inspection or notify Contractor of unfulfilled requirements. COR will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 - 1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 - 1. Organize list of spaces in sequential order, starting with exterior areas first.
 - 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
 - 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of COR.
 - d. Name of Contractor.
 - e. Page number.
 - 4. Submit list of incomplete items in the following format:
 - a. PDF electronic file.
 - b. Six (6) paper copies of product schedule or list, unless otherwise indicated. COR will return two copies.

1.6 WARRANTIES

- A. Submittal Time: Submit written warranties on request of COR for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Contracting Officer during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 - 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or

- installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
 4. Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide table of contents at beginning of document.
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
1. Use cleaning products that meet Green Seal GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.

- g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Sweep concrete floors broom clean in unoccupied spaces.
 - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
 - j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - k. Remove labels that are not permanent.
 - l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - 1) Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates.
 - m. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
 - o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - p. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter upon inspection.
 - 1) Clean HVAC system in compliance with NADCA Standard 1992-01. Provide written report upon completion of cleaning.
 - q. Leave Project clean and ready for occupancy.
- C. Construction Waste Disposal: Comply with waste disposal requirements in Division 01 Section "Construction Waste Management and Disposal."
- 3.2 USE OF EQUIPMENT BY GOVERNMENT
- A. The Government may take over and operate, with Government employees, such equipment as is necessary for heating or cooling such areas of the building as require the service, as soon as the installation is sufficiently complete.
 - B. The Contracting Officer will advise the Contractor by letter, prior to the use of equipment, which items of equipment will be operated, and the date and time such operation will begin.
 - C. Government operation of equipment will not relieve the Contractor of the guarantee on materials and workmanship elsewhere provided for in this contract.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory.
 - 2. Operation manuals for systems, subsystems, and equipment.
 - 3. Product maintenance manuals.
 - 4. Systems and equipment maintenance manuals.
- B. Related Sections:
 - 1. Division 01 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
 - 2. Division 01 Section "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.
 - 3. Division 13 Section "Cleanroom Certification" for recertification and verification of cleanroom area. Provide all documentation for COR for review and approval.
 - 4. Divisions 13 & 23 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual specification sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Where applicable, clarify and update reviewed manual content to correspond to modifications and field conditions.

- B. Format: Submit operations and maintenance manuals in the following format:
 - 1. PDF electronic file. Assemble each manual into a composite electronically-indexed file. Submit on digital media acceptable to COTR.
 - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically-linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.
 - 2. Six (6) paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. COTR will return two copies.
- C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. COTR will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. COTR will return copy with comments.
 - 1. Correct or modify each manual to comply with COTR's comments. Submit copies of each corrected manual within 15 days of receipt of COTR's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Organization: Include a section in the directory for each of the following:
 - 1. List of documents.
 - 2. List of systems.
 - 3. List of equipment.
 - 4. Table of contents.
- B. The Contractor shall furnish four (4) complete sets of manuals and/or instruction booklets and spare parts catalogs with each piece of equipment furnished under this contract.
- C. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- D. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
 - 1. Within (10) ten calendar days after Award of Contract, and prior to the commitment for purchase of any materials and/or equipment to be utilized on this Contract, the Contractor shall submit for review and for tentative approval only, four (4) copies of a complete listing of such materials and/or equipment. The listing shall include sufficient data to identify the materials and equipment as to type, quality, sizes when applicable, and manufacturer or source. Tentative approval of the items in the materials and equipment

list will be given, however all items will be subject to final review and approval by the COTR upon submittal of samples and/or shop drawings when specified. Materials and/or equipment shall not be fabricated or installed without prior approval.

- E. Tables of Contents: Include a table of contents for each operation, and maintenance manual.
- F. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.2 REQUIREMENTS FOR OPERATION, AND MAINTENANCE MANUALS

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- B. Title Page: Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name and address of Contracting Officer.
 - 4. Date of submittal.
 - 5. Name and contact information for Contractor.
 - 6. Name and contact information for COTR.
 - 7. Name and contact information for Commissioning Agent.
 - 8. Name and contact information for Recertification Agent.
 - 9. Names and contact information for major consultants to the COTR that designed the systems contained in the manuals.
 - 10. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 - 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 2. File Names and Bookmarks: Enable bookmarking of individual documents based upon file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel upon opening file.
- F. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.
1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
 4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.

2. Performance and design criteria if Contractor is delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.4 PRODUCT MAINTENANCE MANUALS

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference

Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

- C. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.

- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training video recording, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

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

- D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - 1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of operation and maintenance manuals.
 - 2. Comply with requirements of newly prepared record Drawings in Division 01 Section "Project Record Documents."
- F. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.
- B. Related Sections:
 - 1. Division 01 Section "Closeout Procedures" for general closeout procedures.
 - 2. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 3. Divisions 13 & 23 Sections for specific requirements for project record documents of the Work in those Sections.

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set(s) of marked-up record prints.
 - 2. Number of Copies: Submit copies of record Drawings as follows:
 - a. Initial Submittal: Submit one paper copy set of marked-up record prints and one set(s) of plots from corrected record digital data files. COTR will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal: Submit one paper copy set] of marked-up record prints. Print each Drawing, whether or not changes and additional information were recorded.
 - c. Final Submittal: Submit one paper copy set of marked-up record prints, one set(s) of record digital data files, and three set(s) of record digital data file plots. Plot each drawing file, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit one paper copy of Project's Specifications, including addenda and contract modifications.

- C. Record Product Data: Submit one paper copy of each submittal.
 - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.
- D. Miscellaneous Record Submittals: Refer to other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit one paper copy of each submittal.
- E. Reports: Submit written report indicating items incorporated in Project record documents concurrent with progress of the Work, including modifications, concealed conditions, field changes, product selections, and other notations incorporated.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding archive photographic documentation.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following COTR's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with COTR. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
 2. Format: Annotated PDF electronic file with comment function enabled.
 3. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 4. Refer instances of uncertainty to COTR for resolution.
 5. COTR will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.
 - a. Refer to Division 01 Section "Submittal Procedures" for requirements related to use of COTR's digital data files.
 - b. COTR will provide data file layer information. Record markups in separate layers.
- C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of COTR.
 - e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
 5. Note related Change Orders, record Product Data, and record Drawings where applicable.
- B. Format: Submit record Specifications as annotated PDF electronic file, paper copy, and scanned PDF electronic file(s) of marked up paper copy of Specifications.

2.3 RECORD PRODUCT DATA

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

2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals as PDF electronic file, paper copy, and scanned PDF electronic file(s) of marked up miscellaneous record submittals.
1. Include miscellaneous record submittals directory organized by specification section number and title, electronically linked to each item of miscellaneous record submittals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and modifications to project record documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for COTR's reference during normal working hours.

END OF SECTION 017839

SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. OPR and BOD documentation are included by reference for information only.

1.2 SUMMARY

- A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.
- B. Related Sections:
 - 1. Division 23 Section "Commissioning of HVAC" for commissioning process activities for HVAC&R systems, assemblies, equipment, and components.

1.3 DEFINITIONS

- A. BOD: Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- C. CxA: Commissioning Authority.
- D. OPR: Contracting Officer's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.
- E. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 COMMISSIONING TEAM

- A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to,

representatives of the Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members Appointed by Contractor:

1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Contractor shall engage and provide an independent third party CxA.
2. Representatives of the facility user and operation and maintenance personnel.
3. COTR and engineering design professionals.

1.5 CONTRACTING OFFICER'S RESPONSIBILITIES

- A. Provide the OPR documentation to the CxA and Contractor for information and use.
- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
 1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
 2. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
 3. Attend commissioning team meetings held on a monthly basis.
 4. Integrate and coordinate commissioning process activities with construction schedule.
 5. Review and accept construction checklists provided by the CxA.
 6. Complete electronic construction checklists as Work is completed and provide to the Commissioning Authority on a weekly basis.
 7. Review and accept commissioning process test procedures provided by the Commissioning Authority.
 8. Complete commissioning process test procedures.

1.7 CxA'S RESPONSIBILITIES

- A. Organize and lead the commissioning team.
- B. Provide commissioning plan.
- C. Convene commissioning team meetings.
- D. Provide Project-specific construction checklists and commissioning process test procedures.
- E. Verify the execution of commissioning process activities using random sampling. The sampling rate may vary from 1 to 100 percent. Verification will include, but is not limited to,

equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, the CxA will report the failure in the Issues Log.

- F. Prepare and maintain the Issues Log.
- G. Prepare and maintain completed construction checklist log.
- H. Witness systems, assemblies, equipment, and component startup.
- I. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 019113

SECTION 130001 – CLEAN ZONE GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This Section specifies the general requirements for every person who performs any work or function within the defined boundaries of the Clean Zone.
- B. The objective of this Section is to provide a controlled clean environment within which all mechanical, electrical, cleanroom systems, and process piping will be installed.
 - 1. This clean environment shall be maintained from the initial construction stage through final cleanroom certification.
 - 2. All products brought into the Clean Zone shall meet minimum cleanliness standards on both interior and exterior surfaces.
 - 3. Personnel cleanliness levels and construction protocol standards shall be established and monitored for each construction stage.
 - 4. Active contamination controls will be enforced consistent with each construction stage.
 - 5. The required level of cleanliness will be monitored using spot checks at prescribed locations.

1.2 DESCRIPTION

- A. Cleanrooms as specified in this section and as indicated on the drawings shall be maintained by a Cleanroom Contractor responsible for compliance with the documents.
 - 1. The Cleanroom Contractor shall provide a Clean Zone Director for the duration of all construction and start-up activities covered by this section.
 - 2. The Contractor shall employ and pay for the services of a qualified cleanroom testing and certification contractor (Certifying Agency) as a subcontractor to perform services specified in Section 130003.
 - 3. This subcontractor shall be independent from the Cleanroom Contractor, system manufacturer and the installer.
 - 4. Clean Zone Director shall have a minimum ten years experience in the construction of cleanrooms.
 - 5. Clean Zone Director shall have completed a minimum of two projects dealing with submicron wafer technology under Class 100 or better.
 - 6. Clean Zone Director shall have full authority over all construction procedures and personnel in the Clean Zone Area.
 - 7. Clean Zone Director shall initiate weekly meetings to be attended by all contractors installing equipment in Clean Zone.
 - a. Clean Zone Director shall keep minutes of all meetings, establish the agenda and maintain coordination between trades working in the Clean Zone.
 - 8. Clean Zone Director shall log and document all staged construction events.

9. Clean Zone Director shall organize and lead protocol training sessions required to assure compliance with the documents and construction requirements.
10. Clean Zone Director shall, or shall coordinate, all cleaning procedures, testing and balancing and commissioning procedures specified in the documents.

1.3 CLEAN ZONE BOUNDARIES

- A. Clean Zone includes cleanrooms scheduled in Section 130003, and remote rooms for cleanroom support equipment, bounded by and inclusive of:
 1. Top of isolation floor slab below.
 2. Bottom of structural slab above.
 3. Perimeter walls on all sides.

1.4 CLEAN ZONE CONSTRUCTION STAGES

- A. Milestones for scheduling construction stages include:
 1. Ceiling HEPA Filters Installed.
 2. Certification Tests Completed.

1.5 DEFINITIONS

- A. Refer to Federal Standard 209E for a complete list of definitions appropriate to cleanrooms.
 1. Specific words and phrases used within these Contract Documents are defined below for easy reference.
- B. As-Built Facility: Cleanroom which is complete and ready for operation, with all services connected and functional, but without production equipment or personnel within the room.
- C. At-Rest Facility: Cleanroom which is complete and has production equipment installed and operating, but without personnel within the room.
- D. Basement: A defined utility area bounded by the building slab-on-grade below, the bottom of the cleanroom structural floor slab above, and the perimeter boundary walls on all sides, including all spaces, products, and utilities within.
- E. Certifying Agency: The cleanroom testing and certifying firm or agency retained by the Contractor to assist and verify Acceptance and performance of all cleanroom systems. Also referred to as the Quality Assurance Agency.
- F. Classes of Cleanliness: Statistically allowable number of particles of a given size per cubic foot volume of air. For this project the concentration and size of particles shall meet the requirements of Federal Standard 209E, measured at 0.5 micrometers.
- G. Cleanroom: A defined clean area or room in which the concentration of airborne particles is controlled to specified limits. For this project, that shall be defined as the space bounded by the

cleanroom structural floor slab below, the cleanroom filtered ceiling grid above, and the perimeter cleanroom walls on all sides, including all spaces, products, and utilities within.

- H. Clean Zone: A defined clean area in which the concentration of airborne particles is controlled to specified limits. For this project, that shall be defined as the building space described in Article, Clean Zone Boundaries, bounded by and inclusive of top of isolation floor slab below, bottom of structural slab above, and the perimeter fire/separation/boundary walls on all sides, which encompass any and all cleanrooms of any cleanliness classification, as well as any remote special rooms for cleanroom support equipment, including all spaces, products, and utilities within.
- I. Clean Zone Construction Stage: See Stage.
- J. Clean Zone Director: The person vested with authority by the Cleanroom Contractor to supervise all construction personnel working within the Clean Zone and ensure requirements of the Contract Documents are met in completion of the Clean Zone construction, including all spaces, products, and utilities within.
- K. Fan Attic: A defined clean area bounded by the existing top of the concrete recirculation air support structure and the bottom of the building roof membrane above, and the perimeter fire/separation/boundary walls on all sides, including all spaces, products, and utilities within.
- L. Interstitial: A defined clean area bounded by the plane of the cleanroom filtered ceiling below, the bottom of the fan attic floor above, and the perimeter fire/separation/boundary walls on all sides, including all spaces, products, and utilities within.
- M. Office Clean: A standard of cleanliness commonly maintained in finished commercial office spaces, with no visible residues of dirt, dust, oil, grease, or debris, on the floor, walls, or work stations, as normally achieved by cleaning, wiping, and vacuuming.
- N. Operating Facility: Cleanroom in normal operation with all services functioning and with production equipment and personnel present and performing their normal work functions within the room.
- O. Products: Materials, equipment, physical items, and packaged systems.
- P. Quality Assurance Agency: The quality assurance cleanroom certifying firm or agency retained and paid for by the Contractor to spot check and verify proper cleanroom construction and performance.
- Q. Stage: The phase or degree of construction completion that mandates specific activities, training, security clearance, dress and work protocol, cleaning procedures, work habits, and system performance, all as defined in Section 130002.
- R. Staging area: Controlled room or defined area in the building, including enclosed access routes to the Clean Zone, where products to be installed during a workday are unpackaged, cleaned and otherwise made ready for installation that same day in the cleanroom.

1.6 DESIGN CRITERIA

A. Design criteria:

1. FED-STD-209E for cleanliness classes in cleanrooms and clean zones.
2. ASHRAE Handbook: Fundamentals.
3. Institute of Environmental Science (IES) recommended practices:
 - a. IES-RP-CC001: HEPA and ULPA Filters.
 - b. IES-RP-CC006.2: Testing Cleanrooms.
4. NFPA 318 for standard for the protection of cleanrooms.

1.7 SUBMITTALS

A. Shop drawings:

1. Complete shop drawings indicating construction limits and details of Clean Zone.

B. Product data: Not required for COR review.

C. Samples: Not required for COR review.

D. Project information:

1. Clean Zone Director's resume.
2. Checklists of requirements for reviewing procedures and work performed.

E. Contract closeout information: Not required for COR review.

1.8 PRECONSTRUCTION CONFERENCE

A. Preconstruction conference, directed by Clean Zone Director, will be held prior to beginning of Cleanroom installations. Meeting agenda will include, but not limited to:

1. Contract Document requirements.
2. Scheduling.
3. Cleanroom drawings.
4. Ceiling manufacturer's specifications and details.
5. HVAC system manufacturer's specifications and details.
6. Life safety requirements.
7. Available on site storage.
8. Protection from damage by other trades.
9. Testing, balancing and commission protocol.
10. Installation drawings.
11. Manufacturer product data.
12. Warranties.
13. Project schedule.
14. Other information deemed pertinent for sound and secure application.

- B. Attendance is required for:
 - 1. Contractor's superintendent.
 - 2. Ceiling manufacturer's representative.
 - 3. Ceiling installation supervisor.
 - 4. HEPA filter manufacturer.
 - 5. Mechanical installation supervisor.
 - 6. Sheet metal installation supervisor performing ductwork.
 - 7. Other trades working within the Clean Zone or whose work may affect cleanroom construction.
- C. Minimum two weeks prior to conference forward pertinent information to COR for review.
- D. Conference shall review specifications, details, application requirements and preliminary work.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Clean Zone components shall be delivered with an approved protective covering and packaged to prevent transit and construction dust from contaminating the surfaces.
 - 1. Return any material or equipment to the manufacturer for recleaning and repackaging where the original shipping protective wrap is torn or defective.
 - 2. Stripping of packaging shall be done inside the designated equipment staging room outside the cleanroom.
- B. Materials must be sealed in their original unopened packages.
- C. Open ends of all ducts and pipes shall be sealed with moisture-proof barrier until product is being connected during installation.
- D. Products and components shall be stored in such manner as to prevent damage or intrusion of foreign matter.
 - 1. Conspicuously mark "Rejected" on any materials which have been damaged, and remove them from the job site.
- E. Use extreme care when handling components to prevent damage.
- F. Products shall be stored within the building in controlled space designated by the Contractor.
- G. Products shall not be stored in the staging area in excess of that used in one day's work.
- H. Contaminated materials must not be stored in the staging areas or Clean Zone.

1.10 QUALITY ASSURANCE

- A. Review the procedures and work performed on a continuous basis to verify compliance with these requirements.

1. Prepare checklists of requirements as basis for reviewing procedures and work performed.
- B. Provide training for new personnel during construction before they are allowed to work in Clean Zone.
- C. Weekly reports shall be submitted to the COR that summarize the following activities:
 1. Cleanup crew operations for the previous week.
 2. Clean Zone particle-counts for each day of the previous week.
 3. Updated list of visitors entering the Clean Zone for the previous week.
 4. Inventory list of tools, equipment, materials, and other items entering the Clean Zone for the previous week.
 5. Updated list of construction workers authorized and cleared for entry into the Clean Zone for the upcoming week.
- D. Take particle counts within the Clean Zone on a random schedule at least twice each week.
 1. Maintain particle count records and submit as part of monthly status reports.

PART 2 - PRODUCTS

2.1 CLEANROOM SYSTEMS

- A. Acceptable Clean Zone Contractors:
 1. Cleanrooms: Shall be submitted along with qualifications for COR approval. Clean Zone contractor shall meet all qualifications included in this specification.
- B. Architectural elements:
 1. Flow-through grid system:
 - a. Manufacturer's integral modular ceiling system by Gordon Inc., Laminaire, Lepco, Messer & Wurst, Texas Technology or approved equal.
 - b. Prefinished aluminum grid with integral manufacturer's standard (dielectric silicone or urethane) gel track and prefinished side panels. Gaskets shall be cellular urethane foam tape coated one side with aggressive high strength adhesive.
 - c. Sealants shall be Dow Corning 732 or 999A or approved equal by Pecora. Color to match plenum.
 - d. Diffusion screen: 0.75 mm perforated sheet metal with 23 mm holes staggered at 5 mm centers, 23 percent open. Paint to match ceiling grid. Screen shall be removable from room side without removing filter. Diffusion screen shall be flush with grid face.
- C. Mechanical elements:
 1. HVAC systems:

- a. Recirculating AHU system including ductwork, plenums, piping, dampers, coils, sound attenuators, mounting, connection to filters connection to make-up AHU system. Refer to Division 23.
- b. HEPA filters. Refer to Division 23.

PART 3 - EXECUTION

3.1 JOB CONDITIONS

- A. Cleanroom Contractor to furnish, install and maintain temporary envelope around cleanroom construction.
- B. Provide continuous and uninterrupted staging areas and enclosed access routes to Clean Zone.
- C. Construct temporary gowning areas for all personnel involved in cleanroom construction.
- D. Provide separate temporary staging area for equipment and equipment storage.
- E. Temporary clean room meeting Class 1,000 standards is required for field fabrication, storage, cleaning, and assembly of ceilings, and for storage of HEPA filters prior to installation.
 1. Temporary cleanroom shall be provided and maintained by Cleanroom Contractor.

3.2 TEMPORARY CLIMATE CONTROL

- A. Clean Zone Director shall assure that positive pressure within Clean Zone of 0.012 kPa continuously until permanent makeup air system is activated and the building has reached Class 1,000.
- B. Provide, or have furnished, temporary fans with 30 percent prefilters and 99.99 percent HEPA filters operating with 100 percent outside air.
 1. Provide sufficient fans for minimum six air changes per hour.
 2. Replace prefilters and HEPA filters every 30 days minimum.
 3. Assure that emergency backup power is available to maintain Clean Zone climate control.
- C. Temporary flooring, partitions and doors:
 1. Provide products that are water resistant, sealed against particle gathering or release, airtight and suitable for function intended.
 2. Provide sufficient weatherstripping on doors to prevent passage of air outside of Clean Zone. Replace or install where no weatherstripping or gasketing is damaged or missing. Submit gasketing material for review.

END OF SECTION 130001

SECTION 130002 - CLEANROOM PROTOCOL

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. Refer to Section 130001 for Clean Zone General Requirements.

1.2 DESCRIPTION

- A. Perform all special cleanroom cleaning as specified in this section in addition to cleaning specified elsewhere.
- B. Cleanroom areas include rooms and associated spaces identified in the Schedule of Required Classifications in Section 130003.

1.3 QUALITY ASSURANCE

- A. Supervise cleaning procedures and provide competent technicians to conduct all the work.
- B. Cleanroom cleaning supervisor shall have a minimum of 3 years uninterrupted experience, devoted exclusively to cleaning of cleanroom facilities.
- C. Use cleaning products which are compatible with surface to be cleaned, and which will cause no damage to adjacent materials.

1.4 SUBMITTALS

- A. Shop drawings: Not required for COR review.
- B. Product data: Not required for COR review.
- C. Samples: Not required for COR review.
- D. Project information:
 - 1. Submit qualifications and references of proposed cleanroom cleaning contractor, supervisor, and personnel.
 - 2. Submit product data for cleaning materials and program of cleaning procedures.
 - 3. Submit product data for proposed cleanroom gowning materials to be provided by contractor.
- E. Contract closeout information: Not required for COR review.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

- A. Wipe-down fabric:
 - 1. Lint-free "Techni-Cloth", "Miracle-Wipes", and Tech-Wipes".
- B. Wipe-down liquid:
 - 1. EKC "Lab Clean".
 - 2. "Floor Clean".
 - 3. "Glass Clean".
 - 4. Allied Chemical, WRS-200.
- C. See subarticle 3.2, A through E, for other generic product requirements.

PART 3 - EXECUTION

3.1 CLEANROOM CLEANING - GENERAL

- A. Vacuum all spaces which will be concealed by subsequent construction as the work progresses.
- B. Operate recirculating fan units, without HEPA-Filters installed, for at least 24 hours continuously before final cleaning.
- C. Remove construction debris promptly.
- D. Shovels, brooms, dustpans, mops and buckets may be used during Stage 1 cleaning.
 - 1. Minimize need for brooms and sweeping tools during Stage 2 cleaning, and primarily use wet mopping and vacuum cleaning for floor cleaning.
 - 2. Where surfactants are needed, use only non-ionic type.
- E. Use 99.99 percent HEPA filtered vacuum cleaner during Stage 3 and later cleaning.
 - 1. Output filter shall be tested at least weekly with a particle counter to assure minimum Class 100 performance.
- F. Beginning during Stage 2 cleaning, provide positive pressurization to prevent infiltration of contamination from surrounding areas.
 - 1. During welding, grinding and other construction operations requiring additional measures to remove contaminants, provide negative pressure ducted smoke removal fans.
- G. The following materials shall not be used in cleanroom construction:
 - 1. Masking tape.
 - 2. Duct tape.

3. Lubricants, pastes and fluxes containing ionic contaminants.
4. Freons, aerosols and spray products.
5. Salt, soap and other materials containing sodium, potassium or other heavy metals.

H. Contractor performing work shall be responsible for cleaning their own tools, cleaning their construction materials, and removing their construction debris.

1. Contractor shall provide minimum one cleaning person for every ten or less of their workers on the job.

3.2 BASIC CLEANROOM PROTOCOL

A. Adhere to following protocol after general construction within cleanrooms is complete.

B. Materials not permitted:

1. Ordinary paper pads, notebooks, manuals, or writing paper.
2. Ordinary writing pencils, pens, erasers, crayons, or chalk
3. Any type of wood.

C. Notes and records shall be kept on lint-free paper, plastic sheet, using ball point pens or other suitable nondust generating materials.

1. Drawings, Specifications, and other instructions shall be covered with plastic film or other lint-free, nondust generating materials.

D. Maintain a complete set of tools, ladders, and material handling devices for use only within confines of clean room areas.

1. This equipment shall remain in cleanroom to avoid unnecessary transfer of contamination.

E. Provide handtrucks, dollies, and other rolling devices which are equipped with nonlubricated bearings for use within cleanroom.

F. Personnel shall wear cleanroom gowns while within confines of cleanroom.

1. Gowns and gowning procedures shall be as approved by Clean Zone Director.

3.3 FINAL CLEANROOM CLEANING

A. Throughout area prior to certification, but after general construction is complete, perform following final cleaning:

1. Clean cleanroom areas as follows with the vacuuming and wiping down of surfaces occurring in the order of ceiling areas first, walls second, and floors last.
 - a. Vacuum light fixtures inside and out, H.E.P.A. filter protective grids, ceiling channels and angles, automatic fire sprinklers and escutcheons and ceiling tiles, using portable or

- central vacuum system with maximum 0.2 micron size filter and discharge to the building exterior.
 - b. Vacuum wall surfaces, including furnishings, hardware, etc.
 - c. Vacuum exposed surfaces of process piping, drain lines, interior and exterior of ductwork, electrical raceways, including interior, utility rack framing, and all connections to process equipment.
 - d. Vacuum floors in cleanrooms, including integral coved base and reducer strip, floor penetration coverings, etc.
 - e. Final wipe-down: After vacuuming of cleanroom areas has been completed, wipe down hard surfaces including glazing, using wipe-down fabric soaked in wipe-down liquid.
- B. Completed work areas shall be subjected to certification testing to confirm conformance to specified cleanliness standards.
- 1. Reclean areas not conforming to whatever extent necessary to reach certification.

3.4 CLEANROOM PROTOCOL SUMMARY

- A. Stage 1:
- 1. Zone: Cleanroom, Subfloor:
 - a. Work: Semiclean: Commence modifications of clean supply and return ductwork, ceiling modifications.
 - b. Garments: Clean construction boots.
 - c. Cleaning: Continuous trash removal and floor sweep removed from Class 100 areas.
 - d. Maintain "Office Clean" environment.
 - 2. Zone: Cleanroom, Subfloor:
 - a. Work: After completion, vacuum and "coarse clean" from structure down all building elements.
 - b. Garments: Clean booties.
 - 3. Zone: Cleanroom, Subfloor:
 - a. Work: Begin 24 hour per day pressurization with makeup air handler, make-up air handler and recirculation air handler blowdown.
 - 4. Zone: Cleanroom, Subfloor:
 - a. Work: After pressurization and blowdown, COR shall have the opportunity to observe interstitial spaces and confirm that an "office clean" environment exists.
 - b. Provide a "final" coarse cleaning from structure down for those areas not complying with "office clean" environment.
 - c. Garments: Clean booties.
 - d. Cleaning: Daily damp mopping.
- B. Stage 2:
- 1. Zone: Cleanroom, Subfloor:
 - a. Work: Clean: Controlled gowning area, access flooring, ceiling grid.

- b. Garments: Clean smock jacket, clean booties and headgear.
 - c. Cleaning: Continuous trash and debris removal, vacuuming, and wipe down of all surfaces.
 - 2. Zone: Cleanroom:
 - a. Work: After completion, provide clean zone initial washdown from interstitial elevation down.
 - b. Garments: Full-length suit, clean booties and headgear.
- C. Stage 3:
 - 1. Zone: Cleanroom, Subfloor:
 - a. Work: Clean: HEPA filters materials cleaned, continuous cleaning, i.e., wipedown, vacuum and trash removal.
 - b. Garments: Clean smock jackets, booties and headgear_.
 - c. Cleaning: Equipment, tools and clean booties.
 - 2. Zone: Cleanroom, Subfloor:
 - a. Work: After completion, provide a cleanroom final washdown of all surfaces within cleanroom.
 - i. Provide a black and white felt rubdown test when complete.
 - b. Garments: Full-length suit, knee high boots and headgear (first level only).
- D. Stage 4:
 - 1. Zone: Cleanroom:
 - 2. Work: Test and certification.
 - 3. Garments: Full length suit, knee-high boots, and headgear.
 - 4. Cleaning: Equipment, tools, and materials cleaned before entering.

END OF SECTION 130002

SECTION 13003 CLEANROOM CERTIFICATION

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. Refer to Section 130001 for Clean Zone General Requirements.
- B. Refer to Section 230593 for testing and balancing of mechanical systems serving cleanrooms.
- C. Refer to Section 130002 for cleanroom cleaning procedures.

1.2 DESCRIPTION

- A. Employ and pay for the services of a qualified Cleanroom Testing and Certification Contractor (Certifying Agency), as a subcontractor to perform specified service. The Cleanroom Testing and Certification Contractor shall be independent from the cleanroom contractor, system manufacturer and installer. Cleanroom Testing and Certification shall be a separate activity from other services which may be offered by this contractor. Employment of the independent subcontractor shall in no way relieve the Contractor's obligation to perform work of Contractor's Contract.
- B. Provide certification that the completed construction of the rooms scheduled below complies with the air cleanliness classification required in accordance with Federal Standard 209E "Clean Room and Work Station Requirements, Controlled Environment".
- C. Use test methods for characterizing the performance of cleanrooms in accordance with the Institute of Environmental Sciences IES-RP-CC006.2, "Testing Cleanrooms". Refer to Part 3 of this section for specific tests required and the acceptance criteria.

1.3 QUALITY ASSURANCE

- A. The Testing and Certification Contractor shall supervise all tests and shall provide competent test technicians to conduct all tests in the presence of the COR's authorized representative. The test technician shall:
 - 1. Have a minimum of four years uninterrupted service, devoted exclusively to the Testing and Certification of Cleanroom Facilities.
 - 2. Or shall be under the direct supervision of the above described person.
- B. The tests must be performed under the observation of the COR. The tests shall be performed after initial operating and balancing adjustments have been completed by the Contractor to the satisfaction of the COR. Provide a copy of the Air Balancing report to the Testing and Certification Contractor to satisfy requirements that the facility is ready for "Cleanroom Certification" testing.

- C. Instrumentation to be used shall be in accordance with the descriptions given in each test procedure, and shall have a demonstrated accuracy and sensitivity suitable for the test procedure. All instruments shall be properly calibrated according to the manufacturer's recommendations and so certified by Cleanroom Testing and Certification Contractor at the time of the test.

1.4 SUBMITTALS

- A. Shop drawings: Not required for COR review.
- B. Product data: Not required for COR review.
- C. Samples: Not required for COR review.
- D. Project information:
 - 1. Submit qualifications and references of the proposed testing laboratory, supervisor, and personnel.
 - 2. Submit program of test procedures and specimen copy of each of the report forms proposed for use.
 - 3. Submit three copies of a complete list of instruments proposed to be used, organized in appropriate categories, with data sheets for each indicating:
 - a. Manufacturer and Model Number.
 - b. Size, Capacity, and Sensitivity Range.
 - c. Serial Number.
 - d. Latest Calibration Date and method of calibration employed.
 - 4. Submit reports of all initial tests and retesting required after corrective measures have been taken.
 - 5. Submit proposed method of test procedures for Airflow Parallelism and Dispersion Test in Cleanrooms where the Government's process equipment will be in place at the time of the test.
 - 6. Submit a schedule for performing all tests specified indicating the duration of the testing period for each room indicated in "Schedule of Required Classifications" and indicate total duration for each lab.
 - 7. After completion and acceptance of all required tests, the Cleanroom Testing and Certification Contractor shall compile all of the test and certification data and shall submit three copies of the completed report to the COR. The report submitted shall include a signed and dated certificate, stating compliance with the specified performance criteria.
- E. Contract closeout information: Not required for COR review.

PART 2 - PRODUCTS - Not applicable.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION

- A. Prior to the start of Cleanroom Certification Testing, the Testing and Certification Contractor shall verify that the work of the Air and Water Balancing Contractor has been completed.
In addition, the Testing and Certification Contractor shall verify that all construction Contract work has been completed within the clean space. Prior to doing any Airborne Particle Monitoring, clean the Cleanroom to the satisfaction of the Testing and Certification Contractor.

3.2 TEST PROCEDURES - GENERAL

- A. The Testing and Certification Contractor shall report the location of all sample points on an accurate grid diagram which represents the actual ceiling layout.
- B. Discrepancies with acceptance criteria shall be promptly reported to the COR for defect resolution strategy.
- C. Coordinate the schedule of all work to be done with the COR to accommodate phased completion.

3.3 ON-SITE PRE-INSTALLATION TESTING OF HEPA FILTERS

- A. Test each HEPA filter individually for leaks by full DOP challenge and scan with an aerosol photometer of either linear or logarithmic readout type. Perform testing in a suitably isolated and clean area.
- B. Each filter shall be clamped into a holding fixture which provides complete access to the downstream face of the filters and upstream plenum for supplying the air and test smoke mixture to the filter. The upstream plenum shall have two sample ports, one on each side and the 100 percent reading shall be taken at the lower of the two to assure sufficient concentration.
- C. Filter shall be tested at an average flow rate equal to operating design flow rate within +20 percent. A shielded hot-wire anemometer (0.13 m/s-1.5 m/s) face velocity profile, 300 mm downstream of filter face shall establish the average velocity in feet per minute across the face of the filter pack. Velocity shall be uniform within these limits without evidence of "dead spots".
- D. Test smoke shall be cold DOP smoke generated by air pressure (140 kpa + 5 kpa) through two, four jet, Laskin type nozzles as per USA Standard N-5.11. The aerosol light scattering droplet size distribution shall be listed in IES-RP-CC006.2.

- E. Upstream concentration to the test filter shall be 10^{-4} above the minimum sensitivity of the logarithmic readout photometer, or produce 100 percent reading which will allow the linear readout photometer to be stray - light adjusted to zero on the lowest scale. Measurement shall be taken in the plenum immediately ahead of the test filter. Prolonged exposure of filter to DOP shall be avoided. The least amount of DOP necessary to perform testing shall be introduced.
- F. The test instrument shall be an aerosol photometer of sufficient sensitivity to indicate a test smoke concentration of not less than 100 micrograms/liter and a threshold sensitivity of not less than 0.001 micrograms/liter. It shall have a minimum sample flow rate of 0.5 L/s. Probe size shall be dependent upon the actual filter velocity and shall be such that the air flow velocity through the probe is 0.45 m/s $\pm$ 20 percent. (24 mm diameter for 0.24 L/s sample flow rate and 38 mm diameter for 0.6 L/s sample flow rate.)
- G. Scanning shall be accomplished by passing the probe over the filter in slightly overlapping strokes so that the entire area of the filter is scanned. A separate pass shall be made around the periphery of the filter and the adhesive bond between the filter pack and the rigid frame. Factory repair patches shall be double checked. The probe shall be a maximum of 25 mm from the filter face. The scanning method shall conform to IES-RP-CC006.2.
- H. A leak indicated by a repeatable steady photometer (linear readout type) reading greater than 0.01 percent of the upstream concentration is defined as a significant leak. For a logarithmic readout photometer, a reading of .01 percent of upstream on the instrument logarithmic calibration chart is defined as a significant leak.
- I. Those filters that are found to have leaks after floor testing shall be repaired providing:
 - 1. The size of the repair(s) is less than 5 percent of the filter face area.
 - 2. One dimension of any repair is limited to 38 mm maximum. The Testing and Certification Contractor shall keep a daily record of the defective filters found during on-site testing. Those defective filters shall be reboxed immediately, before being repaired, until such time that the problem(s) is identified. The integrity of the filters is the responsibility of the General Contractor.

3.4 SCHEDULE OF CLEANROOM PERFORMANCE TESTING

- A. The following tests shall be required for rooms listed in the Schedule of Classifications at the listed operational modes:

I.E.S SECTION NO. (REF.)	CERTIFICATION TEST	AS BUILT		OPERATING	
4	Air Velocity Uniformity	100	1,000	*10,000	100,000
5	Final HEPA Filter Installation Leak Test	100	1,000	10,000	
6	Airflow Parallelism and Dispersion	100	**1,000		
7	Room recovery Test	100	1,000	*10,000	*100,000
8	Airborne Particle Monitoring	100	1,000	10,000	100,000
11	Room Pressurization	100	1,000	10,000	100,000

* = These tests shall be made for the sole purpose of providing performance data to the COR.

** = Airflow Parallelism and Dispersion Tests shall be made at all rooms classified. The tests shall be made for the sole purposed of providing performance data to the COR.

3.5 SCHEDULE OF ACCEPTANCE CRITERIA

- A. In addition to the general basic cleanliness requirements in Federal Standard 209E, comply with the following criteria:
1. Air Velocity and Uniformity height Class 100: 0.4 M/S + 20 percent
Class 1,000: +0.35 M/S
Class 1,000 For information only, taken across total room area.
 2. Final HEPA Filter Installation Leak Test Minimum efficiency of filters must be 99.99 percent on 0.3 micron thermally generated particles in accordance with Federal Standard 209E.
 3. Airflow Parallelism and Dispersion Offset in vertical airflow must not exceed 14 degrees
 4. Room Recovery Test Class 100: 30 second recovery
Class 1,000: 4 minute recovery
 5. Airborne Particle In accordance with Federal Standard Monitoring 209E measured at a workstation height of 860 mm above finish floor. See Schedule of Room Classifications.
 6. Room Pressurization Pressure shall be such that as the cleanliness requirement of the area decreases, the relative pressure decreases (i.e. Class 100 more positive than Class 1,000, and Class 1,000 more positive than Class 10,000, etc.) Minimum acceptable pressure differential is 1.2 pa. Indicate room pressure on both sides of wall and pressure differential for each test point in all reporting.

3.6 SCHEDULE OF REQUIRED CLASSIFICATIONS

- A. Refer to drawing 215-M411 for space classifications. Further classification shall be requested from COR.

3.7 GASKETING LEAKAGE TEST

- A. While performing Final HEPA Filter Installation Leak Test, scan ceiling grids for leakage at gasketing, perimeter ceiling angle conditioner and at any fixture mounted through the HEPA filters, with particle counter using the same procedures as in the Final HEPA Filter Installation Leak Test. Notify Government Inspector in advance of this Work and allow Inspector to witness test. Report all locations of ceiling grid leakage to Cleanroom Director for immediate defect resolution.
- B. Retest all locations of leaks after defects have been corrected.

END OF SECTION 130003

SECTION 230100 - BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 CONTRACT DOCUMENTS

- A. Unless otherwise modified, provisions of General Conditions, Supplementary Conditions and Division-01 govern work under the Mechanical Divisions.
- B. Contract drawings for mechanical work are diagrammatic, intended to convey scope and general arrangement. Contractor shall review and coordinate routing of new work to clear existing piping, duct, electrical, structure, etc. at no cost to the Government. All dimensions of existing conditions shall be considered approximate (for information only). All dimensions shall be verified prior to construction.
- C. Contract Document Interpretation/Discrepancies:
 - 1. Should the Contractor discover any discrepancies or omissions on the drawings or in the specifications, he shall notify the COR of such conditions prior to the bid date. Otherwise, it will be understood that the drawings and specifications are clear as to what is intended and shall be as interpreted by the COR and Engineer.
 - 2. In addition, should any contradiction, ambiguity, inconsistency, discrepancy or conflict appear in or between any of the Contract Documents, the Contractor, shall, before proceeding with the work in question, notify the COR and request an interpretation. In no case shall he proceed with the affected work until advised by the COR.
 - 3. If the Contractor fails to make a request for interpretation of discrepancies or conflicts in the drawings or specifications, no excuse will be accepted for failure to carry out the work in a satisfactory manner, as interpreted by the COR. In all cases, the Contractor will be deemed to have estimated the most stringent materials and methods (i.e. the highest quality materials and most expensive manner of completing the work) unless he has requested and obtained written authorization as to which methods or materials will be required.
 - 4. Each and every trade or subcontractor will be deemed to have familiarized himself with all drawings of this project, including Mechanical, Electrical, etc. so as to avoid coordination errors, omissions, and misinterpretations. No additional compensation will be authorized for alleged errors, omissions, and misinterpretation, whether they are a result of failure to observe these requirements or not.
- D. The complete set of Mechanical drawings, specifications, and addenda apply to this work.

1.2 SCOPE

- A. The work in Division-23 includes furnishing and installing the mechanical systems complete and ready for satisfactory service.
- B. Requirements specified govern work in all sections of Division-23.

1.3 REFERENCES

- A. References to standards, codes, catalogs and recommendations are latest edition in effect on date of invitation to bid.
- B. Refer to applicable contract drawings, specifications and addenda pertaining to other divisions for conditions affecting work.
- C. Refer to Division-01 & construction documents for description of alternates.
- D. Refer to Division-01 for description of allowance items.
- E. Refer to Division-01 for description of base bid items.
- F. Refer to Division-23 for HVAC equipment close-out documentation

1.4 DEFINITIONS

- A. Following are definitions of terms and expressions used in this Division:
 - 1. "Approve" - to permit use of material, equipment or methods conditional upon compliance with contract document requirements.
 - 2. "Concealed" - hidden from normal sight; includes work in crawl spaces, above ceilings, and in building shafts.
 - 3. "Directed" - directed by Engineer.
 - 4. "Ductwork" - includes ducts, fittings, housings, dampers, supports and accessories comprising a system.
 - 5. "Equal, equivalent" - possessing the same performance qualities and characteristics and fulfilling the same utilitarian function.
 - 6. "Exposed" - not concealed.
 - 7. "Indicated" - indicated in Contract Documents.
 - 8. "Piping" - includes pipe, fittings, valves, supports and accessories comprising a system.
 - 9. "Provide" - furnish and install.
 - 10. "Removable" - detachable from the structure or system without physical alteration of materials or equipment or disturbance to other construction.
 - 11. "Review" - limited observation or checking to ascertain general conformance with design concepts and general compliance with contract document requirements. Such action does not constitute a waiver or alteration of the contract requirements. Verification of quantities and dimensions shall be the responsibility of the Contractor.
 - 12. "Appurtenances" - a device or assembly installed in the referenced system which performs some useful referenced function in the operation, maintenance, servicing, economy or safety of the system. Some examples include, but are not limited to aerators, anchors, supports, gauges, backflow preventers, expansion tanks, filters, flow controls, heat exchangers, interceptors, meters, pressure reducing valves, relief valves, dampers, separators and similar devices.
 - 13. "Record Documents" - drawings, plans and specifications that indicate the nature and location of work reported by Contractors, but not verified by Consultant. Record documents cannot be considered reliable; as they are based on information reported by the Contractor only and is not verified by the Architect or Engineer (A/E).

1.5 RIGGING REQUIREMENTS

- A. Prior to bidding, the Contractor shall verify that all equipment can be physically rigged to the proposed location without disturbance or dismantling of any existing or new physical obstacles. Should the rigging of any new equipment appear to be an issue, the Contractor shall inform the Architect or Engineer (A/E) seven (7) days prior to the bid date that the rigging of the new equipment may present a problem. Otherwise, the Contractor shall, in accordance with the manufacturer's approval and without voiding warranties and/or certifications, have the equipment "broken down" into sections as required to install the equipment in its proposed location without disturbance or dismantling of any existing or new physical obstacles.
- B. Failure to inform the Architect or Engineer (A/E) seven (7) days prior to the bid of any rigging problems will result in the Contractor accepting full responsibility for all modifications to the equipment or the physical obstacles required to install the equipment in its proposed location without additional cost to the Government.

1.6 CONTRACTOR'S INSTALLATION DRAWINGS

- A. Prior to fabrication and installation, submit shop drawings (min. scale - 1/4" = 1' - 0") illustrating all ductwork, HVAC piping, plumbing piping, lighting fixtures, cable tray, conduit, expansion loops, supports, alignment guides and fire protection coordinated with each other and with the structure. Installation drawings shall be reviewed by COR prior to fabrication and installation of any new work and prior to the ordering of any mechanical equipment.
- B. Should the Contractor not provide the coordinated installation drawings required above, the following shall apply:
 - 1. The Contractor shall accept full and absolute responsibility for the coordination of all project materials and equipment to be installed as indicated on the contract documents.
 - 2. Proposed change orders and/or time extensions will not be accepted for any additional work that results from coordination related changes.
 - 3. A credit shall be issued to the government for the value of the coordinated installation drawings; the value of the credit to the government shall be as determined by the COR.

1.7 MATERIAL, EQUIPMENT AND SUBSTITUTION REQUIREMENTS

- A. Use products of one manufacturer where two or more items of same kind of equipment are required.
- B. Materials and equipment shall have a record of two (2) years successful field use.
- C. Where a specific manufacturer is listed on the drawings, that manufacturer shall be considered the basis of design for that particular item of equipment. Only the basis of design manufacturer has been verified to meet the project requirements (i.e. dimensions, weights, service clearances, electrical requirements, etc.).
- D. Where the drawings and/or specifications indicate more than one manufacturer for a particular item of equipment, only those listed may submit products and services to be included in the work; manufacturers other than those listed will not be acceptable. Should the contractor choose to use

one of the specified manufacturers other than the basis of design, it shall be the responsibility of the contractor to verify that the equipment meets all project requirements including, but not limited to, verification of all dimensions, weights, service clearances, electrical requirements, etc. All changes incurred shall be the responsibility of the contractor and shall be provided at no additional cost to the Government.

- E. Substitutions must be submitted for consideration seven (7) days prior to the original bid date unless otherwise noted. Consideration of substitutions shall be at the sole discretion of the COR. Substitution submittals shall include all information required in the "Submittals" paragraph of this specification section, as well as all other requirements indicated through the Division-23 specifications. Substitutions will not mitigate, in any way, the Contractor's responsibility in complying with the coordination, contract requirements or design intent. Any additional electrical, structural or special requirements, etc. shall be the responsibility of the Contractor. Also, any additional cost incurred as a result of substitution shall be the responsibility of the Contractor.
- F. Nameplate: For each piece of power operated mechanical equipment provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.
- G. Where items of equipment are indicated as Base Bid on the bid form include in the Bid price the cost of providing the equipment upon which the specification is based. In addition, submit with bid for Contracting Officer's consideration the amount to be added or deducted from the base bid for other listed manufacturers' equipment. Government will advise Contractor within forty-five (45) days after award of contract of his selection.

1.8 MATERIAL AND EQUIPMENT LIST

- A. Within thirty (30) days after award of the contract, submit for Engineer's review a list of subcontractors' and manufacturers' names for items proposed for this project.

1.9 SUBMITTALS

- A. Where the drawings and/or specifications indicate more than one allowable manufacturer for a particular piece of equipment and/or product, only those manufacturers indicated may submit products and services to be included in the work. Unless otherwise indicated, manufacturers other than those listed will not be acceptable.
- B. Submit shop drawings, manufacturer's data and certificates for equipment, materials and finish, and pertinent details for each system where specified in each individual section, and obtain approval before procurement, fabrication, or delivery of the items to the job site. Partial submittals are not acceptable and will be returned without review.
- C. Shop Drawings: Drawings shall include floor plans, sectional views, wiring diagrams, and installation details of equipment. Include equipment spaces identifying and indicating proposed location, layout and arrangement of items of equipment, control panels, accessories, piping, ductwork, and other items that must be shown to assure a coordinated installation. Wiring diagrams shall identify circuit terminals, and indicate the internal wiring for each item of

equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. If equipment is disapproved, drawings shall be revised to show acceptable equipment and be resubmitted. All equipment and/or products shall be submitted by an authorized factory representative of that particular product.

- D. **Manufacturer's Data:** Submittals for each manufactured item shall be manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts.
- E. **Standards Compliance:** When materials or equipment must conform to the standards of organizations such as the American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), American Society of Mechanical Engineers (ASME), American Gas Association (AGA), American Refrigeration Institute (ARI), and Underwriters' Laboratories (UL), proof of such conformance shall be submitted to the Engineer for review. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified in the individual sections. In lieu of the label or listing, the Contractor shall submit a certificate from an independent testing organization, which is competent to perform acceptable testing. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard. For materials and equipment whose compliance with organizational standards or specifications is not regulated by an organization using its own listing or label as proof of compliance, a certificate of compliance from the manufacturer shall be submitted for review. The certificate shall identify the manufacturer, the product, and the referenced standard and shall simply state that the manufacturer certifies that the product conforms to all requirements of the project specification and of the referenced standards listed.
- F. Contractor shall thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission and coordinate installation requirements for equipment submitted, including, a) the verification of equipment weights relative to the existing and/or new structural support system and b) the verification of equipment dimensions relative to existing and/or new architectural conditions. Contractor shall be responsible for correctness of all submittals.
- G. Submittals will be checked only for general conformance with the design concept and are subject to the original contract documents, as well as any corrections and comments noted. Comments noted, if any, will not be considered a complete list of all omissions, deviations and corrections necessary to meet the requirements of the contract documents. The contractor will be responsible to confirm that the final product and installation will be in conformance with the contract documents in their entirety, including the responsibility to fully coordinate all work with other trades and to confirm the correctness of dimensions, quantities, and capacities. Submittal review does not authorize or constitute a change to the contract requirements and does not release the contractor of responsibility to conform to the contract requirements. Requirements of the contract are not waived by review of any and all substitutions. The contractor must fulfill the terms of the contract.
- H. **Compliance Review Form:** Each equipment submittal must include a Compliance Review Form formatted as follows:
 - 1. Section 1: Certify that the submittal is in complete compliance with the plans and

- specifications, except for the numbered and footnoted deviations and exceptions as defined herein. Deviations or exceptions taken in a cover letter or by contradiction or omission shall not constitute a release from the requirement that the equipment be in complete compliance with the plans and specifications.
2. Section 2: Provide a detailed paragraph by paragraph annotation of the specification with an individual “C”, “D”, or “E” noted in the margin, as follows:
 - a. “C” shall mean compliance with no exceptions. Provide a numbered footnote (i.e. C1, C2, C3, etc.) for each comment or clarification.
 - b. “D” shall mean compliance with deviations. For each deviation, provide a numbered footnote (i.e. D1, D2, D3, etc.) with a detailed explanation of how the intent of this specification is to be satisfied.
 - c. “E” shall mean exception. The equipment offered is not in compliance with the specifications. For each exception, provide a numbered footnote (i.e. E1, E2, E3, etc.) with a detailed description of the exception.
- I. Electronic Submittals: Should the contractor elect to submit electronic shop drawings/submittals, the procedure shall be as follows:
1. Provide a transmittal with the electronic shop drawing/submittal indicating that the document was transmitted electronically. Transmittal shall also include verification of the contractor’s review indicating compliance with the contract documents in accordance with paragraph 1.09.F of this section.
 2. Sequentially number all pages on the electronic shop drawing/submittal. The total number of pages shall be reflected in the transmittal.
 3. Submittal review comments shall be transmitted electronically. Large documents will be scanned with comments as necessary and returned electronically.
 4. All shop drawings such as, but not limited to: coordination drawings, ductwork shop drawings, fire alarm drawings, ductbank layouts, etc. shall be submitted in hard copy, full size format.
 5. Provide hard copy of the shop drawing/submittal for each of the Operations and Maintenance Manuals.
 6. Failure to comply with the above will result in the submittal being returned and marked “Not Reviewed”.
- J. Submittals will be reviewed for general compliance with design concept in accordance with contract documents. Dimensions, quantities, weights, or other details will not be verified by the A/E; this is the responsibility of the Contractor.
- K. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted.
- L. Review Period: BKM shall be allotted two (2) weeks for the processing, review and return of all submittals. It shall be incumbent upon the Contractor to include this time period in their schedule.
1. Resubmittals: BKM shall be allotted an additional two weeks (14 days) for the review of each resubmittal. Again, it shall be the Contractor’s responsibility to submit the appropriate materials in a timely fashion.
 2. Contract Extension: No extension in contract time will be authorized as a result of the timeline addressed above.

M. Submittal Identifications:

1. Place a permanent label or title block on each submittal for identification.
2. Indicate name of firm or entity that prepared each submittal on label or title block.
3. Provide a space approximately 4 by 5 inches on label or beside title block to record contractor's review and approval markings and action taken by Engineer.
4. Include the following information on label for processing and recording action taken:
 - a. Project name
 - b. Date
 - c. Name and address of A/E
 - d. Name and address of contractor
 - e. Name and address of subcontractor
 - f. Name and address of supplier
 - g. Name of manufacturer
 - h. Unique identifier, including revision number
 - i. Number and title of appropriate specification section
 - j. Drawing number and detail references, as appropriate
 - k. Other necessary identification
1. Example: 230700-01-0
 - i. 230700 references the spec section
 - ii. 01 indicates this is the first submittal from this spec section
 - iii. 0 indicates this is the original submittal (where 1 would indicate this is the first re-submittal)

N. The engineer will provide a maximum of two (2) submittal reviews per equipment submittal; the initial review plus one (1) re-submittal. Should the re-submittal be returned "Not Acceptable" or "Revise and Resubmit", the contractor shall choose one of the following courses of action:

1. Provide the exact manufacturer and model indicated in the contract documents as the basis of design, or
2. Reimburse the engineer for all additional review time required to achieve a submittal review from the engineer of "No Exceptions Taken."
3. Should the contractor choose option 2 above, the engineer shall be reimbursed at an hourly rate of \$175 per hour with payment due prior to the return of the final submittal. In addition, the contractor shall accept complete responsibility for all delays resulting from the submittal review process extending beyond two (2) reviews per equipment submittal.

O. Resubmittals: Resubmittals shall comply with paragraph 1.09 of this section and the following additional requirements.

1. Resubmittals shall include a written response to each submittal comment. Provide a detailed comment by comment annotation of the submittal review comments with an individual "C", "D", or "E" as follows:
 - a. "C" shall mean compliance with no exceptions. Provide a numbered footnote (i.e. C1, C2, C3, etc.) for each comment or clarification.
 - b. "D" shall mean compliance with deviations. For each deviation, provide a numbered footnote (i.e. D1, D2, D3, etc.) with a detailed explanation of how the intent of this specification is to be satisfied.

- c. "E" shall mean exception. The equipment offered is not in compliance with the specifications. For each exception, provide a numbered footnote (i.e. E1, E2, E3, etc.) with a detailed description of the exception.

1.10 MANUFACTURER'S RECOMMENDATIONS

- A. Installation procedures are required to be in accordance with the recommendations of the manufacturer of the material being installed.

1.11 ACCESSIBILITY

- A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

1.12 SAFETY REQUIREMENTS

- A. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts located so that any person can come in close proximity thereto shall be fully enclosed or properly guarded in accordance with OSHA. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be properly guarded or covered with insulation of a type as specified herein. Items such as catwalks, ladders, and guardrails shall be provided where required for safe operation and maintenance of equipment.

1.13 WORKMANSHIP

- A. Remove and replace, at no extra cost, all work not orderly, reasonably neat, or workmanlike.
- B. Coordinate all work and cooperate with other trades to facilitate execution of work.

1.14 SITE EXAMINATION/EXISTING CONDITIONS VERIFICATION

- A. Failure to visit site and become familiar with existing conditions prior to bidding will not relieve the Contractor of responsibility for complying with the Contract documents.
- B. Contractor shall field verify existing services and direction of flow of piping and ductwork prior to connection. Existing mechanical identification shall not constitute proper verification of service or direction of flow.

1.15 REGULATIONS AND PERMITS

- A. Comply with all applicable codes and regulations.
- B. All equipment provided shall be in accordance with all applicable local, state, and federal codes,

guidelines and standards, as well as the authority having jurisdiction. Equipment and installation shall be in compliance with all applicable energy codes including the most current version of ASHRAE Standard 90.1.

- C. Obtain and pay for all required permits.

1.16 CUTTING AND PATCHING

- A. Unless otherwise directed, do all cutting and patching. Damaged work, including fireproofing and waterproofing shall be repaired by skilled mechanics of the trade involved.
- B. Do not cut walls, floors, roofs, reinforced concrete or structural steel without structural Engineer's permission. Install services without affecting reinforcing steel.
- C. In precast concrete plank drill all holes with a Carboloy tipped drill. Follow instructions of structural Engineer. Cut no reinforcing bars.

1.17 CLEANING UP

- A. For cleaning of all work related to cleanroom, refer to Specification Section 130002.
- B. Keep premises free from accumulation of debris.
- C. Remove tools, scaffolding, surplus material, debris, and leave premises broom clean.
- D. On discontinuance of part of the work, place all debris in containers and promptly remove them from the Government's property.
- E. Leave all areas broom clean.
- F. Final clean-up shall be performed.

1.18 PROTECTION

- A. Protect mechanical and electrical material and equipment from the elements or other injury as soon as delivered on premises.
- B. Cap or plug openings in equipment, piping, duct, and conduit systems to exclude dirt and other foreign material. Rags, wool, cotton, paper, waste or similar materials shall not be used for plugging.
- C. Unless approved by COR, HVAC equipment shall not be used for temporary heating or ventilation during construction.
- D. Contractor shall protect all existing mechanical, electrical and architectural equipment, materials, finishes, etc. located within or adjacent to the work environment. Contractor shall be responsible for restoration of all existing mechanical, electrical and architectural items to remain. All equipment to remain must be restored to its pre-existing condition prior to the start of work. Restoration and/or replacement shall be at no cost to the Government.

- E. Contractor shall provide temporary cooling and heating as required to protect all construction materials from the potential adverse effects of high or low temperature and humidity. Upon delivery of ceiling and other finish materials to a location within the building, environmental conditions in all spaces where the materials will be either stored or installed shall be permanently maintained at 75°F (+2°F) and 50% RH (+5%). Should the HVAC include a reheat system, the reheat system shall be energized to provide temperature and humidity control whenever the HVAC system is energized. Contractor shall pay for all utility, fuel, operational, maintenance and repair costs associated with providing the environmental conditions indicated above until the COR accepts occupancy of the building.

1.19 CLEANING OF SYSTEMS

- A. After satisfactory completion of pressure tests and before permanently connecting fixtures, equipment, strainers and other accessory items, thoroughly clean all systems. Blow out and flush piping or tubing until interiors are free of foreign matter.
- B. Clean fans, ductwork, enclosures, registers, grilles and diffusers at completion of work.
- C. Permanent air systems operated for temporary heating during construction shall only be operated with filters installed of equal efficiency to those specified. Prior to acceptance and after cleaning of system, replace with clean filters as specified. Return air openings shall be equipped with filter cloth to protect against debris entering the ductwork.
 - 1. If upon periodic inspection, it is determined that the permanent ductwork has become contaminated with construction debris, then the contractor shall be required to procure the services of a professional duct cleaning agency prior to substantial completion, at no additional cost to the Government.
- D. Should any system become clogged with construction refuse after acceptance, the contractor shall pay for all labor and materials required to locate and remove the obstruction and replace and repair work disturbed.
- E. Leave all systems clean, and in complete running order.
- F. Equipment that has been subjected to the elements shall be cleaned of all rust, dirt and debris and repainted to match original finish.

1.20 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION

- A. General: In addition to the tests required during and after installation of all mechanical systems, as well as any other formal commissioning requirements, the Contractor shall perform functional performance tests to verify that all systems are designed, installed, calibrated and adjusted to perform as required in the Contract.
- B. Comply with all applicable specification sections including, but not be limited to, "Basic HVAC Requirements", "Testing, Adjusting and Balancing", "Automatic Temperature Controls" and "Commissioning", where applicable.
- C. Prior to functional performance testing, all indicating, recording and control devices shall be

calibrated. A verification calibration report shall be provided with the final test report.

- D. Provide functional performance testing to verify proper operation of each and every control sequence indicated throughout the contract documents.
- E. Failure of Tests: Should any test, verification, or demonstration fail to meet the specification requirements, the component of the system causing the failure shall be repaired, replaced or readjusted. The failed test, verification, or demonstration shall then be repeated.
- F. A "Functional Performance Test Verification Form" is included at the end of Section 230900. This form (electronic version is available upon request) shall be completed for all mechanical equipment provided under this contract. This shall include, but not be limited to each air handling unit, fan, VAV terminal, , etc.
- G. Test Report: Upon satisfactory verification of calibration and functional performance tests, a copy of the final test results shall be bound in the operations and maintenance manual. The final report shall also include a full compliance statement, on company letterhead, indicating that all systems are installed and functioning per the contract requirements including drawings, specifications, control sequences and accepted submittals.
- H. The mechanical systems shall not be considered complete until all functional performance verification forms, calibration reports and compliance statement have been submitted and reviewed. Submit in accordance with the submittal requirements indicated elsewhere in these specifications.

1.21 TOOLS AND LUBRICANTS

- A. Furnish and turn over to the COR, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the COR.
- D. Lubricants: A minimum of one quart (.9 L) of oil, and one pound (450 g) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

1.22 DEMOLITION

- A. This work shall include the disconnection and capping of existing services, relocation of certain equipment, and the removal of existing wiring, fittings, equipment,, ductwork, etc., not reused in the new work or required to complete the renovation work. Contractor shall note the drawings specify certain existing equipment to be reused.
- B. Where supports and piping are removed, holes remaining in floors, walls and ceilings must be patched and refinished to match the adjoining original surfaces and finishes.

- C. Any removed items requested by the COR shall remain the property of the Government. Contractor shall remove equipment and store on site as directed by the COR. All other equipment or material shall become the property of the Contractor and shall be removed from the site. Contractor shall meet Federal EPA Laws, Regulations and Guidelines in regard to removal of asbestos insulation.
- D. The contractor shall use care when performing selective building. The contractor shall be responsible for damage inclusive of but not limited to: lab equipment, cleanroom equipment, building finishes, lighting, furniture, structure, site, utilities (above and below ground), mechanical, telecommunications and electrical equipment / systems. Should any damage occur or should any remedial work be required, the contractor shall be responsible to repair and or replace the damaged item(s) to the COR's satisfaction at no additional cost.

1.23 OUTAGES

- A. All mechanical outages which will interfere with the normal use of the building in any manner shall be done at such times as shall be mutually agreed upon by the Contractor and the COR.
- B. Unless otherwise specified, outages of any services required for the performance of this contract and affecting areas other than the immediate work area shall be scheduled at least two (2) weeks for minor outages and six weeks for outages impacting six or more labs in advance with the COR. All such outages shall be performed during other than normal duty hours.
- C. The Contractor shall include in his price the cost of all premium time required for outages and other work which interferes with the normal use of the building, which will be performed, in most cases, during other than normal work time and the convenience of the using agency.

1.24 GUARANTEE/WARRANTY

- A. Each Contractor shall furnish a guarantee covering all labor and materials furnished by him for a period of two (2) years from the date of final acceptance of his work, and he shall agree to repair and make good at his own expense any and all defects which may appear in his work during that time if, in the judgment of the Engineer, such defects arise from defective workmanship and/or imperfect or inferior material.
- B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of guarantee shall be delivered to the Government.
- C. Within the two (2) year warranty/guarantee period, manufacturer's recommended maintenance shall be provided by the Contractor.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION 230100

SECTION 230200 - PROJECT CLOSEOUT HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This section provides a summary of the primary mechanical project closeout activities, however, this section does not attempt to address all project closeout requirements. Closeout activities referenced in this section include the following:
 - 1. Pressure Testing
 - 2. Start-up
 - 3. Punch-out Procedures
 - 4. Testing, Adjusting and Balancing
 - 5. Functional Performance Testing and Verification
 - 6. Operation and Maintenance Manuals (O & M Manuals)
 - 7. Demonstration and Training
 - 8. Record Documents
 - 9. Close-out Documents
- B. This Section shall not supersede any other close-out section or requirements of the Contract. Refer to other Divisions of the specifications and the General Requirements of the Contract for further instructions.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 PRESSURE TESTING

- A. Piping: The Contractor shall perform pressure testing on all piping systems as indicated in Division-23 section "Testing, Adjusting and Balancing", and elsewhere as indicated.
- B. Ductwork: The Contractor shall perform pressure testing on all ductwork systems as indicated in Division-23 sections, "Testing, Adjusting and Balancing", "Low Pressure Ductwork" and "High Pressure Ductwork" and elsewhere as indicated.
- C. Air Handling Units: The Contractor shall perform factory and / or field pressure testing on all air handling units where required by the drawings or specifications.
- D. Final pressure test results shall be submitted as a separate project submittal for review and included with the Test and Balance Report. Upon review for general conformance, include all

pressure tests in the O & M Manual.

- E. All factory performed equipment test results shall be included in the final O & M Manuals.
- F. Where re-tests were required, indicate remedial action taken and submit in test report.

3.2 START-UP

- A. The Contractor shall perform start-up on each piece of mechanical equipment as specified in each section of Division-23.
- B. Where indicated in each section of Division-23, the services of a factory authorized and certified technician shall be required to perform the equipment start-up. Start-up by any other organization other than as required by the manufacturer is unacceptable.
- C. Start-up reports shall be provided for all equipment and be included in the final O & M Manuals.

3.3 PUNCH-OUT PROCEDURES

- A. Preliminary Punch-out:
 - 1. Prior to requesting an inspection from the COR, Engineer, or Permit Official, the General Contractor or Construction Manager (GC or CM) shall provide a preliminary punch-out of the area in question.
 - 2. Once completed, their punch list shall be supplied to each trade for corrections and completion. The punch list shall also be provided to the Engineer for their use.
 - 3. Upon being informed that the trade contractors have addressed all of the outstanding items, the GC / CM shall backcheck the work and update the punch list.
- B. Final Punch-out:
 - 1. Final punch-out by the engineer shall not commence until the GC or CM has exhausted their review and has signed off on all items.
 - 2. A copy of the sign-off shall be provided to the Engineer for their record.
 - 3. Once the above has been completed, the Engineer shall be notified that the work is substantially complete and ready for a final punch-out.
 - 4. Depending on the size, schedule, and project complexity, punch-outs may be requested for specific areas or systems, rather than the facility as a whole. Examples of specific requests include the following:
 - a. Above ceiling
 - b. Penthouse
 - c. Cleanroom
- C. Upon completion of any and all punch lists (i.e. above ceiling, final, partial, phased, or specific item) the contractor shall provide an item by item sign-off indicating the date and who completed the item. The sign-off shall be submitted to the A/E and COR before final payment is processed. Should the contractor disagree with any item, they shall provide a written exception giving reason for review.

3.4 TESTING, ADJUSTING AND BALANCING

- A. Comply with all provisions of Division-23 Section, "Testing, Adjusting and Balancing" (TAB) for the systems listed, but not limited to, the following:
 - 1. Building Automated Systems
 - 2. Fans
 - 3. Air Handling Units
 - 4. Ductwork Systems
 - 5. Terminal Units
 - 6. Fume Hoods
- B. TAB reports shall be submitted as a separate project submittal for review. Upon review for general conformance, include the final TAB report in the O & M Manual.
- C. Comply with testing, adjusting and balancing requirements as indicated in each section within Division-23.

3.5 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION

- A. General: In addition to the tests required during and after installation of all mechanical systems, as well as any other formal commissioning requirements, the Contractor shall perform functional performance tests to verify that all systems are designed, installed, calibrated and adjusted to perform as required in the Contract.
- B. Comply with all applicable specification sections including, but not be limited to, "Basic HVAC Requirements", "Testing, Adjusting and Balancing", "Automatic Temperature Controls" and "Commissioning", where applicable.
- C. Prior to functional performance testing, all indicating, recording and control devices shall be calibrated. A calibration verification report shall be provided with the final test report.
- D. Provide functional performance testing to verify proper operation of each and every control sequence indicated throughout the contract documents.
- E. Failure of Tests: Should any test, verification, or demonstration fail to meet the specification requirements, the component of the system causing the failure shall be repaired, replaced or readjusted. The failed test, verification, or demonstration shall then be repeated.
- F. A "Functional Performance Test Verification Form" is included at the end of Section 230900. This form (electronic version is available upon request) shall be completed for all mechanical equipment provided under this contract. This shall include, but not be limited to each air handling unit, fan, VAV terminal, etc.
- G. Test Report: Upon satisfactory verification of calibration and functional performance tests, a copy of the final test results shall be bound in the operations and maintenance manual. The final report shall also include a full compliance statement, on company letterhead, indicating that all systems are installed and functioning per the contract requirements including drawings, specifications, control sequences and accepted submittals.

- H. The mechanical systems shall not be considered complete until all functional performance verification forms, calibration reports and compliance statement have been submitted and reviewed. Submit in accordance with the submittal requirements indicated elsewhere in these specifications.

3.6 OPERATION AND MAINTENANCE MANUALS

- A. Submit Operation and Maintenance Manuals as follows:

- 1. Provide an electronic version for review by the COR and Engineer, including bookmarks of all section and subsections.
- 2. After acceptance of the electronic copy, produce hard copies in three-ring binders with each section separated by tab divider. Include protective plastic sleeves for any software or folded large documents submitted. Provide a minimum of two (2) copies to the COR.

- B. At a minimum, the manual shall contain the following:

- 1. Title page
- 2. Table of contents
- 3. Contractor and sub-contractor contact information
- 4. Supplier contact information for all mechanical equipment
- 5. Copies of manufacturer's and contractor's warranty information (project and equipment) for all mechanical equipment.
- 6. Submittal log for all mechanical equipment
- 7. One (1) reviewed copy of each shop drawing or submittal incorporating all A/E and COR submittal review comments.
- 8. Copy of inspector acceptance certificates / documents.
- 9. Provide an 11 x 17 fold-out drawing of each floor plan and indicate locations of the following:
 - a. System shutoff valves
 - b. Exhaust Air Terminal Units
 - c. Supply, Makeup and Exhaust Airflow Measuring Stations.
 - d. Differential Pressure Gauges
- 10. All duct, pipe and equipment pressure test reports complete with 11 x 17 fold-out drawing, indicating all systems tested.
- 11. Final Test and Balance (TAB) Reports. Do not include reports that have not been accepted by the A/E. Pencil or partial copies will not be acceptable.
- 12. Maintenance procedures for each item of mechanical equipment to include frequency and type of maintenance, spare parts and attic/stock list. This shall include the manufacturer's literature indicating operating and maintenance instructions, parts list, illustrations and diagrams.
- 13. An itemized list of all spare parts and specialty tools shall be transmitted to the COR.
- 14. A report of the training procedures and content provided as well as the attendance log.
- 15. Valve tag chart
- 16. Lab Exhaust Tool tag chart
- 17. Mechanical systems functional performance verification forms, calibration reports and compliance statement indicating that all systems are installed and functioning per the contract requirements.

3.7 DEMONSTRATION AND TRAINING

- A. Upon completion of work, instruct the COR in the proper operation and maintenance of each mechanical system in accordance with applicable specification sections.
- B. Instructions shall be given by persons expert in the operation and maintenance of each system / equipment.
- C. Prepare statement(s) for signing by COR indicating the date of completion of instructions and hours expended. Furnish copies of signed statements to the Engineer.
- D. Final demonstration of all mechanical equipment shall be recorded in DVD compatible format.
 - 1. The recordings shall be organized systemically from largest to smallest component.
 - 2. The recordings shall include bookmarks to reference each type of equipment, all major components, and each component requiring regular maintenance.
 - 3. No segment shall be unannotated longer than fifteen minutes.
 - 4. Submit a digital link of the draft for review by the COR and Engineer.
 - 5. Submit two hardcopy DVDs of the final approved copy to the COR.
 - 6. Submit a digital link of the final approved copy to the COR.

3.8 RECORD DOCUMENTS

- A. The Contractor shall maintain a record set of mechanical prints at the project site and shall indicate thereon any changes made to the contract drawings, including, but not limited to addenda, field sketches, RFI responses, supplemental drawings, sketches, etc. Where changes are made that are reflective of supplemental instructions, revisions, RFI responses, etc., the Contractor shall make clear references to those changes.
- B. A separate set of neat, legible mechanical contract prints shall be kept at the project site at all times during the construction of the work for the express purpose of showing any and all changes indicated in paragraph A. above. The prints shall be marked up daily showing all changes to the original documents. The prints shall be marked up in a neat, legible manner using a red pen. Periodic review of the Record Documents will be conducted by the COR. Should this review indicate that the Record Documents are deficient or not up to date, the Contractor shall immediately bring the documents into compliance and make the corrections
- C. Upon completion of the project and before final close-out, the Contractor shall be responsible for producing a final set of record documents in electronic CADD format. One (1) set of full size prints, one (1) CD of the electronic CADD drawings (in AutoCad and pdf format), along with the red-lined marked up field set shall be delivered to the COR upon completion. If requested, the electronic CADD documents shall be up-loaded to the Government's FTP site. The final CADD documents shall indicate in the title or revision block "RECORD DOCUMENTS" along with the date completed. The electronic format shall be compatible with the Government's preferred version of AutoCad. Coordinate with the COR before producing the CD or up-loading to the FTP site. Not acceptable are contractor installation drawings, shop drawings or multi-layers of work on a single drawing. The final as- built product shall mirror the contract bid documents using the project page layout, format and project title block.

- D. Computer (CADD) files of mechanical drawings will be made available to the Contractor upon receipt of a signed waiver (available upon request). One CD will be made available to the general contractor or construction manager for distribution to the trades.
- E. Should the Contractor's electronic Record Documents not be considered complete, they will be returned for completion and/or correction.

3.9 CLOSEOUT DOCUMENTS

- A. Prior to Substantial Completion and /or Final Payment, the Contractor shall prepare and submit the following:
 - 1. Final punch lists indicating completion of all items
 - 2. All record drawings
 - 3. All record specifications
 - 4. Operation and Maintenance Manuals
 - 5. Complete final cleaning
 - 6. Remove temporary facilities and complete site restoration

END OF SECTION 230200

SECTION 230500 - BASIC HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 CONTRACT DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this Section.
- B. Requirements specified in Division-23 Section "Basic HVAC Requirements" apply to this Section.

1.2 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with mechanical installations as follows:
 - 1. Mechanical equipment nameplate data.
 - 2. Firestopping: Provide seals for all openings (new and existing) through fire-rated walls, floors, or ceilings used as passage for mechanical and electrical components such as piping, ductwork, conduit, etc.
 - 3. Selective demolition including:
 - a. Nondestructive removal of materials and equipment for reuse or salvage as indicated.
 - b. Dismantling mechanical materials and equipment made obsolete by these installations.
 - 4. Miscellaneous metals for support of mechanical materials and equipment.
 - 5. Access panels and doors in walls, and ceilings for access to mechanical materials and equipment.

1.3 DEFINITIONS

- A. The following definitions apply to firestopping:
 - 1. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.
 - 2. Barriers: Time rated fire walls, smoke barrier walls, time rated ceiling/floor assemblies and structural floors.
 - 3. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gases and smoke.
 - 4. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.
 - 5. Construction Gaps: Gaps between adjacent sections of walls, exterior walls, at wall tops between top of wall and ceiling, and structural floors or roof decks; and gaps between adjacent sections of structural floors.
 - 6. System: Specific products and applications classified and numbered by Underwriters

Laboratories, Inc. to close specific barrier penetrations.

7. Sleeve: Metal fabrication or pipe section extending through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other sections and may or may not be required.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division-01 Specification Sections.
- B. Product data for the following products:
 1. Access panels and doors
- C. Firestopping: Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures.
 1. Provide details of each proposed assembly identifying intended products and applicable UL system number, or UL classified devices.
 2. Provide drawings relating to non-standard applications as needed.
- D. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for mechanical materials and equipment.
- E. Coordination drawings for access panel and door locations in accordance with Division-23 sections.
- F. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.
- G. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
 1. Coordinate sequencing with construction phasing and Government occupancy specified in Division-01 Section "Summary of Work."

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an Installer for the installation and application of access panels and doors, and firestopping materials with at least two years' experience with installations.
- B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

- C. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
 - 1. Provide UL Label on each fire-rated access door.
- D. Local and State Regulatory Requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL firestop system numbers, or UL classified devices.

1.6 PROJECT CONDITIONS

- A. Conditions Affecting Selective Demolition: The following project conditions apply:
 - 1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 - 2. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

1.7 SEQUENCE AND SCHEDULING

- A. Coordinate the shut-off and disconnection of utility services with the COR.
- B. Notify the COR at least two (2) weeks prior to commencing demolition operations.
- C. Perform demolition in phases as indicated.

PART 2 - PRODUCTS

2.1 MECHANICAL EQUIPMENT NAMEPLATE DATA

- A. Nameplate: For each piece of power operated mechanical equipment provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

2.2 FIRESTOPPING

- A. All penetrations through fire barriers (new and existing) shall be firestopped with an approved material that is capable of maintaining the fire resistance rating of the barrier. All firestop sealants shall conform to ASTM E 814, ASTM E 119, UL 1479, UL 2079 CAN/ULC S115, and CAN/ULC S101.
- B. Firestop material shall be latex based, intumescent caulk intended for use for all thru-penetrations

with piping, ducts, cable trays, conduit, and cables.

- C. When exposed to high temperatures or fires, the caulk shall expand in volume to quickly close off voids left by melting or burning construction materials. Caulk shall be applied by a standard caulk gun and remain flexible after curing.
- D. Acceptable products shall be limited to Johns Manville “Firetemp-C1;” Hilti “FS-One;” or 3M “CP25WB+.” Coordinate with General Contractor such that a single manufacturer/ product is utilized throughout the project for all fire and smoke stopping materials.

2.3 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Non-shrink, Non-metallic Grout: Premixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout, recommended for interior and exterior applications.
- F. Fasteners: Zinc-coated, type, grade, and class as required.

2.4 ACCESS DOORS

- A. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
- B. Frames: 16-gage (1.6 mm) steel, with a 1-inch (25 mm) wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - 1. For Gypsum Wallboard or Plaster: Perforated flanges with wallboard bead.
- C. Flush Panel Doors: 14-gage (2 mm) sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees (3.05 Radians); factory-applied prime paint.
 - 1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
- D. Locking Devices: Flush, screwdriver-operated cam locks. [Common use]
- E. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide two (2) keys. [Secured areas only: note as such].

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 FIRESTOP INSTALLATION

- A. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instruction.
- B. Seal new and existing holes or voids made by penetrations to ensure an effective smoke barrier.
- C. Where floor openings without penetrating items are more than four inches (100 mm) in width and subject to traffic or loading, install firestopping materials capable of supporting same loading as floor.
- D. Protect materials from damage on surface subject to traffic.
- E. Place firestopping in annular space around fire dampers before installation of damper's anchoring flanges which are installed in accordance with fire damper manufacturer's recommendations.
- F. Where large openings are created in walls or floors to permit installation of pipes, ducts, cable tray, bus duct or other items, close unused portions of opening with firestopping material tested for the application.
- G. Install smoke stopping as specified for firestopping (new and existing).
- H. Where rated walls are constructed with horizontally continuous air space, double width masonry, or double stud frame construction, provide vertical, 12 inch (300 mm) wide fiber dams for full thickness and height of air cavity at maximum 15 foot (4500 mm) intervals.

3.3 SELECTIVE DEMOLITION

- A. General: Demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- B. Materials and Equipment to be Salvaged: Remove, demount, and disconnect existing mechanical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- C. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

- D. Mechanical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, fixtures, and insulation.
 - 2. Piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove materials above accessible ceilings. Drain and cap piping and ducts that are allowed to remain.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.5 INSTALLATION OF ACCESS DOORS

- A. Provide access doors (minimum 18" x 18") as required to provide maintainable access to all mechanical equipment including, but not limited to, valves, dampers, air terminals, etc.
- B. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- C. Adjust hardware and panels after installation for proper operation.

END OF SECTION 230500

SECTION 230510 - HVAC RELATED WORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of mechanical related work required by this section is indicated on drawings and/or specified in all other Division-23 sections.
- B. Types of mechanical related work specified in this section include the following:
 - 1. Access to Mechanical Work:
 - a. Access doors in floors.
- C. Access door requirements associated with mechanical work and mechanically related electrical components are specified in this section.
- D. Quality control testing for concrete work is required as work of this section.

1.2 QUALITY ASSURANCE

- A. Access Units Fire-Resistance Ratings: Where fire-resistance rating is indicated for construction penetrated by access units, provide UL listed-and-labeled Class B units, except for units which are smaller than minimum size requiring ratings as recognized by governing authority.

1.3 SUBMITTALS

- A. Product Data, Access Units: Submit manufacturer's technical data and installation instructions for each type of access door assembly, including setting drawings, templates, instructions and directions for installation of anchorage devices.

1.4 PROJECT CONDITIONS

- A. Environmental Conditions, Painting Work: Comply with governing regulations concerning use of and conditions for application of paint. Comply with manufacturer's recommendations and instructions. Do not apply paint in unfavorable conditions of temperature, moisture (including humidity) or ambient contamination (dust and other pollutants).

PART 2 - PRODUCTS

2.1 ACCESS TO MECHANICAL WORK

- A. Access Doors - General: Where floors must be penetrated for access to mechanical work, provide types of access doors indicated, including floor doors if any. Furnish sizes indicated or, where not

otherwise indicated, furnish adequate size for intended and necessary access. Furnish manufacturer's complete units, of type recommended for application in indicated substrate construction, in each case, complete with anchorages and hardware.

B. Removable Access Plates:

1. General: Where valves, control devices, and similar elements of mechanical work are located within or behind wall, ceiling or floor construction or finishes, or below grade, and are not (cannot be), provided with integral removable access plates as specified in other Division-23 sections, provide removable access plates of types and sizes needed for access requirements, as indicated. Provide manufacturer's complete unit with anchorages, fasteners and standard factory-applied finishes.
2. Wall/Ceiling Unit Construction: Except as otherwise indicated, and where adaptable to substrate, provide manufacturer's standard frameless round formed stainless steel or chrome-plated brass low profile plate cover, with single exposed flush screw anchor, with bright polished finish.
3. Painted Finish: Where substrate is indicated for painted finish, provide steel units with prime-coat paint finish.

PART 3 - EXECUTION

3.1 ACCESS TO MECHANICAL WORK

- A. Comply with manufacturer's instructions for installation of floor doors, and removable access plates.
- B. Set frames accurately in position and securely attach to supports with face panels plumb or level in relation to adjacent finish surfaces.
- C. Adjust hardware and panels after installation for proper operation.
- D. Remove or replace panels or frames which are warped, bowed, or otherwise damaged.

END OF SECTION 230510

SECTION 230514 - PIPE, TUBE AND FITTINGS FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of pipes and pipe fittings required by this section is indicated on drawings and/or specified in all other Division-23 sections.
- B. Types of pipes and pipe fittings specified in this section include the following:
 - 1. Steel Pipes
 - 2. Copper Tube
 - 3. Miscellaneous Piping Materials/Products
- C. Refer to requirements of Division-26.

1.2 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. Welding: Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9, as applicable, for shop and project site welding of piping work.
 - a. Certify welding of piping work using the Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB).
 - 2. Brazing: Certify brazing procedures, brazers and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job-site brazing of piping work.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of pipe and pipe fitting. In addition, submit a matrix indicating each service and the proposed pipe material and fitting.
- B. Welding Certifications: Submit reports as required for piping work.
- C. Brazing Certifications: Submit reports as required for piping work.
- D. Maintenance Data: Submit maintenance data and parts lists for each type or mechanical fitting. Include this data, product data, and certifications in maintenance manual; in accordance with requirements of Division-1.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps

through shipping, storage and handling as required to prevent pipe-end damage, and eliminate dirt and moisture from inside of pipe and tube.

- B. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.
- C. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service; where type, grade or class is not indicated. Provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.
- B. Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

2.2 STEEL PIPES AND PIPE FITTINGS

- A. Black Steel Pipe: ASTM A 53, A 106 or A 120; except comply with ASTM A 53 or A 106 where close coiling or bending is required.
- B. Threaded Pipe Plugs: ANSI B16.14.
- C. Steel Flanges/Fittings: ANSI B16.5, including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.
 - 1. Material Group: Group 1.1.
 - 2. End Connections: Buttwelding.
 - 3. Facings: Raised-face.
- D. Forged-Steel Socket-Welding and Threaded Fittings: ANSI B16.11 except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe.
- E. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1-1/2" (40 mm), and where pipe size is less than 1-1/2" (40 mm), and do not thread nipples full length (no close-nipples).

2.3 COPPER TUBE AND FITTINGS

- A. Copper Type: ASTM B 88; Type (wall thickness) as indicated for each service; hard-drawn

temper, except as otherwise indicated.

- B. Wrought-Copper Solder-Joint Fittings: ANSI B16.22.
- C. Copper-Tube Unions: Provide standard products recommended by manufacturer for use in service indicated.

2.4 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

- A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.
 - 1. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.
- B. Soldering Materials: Except as otherwise indicated, provide soldering materials as determined by Installer to comply with installation requirements.
 - 1. Tin-Antimony Solder: ASTM B 32, Grade 95TA.
- C. Brazing Materials: Except as otherwise indicated, provide brazing materials as determined by Installer to comply with installation requirements.
 - 1. Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.
- D. Gaskets for Flanged Joints: ANSI B16.21; full-faced or cast-iron raised face for steel flanges, unless otherwise indicated.
- E. Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" (1.6 mm) misalignment tolerance.
 - 1. Comply with ANSI B31 Code for Pressure Piping.
- B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Where trapping is unavoidable, install drain valve with 3/4" (20 mm) hose end connection, cap and chain. Provide access panels as required. Orient

horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent - enclosure elements of building; limit clearance to 1/2" (13 mm) where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1" (25 mm) clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.

3.2 PIPING SYSTEM JOINTS

- A. General: Provide joints of type indicated in each piping system.
 - 1. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
 - 2. Braze copper tube-and-fitting joints where indicated, in accordance with ASME B31.
 - 3. Solder copper tube-and-fitting joints where indicated, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
- B. Weld pipe joints in accordance with ASME Code for Pressure Piping, B31.
- C. Weld pipe joints in accordance with recognized industry practice and as follows:
 - 1. Weld pipe joints only when ambient temperature is above 0°F (-18°C) where possible.
 - 2. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
 - 3. Use pipe clamps or tack-weld joints with 1" (25 mm) long welds; 4 welds for pipe sizes to 10" (250 mm), 8 welds for pipe sizes 12" (300 mm) to 20" (500 mm).
 - 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.
 - 6. At Installer's option, install forged branch-connection fittings wherever branch pipe is indicated; or install regular "T" fitting.
- D. Weld pipe joints of steel water pipe in accordance with AWWA C206.
- E. 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.

3.3 PIPING INSTALLATION

- A. All piping shall be installed level, plumb, and square relative to the adjacent building structure.
- B. Group piping, where practical, and install from common supports.

3.4 FIELD WELD TESTING

- A. Field weld joints for all black steel pipe shall be tested by Ultrasonic or Magnetic particle inspection (MPI) to the extent identified below.
- B. Testing shall be conducted by an independent testing company. The testing company shall provide arrest report identifying the results of each weld tested (pass/fail).
- C. The Contractor shall engage the COR and Engineer of Record to identify welds to be tested.
- D. Testing:
 - 1. If the total quantity of field welds is greater than 50, test 10% of field welds.
 - 2. If the total quantity of field welds is less than 50, test 25% of field welds.
 - 3. Should any of the initial welds tested fail, Contractor will be required to test an additional 20% of all remaining welds, at no additional cost to the Government.
 - 4. Should any of the additional 20% of welds tested fail, Contractor will be requested to test 100% of all remaining welds, at no additional cost to the Government.

3.5 CLEANING, FLUSHING, INSPECTING

- A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.
 - 1. Inspect pressure piping in accordance with procedures of ASME B31.
- B. Disinfect water mains and water service piping in accordance with AWWA C601.

3.6 PIPE TESTING

- A. Refer to Division-23 section "Testing, Adjusting and Balancing" for pipe testing requirements.

END OF SECTION 230514

SECTION 230515 - PIPING SPECIALTIES FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of piping specialties work required by this section is indicated on drawings and schedules and by requirements of this section.
- B. Types of piping specialties specified in this section include the following:
 - 1. Pipe Escutcheons
 - 2. Pipeline Strainers
 - 3. Dielectric Fittings
- C. Piping specialties furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-23 sections.
- D. Refer to requirements of Division-26.

1.2 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. FCI Compliance: Test and rate "Y" type strainers in accordance with FCI 73-1 "Pressure Rating Standard for "Y" Type Strainers". Test and rate other type strainers in accordance with FCI 78-1 "Pressure Rating Standard for Pipeline Strainers Other than "Y" Type".

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions, and dimensioned drawings for each type of manufactured piping specialty. Include pressure drop curve or chart for each type and size of pipeline strainer. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.
- B. Shop Drawings: Submit for fabricated specialties, indicating fabrication, materials, and method of support.
- C. Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured piping specialty. Include this data, product data, and shop drawings in maintenance manual.

PART 2 - PRODUCTS

2.1 PIPING SPECIALTIES

- A. General: Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or if not indicated, provide proper selection to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections.

2.2 PIPE ESCUTCHEONS

- A. General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.
- B. Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.

2.3 LOW PRESSURE Y-TYPE PIPELINE STRAINERS

- A. General: Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125 psi (850 kPa) working pressure, with Type 304 stainless steel screens, with perforations as follows:
 - 1. Piping 2" (50 mm) and Smaller: 1/32" (.8 mm) diameter perforations.
 - 2. Piping 2-1/2" (65 mm) and Larger: 3/64" (1.2 mm) diameter perforations for water systems and 1/16" diameter perforations for steam systems.
- B. Threaded Ends, 2" (50 mm) and Smaller: Brass body, screwed screen retainer with centered blowdown fitted with valve and pipe plug.
- C. Threaded Ends, 2-1/2" (65 mm) and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with valve and pipe plug.
- D. Flanged Ends, 2-1/2" (65 mm) and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with valve and pipe plug.
- E. Butt Welded Ends, 2-1/2" (65 mm) and Larger: Schedule 40 cast carbon steel body, bolted screen retainer with off-center blowdown fitted with valve and pipe plug.

2.4 DIELECTRIC FITTINGS

- A. General: Provide assembly or fitting having insulating material to isolate dissimilar metals to prevent galvanic action and stop corrosion.
 - 1. Dielectric-Flange Insulation 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.

- a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (1035 kPa or 2070 kPa) minimum working pressure to suit system pressures.
2. Dielectric Nipples: Electroplated steel nipple, having inert and non-corrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig (2070 kPa) working pressure at 225°F (107°C) temperature.
3. Dielectric unions shall NOT be acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

- A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration thru floors, walls, partitions, and ceilings where penetration is exposed to view. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.
- B. Y-Type Strainers: Install Y-type strainers full size of pipeline, in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff valve in strainer blow down connection, full size of connection, except for strainers 2" (50 mm) and smaller installed ahead of control valves feeding individual terminals. Where indicated, provide drain line from shutoff valve to drain, full size of blow down connection.
 1. Locate Y-type strainers ahead of the following equipment, and elsewhere as indicated, if integral strainer is not included in equipment:
 - a. Temperature control valves
- C. Dielectric Fittings: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.

END OF SECTION 230515

SECTION 230519 - METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of meters and gauges required by this section is indicated on drawings and/or specified in other Division-23 sections.
- B. Types of meters and gauges specified in this section include the following:
 - 1. Pressure Gauges and Fittings:
 - a. Pressure Gauges
 - b. Pressure Gauge Cocks
 - c. Pressure Gauge Connector Plugs
 - d. Magnehelic Pressure Gauges
 - 2. Flow Measuring Meters:
 - a. Flow Meter Fittings
 - b. Flow Measuring Readout Kit
- C. Meters and gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division-23 sections.

1.2 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.
 - 2. ANSI and ISA Compliances: Comply with applicable portions of American National Standards Institute (ANSI) and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.
- B. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.
- B. Maintenance Data: Submit maintenance data and spare parts lists for each type of meter and gauge. Include this data in Maintenance Manual.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

- A. General: Provide pressure gauges of materials designed and constructed for use in service indicated.
- B. Type: General use, 1% accuracy, ANSI B 40.1 Grade A, phosphor bronze bourdon type, bottom connection.
- C. Case: Drawn steel or brass, glass lens, 5" (125 mm) diameter. For gauges mounted above eight feet (2400 mm), 8" (200 mm) gauges shall be used.
- D. Connector: Brass with 1/4" (6 mm) male NPT. Provide protective syphon when used for steam service.
- E. Scale: White coated aluminum, with permanently etched markings.
- F. Range: Conform to the following:
 - 1. Water: 0 - 100 psi (0 - 690 kPa).

2.2 PRESSURE GAUGE COCKS

- A. General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Construct gauge cock of brass with 1/4" (6 mm) female NPT on each end, and "T" handle brass plug.
- B. Syphon: 1/4" (6 mm) straight coil constructed of brass tubing with 1/4" (6 mm) male NPT on each end.
- C. Snubber: 1/4" (6 mm) brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.
- D. Manufacturer: Same as for pressure gauges.

2.3 PRESSURE GAUGE CONNECTOR PLUGS

- A. General: Provide pressure gauge connector plugs pressure rated for 500 psi (3448 kPa) and 200°F (93°C). Construct of brass and finish in nickel plate, equip with 1/2" (13 mm) NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" (3 mm) O.D. probe assembly from dial type insertion pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

2.4 MAGNEHELIC PRESSURE GAUGES

- A. Provide direct reading magnehelic gauges indicating pressure drop across each cleanroom doors, filter assemblies or air system components. The inlet and outlet of filter assembly shall be

provided with remote dial type gauges of suitable ranges.

1. Gauges measuring pressure differential across doors shall be capable of measuring -0.25" wc to +0.25" (-62 Pa to +62 Pa) .
2. Gauges measuring pressure differential at air handling units or exhaust fans shall be capable of measuring suitable ranges. Contractor shall submit locations, design pressure and gauge ranges for review by COR and Engineer.
3. Where existing gauges are replaced install new shutoff and vent valves and each connection point to magnehelic gauge. All existing tubing shall be cleaned and cleared of obstructions. Any existing tubing deemed damaged shall be replaced to match existing.

2.5 FLOW METER FITTINGS

- A. Furnish and install venturi flow metering elements at each balancing valve location indicated on plans and drawings. Elements 2" (50 mm) and smaller shall be constructed of brass with threaded connections, 2-1/2" (65 mm) and larger shall be constructed of steel with butt weld or flanged connections.
- B. Each primary element shall be selected to permit the design flow rate to fall between 20% to 80% of the full range on the linear scale of the meter. The permanent pressure loss shall not exceed 10% of the indicated flow rate differential.
- C. The accuracy shall be $\pm 3\%$ of flow rate in the flow range indicated on the tabulation as verified by a recognized Independent Laboratory specializing in the research, testing and application of fluid meters, valves and hydraulics.
- D. Each element shall be complete with instrument shut-off valves each with quick disconnect connections and identification tag with a chain, pressure rated to 300 psi (2069 kPa), temperature rated to 250°F (121°C).
- E. Flow meter fittings shall be as manufactured by Preso, Flow Design or Flowset.

2.6 FLOW MEASURING READOUT KIT

- A. Provide portable flow meters with bellows type differential pressure element and minimum 5" (125 mm) diameter indicating dial.
- B. Design pressure elements for full scale pressure differential of 50" or 100" water gauge (12.4 kPa or 24.9 kPa). Design shall incorporate rupture-proof metal beryllium or stainless steel bellows and torque tube drive requiring no lubrication. Design forged bodies for not less than 150% of maximum surge pressure, fully protected against surges, with full provision for venting and draining. Provide integral, adjustable pulsation dampers.
- C. Dials of portable meters shall have square root scales not less than 12" (300 mm) in developed length. Dials shall read from 0 to 10 gpm (0 to .6 L/s) to which multiplier is to be applied, as required; also provide with uniform scale reading from 0" to 10" w.g. (0 kPa to 2.5 kPa), to which multiplier of 10 is to be applied (100" at full scale) (2.5 m at full scale), or from 0" to 5" w.g. (0 kPa to 1.2 kPa), to which multiplier of 10 is to be applied (50" at full scale) (2.5 m at full scale).

- D. Engineer and manufacture in accordance with ASME recommendations for flow meters. Provide portable meters with overall accuracy of $\pm 5\%$.
- E. Provide flow meter with factory-fabricated carrying case with integral carrying handle. Case shall be fitted to hold meter and following accessories:
 - 1. Two 10' (3 m) lengths of connecting hose with suitable female connectors for connecting to venturi tube pressure tap nipples. Design hose for operating pressure of minimum of 150% of maximum system operating pressure.
 - 2. Completely assembled 3-valve manifold with 2 block valves and vent and drain valves shall be piped and mounted on base, which shall be designed for use laying flat on stationary base.
 - 3. Bound set of descriptive bulletins, installation and operating instructions, parts list, and set of curves showing flow verses pressure differential for each orifice or venturi tube with which meter is to be used.
 - 4. Metal instruction plate, secured inside cover, illustrating use of meter. Deliver meter with case to COR.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which meters and gauges are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TEMPERATURE GAUGES

- A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor.
- B. Locations: Install direct mounted thermometers in the following locations, and elsewhere as indicated:
 - 1. At inlet and outlet of each hydronic coil if replaced.
 - 2. Supply, return, fresh air and mixed air for each air handling unit.
- C. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical upright position. Fill well with oil or graphite, secure cap.

3.3 INSTALLATION OF PRESSURE GAUGES

- A. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position.
- B. Locations: Install in the following locations, and elsewhere as indicated:
 - 1. At inlet and outlet of each coil.

- C. Pressure Gauge Cocks: Install in piping tee with snubber. Install syphon for steam pressure gauges.
- D. Pressure Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

3.4 ADJUSTING AND CLEANING

- A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.
- B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked or broken windows and repair any scratched or marred surfaces with manufacturer's touch-up paint.

END OF SECTION 230519

SECTION 230523 - VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of valves required by this section is indicated on drawings and/or specified in other Division-23 sections.
- B. Types of valves specified in this section include the following:
 - 1. Drain Valves
 - 2. Ball Valves
 - 3. Butterfly Valves
 - 4. Check Valves
- C. System Descriptions:
 - 1. HVAC Piping: HVAC piping shall relate to heating water systems.
- D. Valves furnished as part of factory-fabricated equipment, are specified as part of the equipment assembly in other Division-23 sections.

1.2 QUALITY ASSURANCE

- A. Valve Types: Provide valves of same type by same manufacturer.
- B. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating and size clearly marked on valve body.
- C. Codes and Standards:
 - 1. MSS Compliance: Mark valves in accordance with MSS-25 "Standard Marking System for Valves, Fittings, Flanges and Unions".
 - 2. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged or welded-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves".

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing manufacturer's figure number, size, location, and valve features for each required valve.
- B. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

- C. Maintenance Data: Submit maintenance data and spare parts lists for each type of valve. Include this data, product data, and shop drawings in Maintenance Manual.

PART 2 - PRODUCTS

2.1 VALVES - GENERAL

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work, shall be limited to the following, unless otherwise noted:
 - 1. Milwaukee
 - 2. Bray
 - 3. Apollo
 - 4. DeZurik
 - 5. Jamesbury
 - 6. Watts
- B. Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by Installer to comply with installation requirements. Provide end connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.
- C. Size: Unless otherwise indicated, provide valves of same size as upstream pipe size. Pipe size reduction shall be made after valve assembly.
- D. Valve Features: Provide the following as required:
 - 1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features as determined by Installer for installation requirements. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
 - 2. Bypass: Comply with MSS SP-45, and except as otherwise indicated, provide manufacturer's standard bypass piping and valving.
 - 3. Drain: Comply with MSS SP-45, and provide threaded pipe plugs.
 - 4. Flanged: Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5, (steel), or ANSI B16.24 (bronze).
 - 5. Threaded: Valve ends complying with ANSI B2.1.
 - 6. Butt-Welding: Valve ends complying with ANSI B16.25.
 - 7. Socket-Welding: Valve ends complying with ANSI B16.11.
 - 8. Solder-Joint: Valve ends complying with ANSI B16.18.
 - 9. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves 6" (150 mm) and smaller. Provide chain-operated sheaves and chains for overhead valves as indicated.

2.2 DRAIN VALVES

A. HVAC Piping:

1. 3" (75 mm) and Smaller: Class 125, bronze body ball valve with chrome plated ball, hose end with cap and chain. Milwaukee BA100H (Threaded), Milwaukee BA150H (Sweat) or equivalent.

2.3 BALL VALVES

A. Comply with the following standards:

1. Bronze Valves: MSS SP-110.

B. HVAC Piping:

1. 2" (50 mm) and Smaller: Valves shall be rated 150 psi (1035 kPa) SWP and 600 psi (4140 kPa) non-shock WOG and shall have 2-piece cast ASTM B 584 bronze bodies, TFE seats, standard port, separate packing nut with adjustable stem packing, anti-blowout stems and stainless steel ball. Valve ends shall have full depth ANSI threads or extended solder connections and be manufactured to comply with MSS-SP110. Milwaukee BA100S (Threaded), BA150S (Sweat) or equivalent.

- C. Where piping is insulated, ball valves shall be equipped with 2" (50 mm) extended handles of non-thermal conductive material. Also, provide a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation. Memory stops, which are fully adjustable after insulation is applied, shall be included.

2.4 BUTTERFLY VALVES

- A. General: Comply with MSS SP-68. Where butterfly valves are used as shutoffs for terminal or equipment removal or repair, select bubble tight, lug body type valves suitable for dead end service.

B. HVAC Piping:

1. 2-1/2 " (65 mm) to 6" (150 mm): 150 psi (1035 kPa), carbon steel or 316 stainless steel body, extended neck, 316 stainless steel disc, single piece RPTFE seat with stainless steel spring insert, self-lubricating bearings, double shaft and manual lever and lock. Milwaukee Model HP1LCS4212 or equivalent.
2. All valves shall be capable of bubble tight dead end service in either direction without use of additional pinning, screws or mating flanges.
3. Valves shall have pressure energized type seats of RPTFE with seat energizing insert. EPDM rubber seats are not acceptable. Seats shall be field replaceable.
4. Provide packing gland with "V" type ring packing, externally adjustable. Packing gland, nuts and studs shall be constructed of stainless steel.

2.5 CHECK VALVES

A. Comply with the following standards:

1. Cast-Iron Valves: MSS SP-71.
2. Bronze Valves: MSS SP-80.
3. Steel Valves: ANSI B16.34.

B. HVAC Piping:

1. 2" (50 mm) and Smaller: Class 150, bronze body, horizontal swing, T pattern with renewable TFE disc. Milwaukee 510T (Threaded), 1510T (Sweat) or equivalent.
2. 2-1/2" (65 mm) and Larger: Class 125, iron body, bolted bonnet, horizontal swing, renewable seat and disc, flanged ends. Milwaukee F2974A or equivalent.

2.6 BALANCE VALVES

- ### A. HVAC: See Division-23 section "Hydronic Specialties" for HVAC balance valve specification, however all valves shall meet the requirements of this Section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Except as otherwise indicated, comply with the following requirements.

1. Install valves where required for proper operation of piping and equipment, including valves in branch lines, service mains and all equipment connections. Locate valves so as to be accessible and so that separate support can be provided when necessary.
2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.

B. Insulation: Where insulated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with connections to match pipe fittings.

D. Renewable Seats: Install valves with renewable seats, where applicable.

E. Fluid Control: Except as otherwise indicated, install gate, ball, globe, and butterfly valves to comply with ANSI B31.9. Where throttling is indicated or recognized as principle reason for valve, install ball, globe or butterfly valves, as indicated.

F. Installation of Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.

3.2 ADJUSTING AND CLEANING

- A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.
- B. Valve Identification: Tag each valve in accordance with Division-23 section "Identification for HVAC Piping and Equipment".
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of hangers and supports required by this section is indicated on drawings and/or specified in other Division-23 sections.
- B. Types of hangers and supports specified in this section include the following:
 - 1. Horizontal-Piping Hangers and Supports
 - 2. Hanger-Rod Attachments
 - 3. Saddles and Shields
 - 4. Spring Hangers and Supports
- C. Hangers and supports furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division-23 sections.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of hangers and supports, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
 - 1. Code Compliance: Comply with applicable codes pertaining to product materials and installation of hangers and supports.
 - 2. NFPA, UL, and FM Compliance: Provide products which comply with NFPA 13 listed and labeled by UL and FM where used for fire protection piping systems.
 - 3. MSS Standard Compliance:
 - a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
 - b. Select and apply pipe hangers and supports, complying with MSS SP-69.
 - c. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
 - d. Terminology used in this section is defined in MSS SP-90.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing manufacturer's figure number, size, location, and features for each required pipe hanger and support.

PART 2 - PRODUCTS

2.1 HORIZONTAL-PIPING HANGERS AND SUPPORTS

- A. General: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with MSS SP-58, selected by Installer to suit horizontal-piping systems in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems. To avoid future electrolysis or corrosion, copper plated hangers, supports, clamps, rod attachments, and building attachments shall not be in direct contact with copper piping. A separation material shall be installed between the pipe and the copper plated hanger, support, clamp, etc. The separation material shall prohibit electrical conductance and prevent galvanic action or corrosion between dissimilar metals. Separation material shall be guaranteed for a minimum of thirty (30) years.

2.2 HANGER-ROD ATTACHMENTS

- A. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems. To avoid future electrolysis or corrosion, copper plated hangers, supports, clamps, rod attachments, and building attachments shall not be in direct contact with copper piping. A separation material shall be installed between the pipe and the copper plated hanger, support, clamp, etc. The separation material shall prohibit electrical conductance and prevent galvanic action or corrosion between dissimilar metals. Separation material shall be guaranteed for a minimum of thirty (30) years.

2.3 SADDLES AND SHIELDS

- A. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

2.4 SPRING HANGERS AND SUPPORTS

- A. General: Except as otherwise indicated, provide factory-fabricated spring hangers and supports complying with MSS SP-58, selected by Installer to suit piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which hangers and supports are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- C. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.
- D. Provisions for Movement:
 - 1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
- E. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- F. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum

pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.

G. Insulated Piping: Comply with the following installation requirements.

1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.
2. Shields: Where low-compressive-strength insulation or vapor barriers are indicated on chilled water piping, install coated protective shields.
3. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.
4. For all insulated piping 2-1/2" (63 mm) and larger, provide insulated saddles as follows:
 - a. For heating water, provide the following:
 - i. Minimum 3.5 pcf, non-compressive, rigid, phenolic foam insulation. Fire and smoke rating shall be 25/50 or below per ASTM 84.
 - ii. The phenolic foam system shall have a K factor of 0.16 at a mean temperature for 75°F (24°C) and comply with ASTM Standard C1126.
 - iii. Provide visible inspection sticker at the bottom of each saddle.
 - iv. Pipe insulation saddles shall be Tru-Balance CoolDry Saddles as manufactured by Buckaroos, Inc. or equivalent.

H. Spacing: Hanger spacing for piping shall not exceed 8 feet (2400 mm) on centers for pipe 1-1/4" (32 mm) or smaller, and 10 feet (3 m) for pipe 1-1/2" (40 mm) and larger. Regardless of spacing, hangers shall be provided at or near all changes in direction, both vertical and horizontal, for all piping. For cast iron soil pipe, one hanger shall be placed at each hub or bell.

3.3 ADJUSTMENT OF HANGERS AND SUPPORTS

- A. Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

3.4 PAINTING

- A. All hangers, supports, clamps and assemblies shall be primed and painted with rust inhibitors.

END OF SECTION 230529

SECTION 230548 - VIBRATION ISOLATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: The extent of vibration isolation work to be provided under this Contract is covered by the requirements of this Section, all other Division-23 sections and the Contract Drawings including structural, architectural, mechanical and electrical which identify equipment and systems requiring vibration isolation treatment.
- B. Types: Types of vibration isolation equipment and systems specified in this Section include:

<u>TYPE</u>	<u>DESCRIPTION</u>
2I Isolator	Neoprene-In-Shear Type
2H Hanger	Rubber-In-Shear Type
3H Hanger	Combination Spring and Neoprene Type

- C. Selection of Isolators: Provide isolators selected by a vibration isolator equipment specialist.
1. Conform to isolator types herein specified.
 2. Examine the contract drawings for sizes, equipment location and construction type to determine the isolator selection type and deflection required for each piece of mechanical equipment.
 3. Conform to the requirements of the most current edition of American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Handbook, "HVAC Applications", Sound and Vibration Control.

1.2 QUALITY ASSURANCE

- A. Codes: At a minimum, conform to the most current edition of ASHRAE Handbook, "HVAC Applications".
- B. Manufacturer: Isolators of the same type shall be the product of the same manufacturer. The manufacturer shall publish and maintain a full line of materials, engineering and application data and operating and maintenance instructions.

1.3 SUBMITTALS

- A. Contractor's Certification: Vibration isolator submittals shall include a certification, signed by an officer representing the Contractor and stipulating that the submittal prepared by the manufacturer has been reviewed, and checked on an item by item basis against each piece of mechanical equipment, shown or specified in the Contract Documents, which requires vibration isolation.

- B. Manufacturer's Certification: The manufacturer or manufacturers (if there are more than one) shall each certify that the selections of vibration isolation equipment are based upon the drawings and specifications, and that each piece of mechanical equipment has been examined for equipment type, mounting location, and supporting span, and that an appropriate isolator has been selected.
- C. Product Data: Furnish manufacturer's product data covering each isolator type for style, characteristic, and finish.
 - 1. Isolator quantities, dimensions, deflections, capacities and types shall remain the responsibility of the manufacturer and the Contractor.
- D. Shop Drawings: Where coordinated shop drawings are required, provide layout drawings, drawn to a scale of not less than 1/4-inch to 1-foot (6 mm to 300 mm), showing the proposed layout of equipment and piping systems and the location and type of each vibration isolation device.
 - 1. Carefully examine other sections requiring coordinated shop drawings and prepare isolation shop drawings to the same scale showing the location of each vibration isolation equipment base, pipe hanger, flexible connection, and isolator.

1.4 STORAGE AND PROTECTION

- A. Storage: Store vibration isolation equipment indoors in the manufacturer's original shipping containers. Preclude the entrance of construction dirt and debris.
 - 1. Vibration isolation equipment and bases, which show signs of rust, cement or concrete fouling, dirt and construction debris shall be disassembled and cleaned, approved or removed from the project site and replaced with new.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include the following:
 - 1. Mason
 - 2. Vibration Eliminator Co.
 - 3. Kinetics Noise Control

2.2 ISOLATOR TYPES

- A. Type 2I Isolators: Provide double rubber-in-shear or elastomer-in-shear with molded-in steel reinforcement in the top and bottom portions.
 - 1. Deflections shall be limited to 0.5 inches (13 mm) or less.
 - 2. Steel bases shall be drilled with mounting holes and equipment mounting points shall be threaded male or female connections.

3. Treat resilient material with antiozone and antioxidant additives.
- B. Type 2H Hangers: Provide rubber-in-compression suspension hangers, consisting of a formed steel frame and elastomer isolation element and provided with attachments for top and bottom suspension rods.
 1. Design for a minimum 200 percent overload without noticeable deformation or failure.
 2. Metal components shall be galvanized or factory painted.
- C. Type 3H Hangers: Provide combination spring and elastomer hangers consisting of a formed steel frame with coil spring and elastomer insert in compression.
 1. Design hangers to be capable of supporting a 200 percent overload without noticeable deformation or failure.
 2. Design hangers to allow a 30 degree misalignment without binding or a reduction in hanger efficiency.
 3. Design hangers for connection to equipment and supporting rods.

2.3 PIPING AND DUCTWORK

- A. General: All ductwork and piping in mechanical equipment rooms and within fifty feet (15 m) of the vibration source (i.e. mechanical equipment such as air handling units, chillers, pumps, cooling towers, air compressors, etc.) shall be isolated from the building structure with flexible vibration isolators. Air handling units with less than two inches (500 Pa) of external static pressure shall be excluded from this requirement.
 1. Suspend ductwork on Type 3H hangers.
 2. Suspend piping on Type 3H hangers.
 3. Floor-mounted ductwork and piping shall be supported with Type 4 spring isolators with deflections the same as the equipment to which the piping is attached.
- B. Risers: Pipe and duct risers within 100 feet (30 m) of mechanical equipment rooms shall be resiliently anchored to the building structure with Type 1 vibration isolators, near the midpoint of the risers.
 1. Risers shall be isolated and supported at each second floor with pairs of Type 3H hangers, having deflections a minimum of five times the anticipated thermal movement at the support point.
 2. Risers shall be guided as required with four (4) sets of Type 2I vibration isolators.
 3. Provide flexible neoprene or canvas connectors as specified in sheet metal ductwork at the connection point to all air moving equipment.
 4. Support ductwork with an internal pressure exceeding 3 inches (750 Pa) water with Type 3H hangers on maximum 10 foot (3 m) centers with deflections equal to the equipment isolators.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Manufacturer: All vibration isolation equipment shall be installed in accordance with the manufacturer's recommendations.
- B. Manufacturer's Representative: The vibration isolation installation and deflection testing after equipment start-up shall be conducted by a representative of the manufacturer.

3.2 TESTS AND REPORTS

- A. Testing: Each vibration isolation device shall be deflection tested. Two (2) copies of a bound report shall be submitted prior to final acceptance. The certification shall include the following:
 - 1. Certify that equipment has been isolated in accordance with Contract Drawings, specifications and submittals.
 - 2. Certify that all minimum specified deflections have been equaled or exceeded.

3.3 CLEANING

- A. Debris: Remove all debris from under equipment, and thoroughly clean steel bases and check for free movement of existing equipment.
- B. Adjustment: Adjust isolators as required for proper operation prior to starting equipment. Testing of vibration isolators shall be performed by a certified representative of the manufacturer as specified.

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of mechanical identification work required by this section is indicated on drawings and/or specified in other Division-23 sections.
- B. Types of identification devices specified in this section include the following:
 - 1. Pipe and Duct Markers
 - 2. Painted Identification Materials
 - 3. Valve Tags
 - 4. Valve Schedule Frames
 - 5. Engraved Plastic-Laminate Signs
 - 6. Plastic Equipment Markers
 - 7. Plasticized Tags

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
 - 1. ANSI Standards: Comply with ANSI A13.1 or Government's standards for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Schedules: Submit valve schedule replaced valves for each piping system, typewritten and reproduced on 8-1/2" x 11" (213 mm x 275 mm) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for maintenance manuals.
- C. Maintenance Data: Include product data and schedules in maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers' products which may be incorporated in the work include the following:
 - 1. Brady
 - 2. Seton
 - 3. Bunting

2.2 MECHANICAL IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-23 sections. Where more than single type is specified for application, selection is Installer's option but provide single selection for each product category.

2.3 PIPE AND DUCT MARKERS

- A. Snap-on Type: Provide pre-printed, semi-rigid, snap-on color coded identification sleeves complying with ANSI A13.1. This type shall be used for insulated pipe sizes 2" and smaller.
- B. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive, vinyl markers conforming to ANSI A13.1. This style marker shall be applied to all uninsulated piping; insulated piping 2-1/2" and larger, and all ductwork.
- C. Flow Direction: Provide flow directional arrows either as part of markers, or separately attached to pipes and ducts.
- D. Duct System Identification: Markers shall identify ductwork system and system subcategory, duct size, associated branch damper as well as associated fan.

2.4 PAINTED IDENTIFICATION MATERIALS

- A. Piping and Equipment Systems: Continuous color coded painting of piping and equipment shall be provided in all mechanical rooms in compliance with ANSI A13.1.

2.5 VALVE TAGS

- A. Brass Valve Tags: Provide 19-gage (1.2 mm) polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" (6 mm) high letters and sequenced valve numbers 1/2" (13 mm) high, and with 5/32" (4 mm) hole for fastener.
 - 1. Provide 1-1/2" (40 mm) diameter tags, except as otherwise indicated.
- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded

type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

2.6 VALVE SCHEDULE FRAMES

- A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with lexan.
 - 1. Locate one schedule where directed. Provide second schedule to COR framed in rigid plastic frame with rigid plastic glazing.

2.7 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - 1. Thickness: 1/16" (1.6 mm) for units up to 20 sq. in. (12900 mm²) or 8" (200 mm) length; 1/8" for larger units.
- B. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
- C. Duty: Accident-prevention tags with appropriate wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.8 PLASTIC EQUIPMENT MARKERS

- A. General: Provide manufacturer's standard laminated plastic, color coded equipment markers.
- B. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
 - 1. Name and schedule number
 - 2. Equipment service

2.9 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in mechanical identification work with corresponding designations shown on plans. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- B. Where existing identification is applied, remove and apply new identification based on approved template.

3.2 DUCTWORK IDENTIFICATION

- A. General: Identify air supply, return, exhaust, intake and relief ductwork with pressure sensitive markers and arrows, showing ductwork service, associated fan or air handling unit and direction of flow. Identification shall be applied to all exhaust terminations within cleanroom and basement indicating associated exhaust fan, exhaust system, direction of flow, associate branch damper and duct size. Identification shall be applied to all exhaust air valves and air flow monitoring stations, indicating air system, associated fan and equipment number.
- B. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft or similar concealment), and at 25 foot (7500 mm) spacings.
- C. Access Doors: Provide duct markers on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.

3.3 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
- B. Locate pipe markers as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) exterior non-concealed, locations, and concealed gas piping.
 - 1. Near each valve and control device.
 - 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 - 4. At access doors, manholes and similar access points which permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced intermediately at maximum spacing of 25 feet (7500 mm) along each piping run.

3.4 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory fabricated equipment units, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
 - 1. Tagging Schedule: Comply with requirements of "Valve Schedule" of this section.

3.5 MECHANICAL EQUIPMENT IDENTIFICATION

- A. General: Install engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - 1. Exhaust Terminal Unit
 - 2. Air Flow Measuring Station & Associated Readout.
- B. Lettering Size: Minimum 1/4" (6 mm) lettering for name of unit where viewing distance is less than 2'- 0" (600 mm - 0 mm), 1/2" (13 mm) high for distances up to 6'- 0" (1800 mm - 0 mm), and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
- C. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.6 ADJUSTING AND CLEANING

- A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.7 EXTRA STOCK

- A. Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.

3.8 IDENTIFICATION SCHEDULE

SERVICE

Outside Air

DESIGNATION

OA

Makeup Air	MA
Supply Air	SA
Exhaust Air (Acid)	EA (Acid)
Exhaust Air (Hydride)	EA (Hydride)
Exhaust Air (Solvent)	EA (Solvent)
Exhaust Air (General)	EA (General)
Exhaust Air (Vacuum)	EA (Vacuum)
Exhaust Air (Gas Cabinet)	EA (Gas Cabinet)
Vacuum	VAC
Heating Water Supply	HS
Heating Water Return	HR

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of testing, adjusting, and balancing (TAB) work required by this section is indicated on drawings and schedules, and by requirements of this section, and is defined to include, but is not necessarily limited to, air distribution systems, hydronic distribution systems, and associated equipment and apparatus of mechanical work. The work consists of setting speed and volume (flow), adjusting facilities provided for systems, recording data, conducting tests, preparing and submitting reports to achieve the capacities or setpoints indicated on the contract documents, and recommending modifications to work as required to achieve the capacities or setpoints indicated on the contract documents.
- B. Component types of testing, adjusting, and balancing specified in this section shall include, but not be limited to, the following as applied to mechanical equipment:
 - 1. Building automated systems
 - 2. Fans
 - 3. Air handling units
 - 4. Ductwork systems
 - 5. Piping systems
 - 6. Terminal units
 - 7. Air devices
 - 8. Fume hoods
- C. Refer to requirements of Division-26.
- D. See drawings for pre-demolition testing requirements (where applicable).

1.2 QUALITY ASSURANCE

- A. Tester's Qualifications: A firm certified by Associated Air Balance Council (AABC) who is not Installer of system to be tested.
 - 1. AABC Compliance: Comply with the current AABC's Manual "AABC National Standards", as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus.
 - 2. Industry Standards: Comply with AABC recommendations pertaining to measurements, instruments, and testing, adjusting, and balancing, except as otherwise indicated.
 - 3. ASHRAE Standard 111: Comply with current edition of ASHRAE 111, "Measurement, Testing, Adjusting and Balancing of HVAC Systems".
 - 4. Independence: TAB contractor shall be independently owned and operated with no affiliation with the general contractor, mechanical contractor, sheet metal contractor, design engineer, etc.
 - 5. Experience: Each technician shall demonstrate a minimum of three years of actual test and

balance field experience.

- B. Pipe Testing Procedures: Contractor shall pressure test all piping systems in accordance with the following:
 - 1. ASME Code for Pressure Piping B31, most current edition.
 - 2. National Fire Protection Association (NFPA), all applicable sections, most current edition.

1.3 SUBMITTALS

- A. Qualification: TAB contractor qualifications shall be provided as a formal submittal for review to demonstrate conformance with all qualifications indicated throughout the contract documents.
- B. Submit certified test reports, signed by the AABC Test and Balance technician who performed the TAB work. In addition, the report shall be certified by an AABC certified Test and Balance Engineer (T.B.E.) who is familiar with the project.
 - 1. Include identification and types of instruments used, and their most recent calibration date with submission of final test report.
- C. The Contractor shall maintain a copy of AABC standards on the site during all TAB work. Said document(s) shall be made available to COR for reference as to minimum requirements.
- D. Maintenance Data: Include in maintenance manuals, copies of certified test reports, identification of instruments.

1.4 JOB CONDITIONS

- A. Do not proceed with testing, adjusting, and balancing work until work has been completed, tested, operable, and all balancing devices indicated on the contract documents have been installed. Ensure that there is no residual work still to be completed on the equipment to be tested.
- B. Do not proceed until work scheduled for testing, adjusting, and balancing is clean and free from debris, dirt and discarded building materials.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

- A. Except as otherwise indicated, use same products as used by original Installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes.
 - 1. Factory fabricated plastic plugs shall be used to patch drilled holes in ductwork and housings.

2.2 TEST INSTRUMENTS

- A. Utilize test instruments and equipment for TAB work required, of type, precision, and capacity as recommended in the following TAB standards:
 - 1. AABC's Manual "AABC National Standards".
 - 2. Wherever permanently installed measuring equipment is provided, such as air volume monitors, flow meters, temperature and pressure gages, etc., these shall be used in addition to TAB instrumentation. Any discrepancies in accuracy shall be brought to the attention of the COR. Where permanently installed instrumentation meets accuracy requirements for TAB work, they may be used provided TAB Contractor can verify calibration of installed instruments.
- B. The Contractor shall employ manufactured enclosure type cones, capable of air volume direct readings, for all diffuser air flow measurements.

PART 3 - EXECUTION

3.1 FIELD WORK

- A. Prior to the mechanical installation, the mechanical and TAB contractors shall review the design documents for "balanceability" to confirm that all devices required to properly balance each system are to be provided under this contract. Recommended modifications and/or additions shall be made directly to the engineer and a minimum of 30 days prior to the installation of mechanical equipment.
- B. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned, operable and accessible. Do not proceed with TAB work until unsatisfactory conditions have been corrected.
- C. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable AABC standards. All systems and components shall be balanced within $\pm 5\%$ of design air and water flows.
- D. For fan systems, provide sheave replacements where required to achieve specified air flows.
- E. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in manner recommended by original Installer.

3.2 REPORTS

- A. Prepare report of test results, including instrumentation calibration reports, in format recommended by AABC standards. Provide a System Summary page(s) at the front of the report.
- B. An interim/preliminary handwritten report shall be submitted to the Engineer for review prior to the formal submission of the report.
- C. Test reports shall include, but not be limited to, the following information:

1. Air Handling Equipment Test:
 - a. Air handling equipment shall include, but not be limited to, all fans (supply, exhaust, return, make-up, etc.), air handling units, etc.).
 - b. Design Conditions: L/S, static pressure, motor h.p., outside air L/S (where applicable), fan and motor RPM and fan motor h.p. for each fan.
 - c. Installed Equipment: Manufacturer, size, arrangement, class, motor h.p., volts, phase, cycles, and full load amps.
 - d. Field Test Results: Fan L/S, fan RPM, fan motor voltage, fan motor operating amps, fan motor operating b.h.p., total static pressure for each fan. In addition, where applicable provide external static pressure, air pressure drop across each coil, filter bank, attenuator, etc. (ie. provide total static pressure profile of each system), as well as leaving air temperature, outside air conditions (dry bulb/wet bulb) at time of test, coil flow data (L/S), coil entering and leaving air temperatures, coil entering and leaving water temperatures, coil water pressure drop, VFD settings at final test conditions, and duct static pressure setpoint. Air temperature difference measurements will not be acceptable.
2. Air Distribution Test: Main and major branch ducts and individual supply, return and exhaust terminals (VAV terminals, diffusers, registers and grilles):
 - a. Design Conditions: Ductwork: L/S, duct size. Air terminals, diffusers, registers, grilles: L/S, module size and inlet size.
 - b. Field Test Results: Ductwork: L/S, duct size, number of velocity readings, average velocity reading. Air terminals, diffusers, registers, grilles: L/S, module size and inlet size.
3. Miscellaneous Test Results:
 - a. All Coils: Air pressure drop, water pressure drop, water flow (L/S), air flow (L/S), entering water temperature, leaving water temperature, entering air temperature, leaving air temperature and outside air temperature at time of test (where applicable) and KW calculations. Air temperature difference methods will not be acceptable.
 - b. Air Flow Monitors (AFM): Provide verification of AFM accuracy including set-up and adjustment required to verify proper operation and accuracy of each AFM system.
 - c. Balance Valves: All balance valves (including hydronic) shall be adjusted and balanced to include water flow (L/S) and pressure drop (where applicable). Indicate manufacturer/model of each valve type.
4. Critical Space Pressurization: Spaces shall be balanced within $\pm 5\%$ of design airflow while also maintaining the airflow offset (supply versus exhaust) as indicated on the documents. In addition, provide room pressurization readings for all critical spaces (cleanrooms, gowning rooms, ante rooms. etc.). Readings shall be recorded in inches water column (in. w.c) to the thousandths decimal place as well as pascals (Pa).. Where magnehelic gauges are provided, the test and balance contractor shall provide independent readings of the room pressures and discrepancies between readings shall be reconciled by the contractor.
5. Fume Hood Testing:
 - a. As indicated within contract documents testing of laboratory fume hoods in the field shall be completed on a unit cost basis and shall be accomplished in strict conformance with ASHRAE 110-1995.
 - b. These tests should be performed under the following conditions:
 - i. Doors and windows in their normal positions.

- ii. Fume hood sash set in varying positions to simulate both static and dynamic performance.
 - c. Test procedures shall include, but not be limited to the following (where applicable):
 - i. Face velocity test for each fume hood:
 - a) The face velocity shall be 100 FPM unless indicated otherwise by the safety officer. Face velocity measurements shall be taken on a vertical/horizontal grid with each measurement point representing not more than 1 ft.². The measurements shall be taken with a device that is accurate in the intended operating range, and an instrument holder should be used to improve accuracy. Computerized multi-point grid measurement devices provide the greatest accuracy.
 - ii. Flow Visualization Test
 - iii. Tracer Gas Test
 - iv. Sash Movement Test
 - d. All tests shall be performed in accordance with the latest edition of ASHRAE Standard 110 by a certified testing agency under supervision of the Construction Manager or General Contractor.
- D. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced; including, where necessary, modifications which exceed requirements of contract documents for mechanical work.
- E. Record outdoor air temperature (dry bulb and wet bulb) at the time of testing air handling units, chillers, cooling towers, boilers and any other equipment where performance is affected by outdoor air conditions.
- F. Report shall include results of piping and ductwork tests indicated in paragraphs 3.03 and 3.04 of this section.

3.3 TESTS - PIPING

- A. Prior to the balancing of systems by the AABC certified balancing contractor, the mechanical contractor shall air and/or hydrostatically test the following systems in accordance with the latest ASME B31 (ASME Code for Pressure Piping) and NFPA requirements.
 - 1. Hydrostatic Test:
 - a. Heating Water Supply and Return Piping
- B. Pressure tests shall also be performed prior to the installation of all insulation materials.
- C. Hydrostatic Test: Provide temporary equipment for testing, including pump and gages. Test piping system before insulation is installed, wherever feasible and remove control devices before testing. Test each natural section of each piping system independently, but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.
 - 1. Required test period is four (4) hours.

2. Hydrostatically test each piping system at 150% of operating pressure indicated, but not less than 100 psi (690 kPa) test pressure.
 3. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds one percent (1.0%) of test pressure.
 4. Prior to testing, verify the pressures listed above are in accordance with the latest ASME B31 code and NFPA. Should a discrepancy exist between the ASME B31 code, NFPA, and/or the pressures indicated above, contact the Engineer prior to testing.
- D. Refer to Division-23 section "Testing, Adjusting and Balancing" for additional specific test criteria and test form to be completed.
- E. Drain test water from piping systems after testing and repair work has been completed.
- F. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
- G. Contractor shall submit piping leakage test results to the Engineer within 72 hours of completed tests. Only test results that meet the specified leakage requirements shall be submitted. Piping test results shall be recorded on the "Piping Leakage Test Summary Form (Hydronic and Air)" located at the end of this section; no other forms will be accepted. In addition, the pipe leakage submittals shall include 11x17 drawing(s) as required to clearly indicate the full extent of the piping test section (each piping test section shall be numbered and color coded).

3.4 TESTS - DUCTWORK

- A. Prior to the balancing of systems by the AABC certified balancing contractor, all high and low pressure systems shall be tested by the mechanical contractor for duct leakage. Duct leakage shall not exceed 1%. In addition, current SMACNA and AABC Standards shall apply, where applicable, to meet the maximum 1% leakage. Duct leakage shall not exceed 1% of design L/S for a duration of ten (10) minutes. Test pressures shall be not less than the following:
- Ductwork systems less than 2.0 in. wg E.S.P.:
- (Duct Pressure Class 2): Test to 2 in. wg
- Ductwork systems between 2.0 in. wg and 5.0 in. wg E.S.P.:
- (Duct Pressure Class 6): Test to 6 in. wg
- Ductwork systems greater than 5.0 in. wg E.S.P.:
- (Duct Pressure Class 10): Test to 15 in. wg
- B. Insulation materials shall not be applied until systems have been witnessed, documented, and submitted to meet the above testing requirements.
- C. The balance contractor shall witness and certify all duct pressure tests.
- D. Contractor shall submit duct leakage test results to the Engineer within 72 hours of completed

tests. Only test results that meet the specified leakage requirements shall be submitted. Duct test results shall be recorded on the attached "Air Duct Leakage Test Summary Form" at the end of this section; no other forms will be accepted. In addition, the duct leakage submittals shall include 11x17 drawing(s) as required to clearly indicate the full extent of the duct test section (each duct test section shall be numbered and color coded).

- E. All duct leakage test results shall be included with the final TAB report and the O&M manual. The orifice tube calibration chart shall also be included with the final duct leakage test report information.

3.5 TESTS - EQUIPMENT

- A. The contractor shall verify calibration of all indicating, recording, controlling and controlled devices throughout the mechanical system. Verify the proper function of all installed equipment and devices and the interlocking of all new systems as required by the contract documents.
- B. A report including successful calibration and function performance verification of all items indicated above shall be included in the Operations and Maintenance Manual.

3.6 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION

- A. General: In addition to the tests required during and after installation of all mechanical systems, as well as any other formal commissioning requirements, the Contractor shall perform functional performance tests to verify that all systems are designed, installed, calibrated and adjusted to perform as required in the Contract.
- B. Comply with all applicable specification sections including, but not be limited to, "Basic HVAC Requirements", "Testing, Adjusting and Balancing", "Automatic Temperature Controls" and "Commissioning", where applicable.
- C. Prior to functional performance testing, all indicating, recording and control devices shall be calibrated. A verification calibration report shall be provided with the final test report.
- D. Provide functional performance testing to verify proper operation of each and every control sequence indicated throughout the contract documents.
- E. Failure of Tests: Should any test, verification, or demonstration fail to meet the specification requirements, the component of the system causing the failure shall be repaired, replaced or readjusted. The failed test, verification, or demonstration shall then be repeated.
- F. A "Functional Performance Test Verification Form" is included at the end of Section 230900. This form (electronic version is available upon request) shall be completed for all mechanical equipment provided under this contract. This shall include, but not be limited to each air handling unit, fan, VAV terminal, etc.
- G. Test Report: Upon satisfactory verification of calibration and functional performance tests, a copy of the final test results shall be bound in the operations and maintenance manual. The final report shall also include a full compliance statement, on company letterhead, indicating that all systems are installed and functioning per the contract requirements including drawings, specifications,

control sequences and accepted submittals.

- H. The mechanical systems shall not be considered complete until all functional performance verification forms, calibration reports and compliance statement have been submitted and reviewed. Submit in accordance with the submittal requirements indicated elsewhere in these specifications.

3.7 FINAL TESTS, INSPECTION AND ACCEPTANCE

- A. At time of final inspection, Contractor shall recheck, in presence of COR, random selections of data (water and air quantities, air motion, and room pressurization) recorded in Certified Report. Laboratories shall be rechecked for satisfactory air flow and motion in vicinity of and through hoods.
 - 1. Points and areas for recheck shall be selected by COR.
 - 2. Measurement and test procedures shall be same as approved for work forming basis of Certified Report.
 - 3. Selection for recheck (specific plus random), in general, will not exceed 25 percent of total number tabulated in report, except that special air systems may require a complete recheck for safety reasons.
- B. Retests: If random tests elicit a measured flow deviation of 10 percent or more, greater than that recorded in Certified Report listings, at 10 percent or more of the rechecked selections, report shall automatically be rejected. In the event the report is rejected, systems shall be readjusted and tested, new data recorded, new Certified Reports submitted, and new inspection tests made, at no additional cost to the Government.
- C. Marking of Settings: Settings of valves, splitters, dampers, and other adjustment devices shall be permanently marked by the Contractor so that adjustment can be restored if disturbed at any time.

END OF SECTION 230593

AIR DUCT LEAKAGE TEST SUMMARY FORM

Project Name: _____ Project Number: _____ Page __ of __

DESIGN DATA						FIELD TEST DATA RECORD								
Duct Test Section (No./Color)	Air System	Total System L/S	Test Section L/S	Allowable Leakage %	Allowable Leakage L/S	Diameter		Pressure (Pa.)		Actual Leakage L/S	Actual Leakage %	Test Result Pass/Fail	Test Performed By (initials)	Test Witnessed By (initials)
						Orifice	Tube	Duct(1)	Across Orifice					
				1.0%										
				1.0%										
				1.0%										
				1.0%										
				1.0%										
				1.0%										
				1.0%										
				1.0%										
				1.0%										
				1.0%										
				1.0%										
				1.0%										
				1.0%										
				1.0%										

Testing Performed By: _____
(Company/Individual Name)

Witnessed/Certified By: _____
(Company/Individual Name)

(1) Duct test pressure shall be 1500 Pa. for High/Medium Pressure ductwork, or 500 Pa for Low Pressure ductwork.

PIPING LEAKAGE TEST SUMMARY FORM

(HYDRONIC AND AIR)

Project Name: _____ Project Number: _____ Page _____ of _____

System Tested	Sections Tested (1)	System Operating Pressure	Test Pressure (2)	Duration (3)	Pressure Drop (4)	Pass/Fail

Name of Testing Agency/Company: _____

Date of Test(s): _____

Test Conducted By (Print/Sign): _____

- (1) Identified by an 11 x 17 numbered and color coded test section plan. Plan shall accompany this test report.
- (2) 150% of operating pressure but not less than 690 kPa (hydronic).
- (3) Four (4) hours minimum.
- (4) Shall not exceed 1.0%.

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, by requirements of this section, and all other Division-23 sections.
- B. Types of mechanical insulation specified in this section include the following:
 - 1. Piping System Insulation:
 - a. Fiberglass
 - b. Flexible Elastomeric
 - 2. Ductwork System Insulation:
 - a. Fiberglass
 - b. Flexible Elastomeric
 - c. Polyisocyanurate

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Installer's Qualifications: Firms with at least five (5) years successful installation experience on projects with mechanical insulations similar to that required for this project. Provide installer's certification by the manufacturer's training program where applicable.
- C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories, and intended use for each mechanical system requiring insulation.
- B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work, shall be limited to the following:
 - 1. Owens Corning
 - 2. Johns Manville
 - 3. Certainteed
 - 4. Armacell
 - 5. Knauf
 - 6. Aeroflex

2.2 PIPE INSULATION MATERIALS

- A. Fiberglass Pipe Insulation: ASTM C 547, Type 1 (up to 850°F) (up to 454°C), maximum k-value of 0.23 BTU-in/hr-ft²-deg F at a mean temperature of 75°F.
- B. Flexible Elastomeric Pipe Insulation: ASTM C 534, Type I (-40°F to 200°F) (-40°C to 93°C), maximum k-value of 0.25 BTU-in/hr-ft²-deg F at a mean temperature of 75°F.
- C. Jackets for Piping Insulation: Jacket assembly shall be ASTM C 1136, Type I with vapor retarder (0.02 perms). All service jackets shall have a polymer coated exterior facing, shall resist water staining and shall not support mold or mildew growth. All service jackets shall be Owens Corning ASJ Max with SSLII closure system, or equivalent.
 - 1. All fittings shall be provided with pre-molded insulation with equivalent thickness and composition of insulation applied to the adjoining piping. Encase pipe fittings insulation with one-piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.
- D. Bands, Wires and Cement: As recommended by insulation manufacturer for applications indicated.
- E. Adhesives, Sealer, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

2.3 DUCTWORK INSULATION MATERIALS (INDOOR)

- A. Rigid Fiberglass Ductwork Insulation: ASTM C 612-00, Type 1A (up to 450°F) (up to 232°C), minimum k-value of 0.27 BTU-in/hr-ft²-deg F at a mean temperature of 75°F (24°C).
- B. Flexible Fiberglass Ductwork Insulation: ASTM C 553, Type I, maximum k-value of 0.27 BTU-in/hr-ft²-deg F or minimum "out of package" R-value of 6.7 at a mean temperature of 75°F. For ductwork in ceiling space directly below roof, provide insulation with maximum k-value of 0.25 and minimum "out of package" R-value of 8.0 (1.5 LBS/FT³ density).
- C. Flexible Elastomeric Duct Wrap Insulation ASTM C 534, Type II, R-value of 8.0 at 2", (-40°C to 93°C).
- D. Ductwork Insulation Accessories: Provide bands, wires, tape, anchors, corner angles, and similar accessories as recommended by insulation manufacturer for applications indicated.
- E. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Only install mechanical insulation on systems while not in operation.

3.2 HVAC PIPING SYSTEM INSULATION

- A. Insulation Omitted: Omit insulation on hot piping within radiation enclosures and air conditioning condensate piping in mechanical rooms and/or on roofs.
- B. Hot Piping (to 200 Degrees F) (to 93 Degrees C):
 - 1. Application Requirements: Insulate the following hot HVAC system (water piping up to 200°F) (water piping up to 93°C).
 - a. HVAC hot water supply and return piping.
 - 2. Insulate each piping system specified above with the following type and thickness of insulation:
 - a. Fiberglass: 1-1/2" (40 mm) thick for pipe sizes up to and including 1-1/4" (32 mm), 2" (50 mm) thick for pipe sizes 1-1/2" (40 mm) and larger.

3.3 DUCTWORK SYSTEM INSULATION

- A. Insulation Omitted: Do not insulate fibrous glass ductwork, or lined ductwork located inside the building.
- B. Cold Ductwork:
 - 1. Application Requirements: Insulate the following cold ductwork:
 - a. Unconditioned outdoor air intake ductwork between air entrance and fan inlet or HVAC unit inlet.
 - b. HVAC supply air ductwork from air handling unit/fan discharge to diffuser or register, including all duct accessories (sound attenuators, etc.).
 - c. HVAC conditioned outside air ductwork connected to DOAS (dedicated outside air) system from unit discharge to diffuser or register.
 - d. HVAC return ductwork located in ceiling directly adjacent to roof, including all duct accessories (sound attenuators, etc.).
 - e. HVAC plenums and unit housings..
 - f. Insulate neck and bells of supply diffusers.
 - g. External portions of air terminal (VAV, TRU's) heating coils.
 - 2. Insulate each ductwork system specified above with the following type and thickness of insulation:
 - a. Flexible Fiberglass: 2" (50 mm) thick with R-value of 6.7 (provide 2" thick with minimum R-value of 8.0 for supply ductwork located in ceiling space directly below roof), application limited to concealed locations.
 - b. Rigid Fiberglass: 2" (50 mm) thick, application limited to ductwork exposed to view, including mechanical rooms.
- C. Hot Ductwork (Above Ambient Temperature):
 - 1. Application Requirements: Insulate the following hot ductwork:
 - a. Hot supply and return ductwork between fan discharge, or heating unit discharge, and room diffuser/register; except omit insulation on return ductwork located in return air ceiling plenums.
 - b. Heating plenums and unit housings.
 - 2. Insulate each ductwork system specified above with the following type and thickness of insulation:
 - a. Flexible Fiberglass: 2" (50 mm) thick.

3.4 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
 - 1. Insulation materials shall not be applied until systems have been witnessed, documented, and submitted to meet pressure testing requirements indicated throughout these

specifications.

- B. Install insulation on pipe systems subsequent to installation of heat tracing, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Staples shall not be used.
- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Provide factory molded insulation or pre-fabricated fittings for all valves, fittings, unions, etc. Valve handles must be extended by the mechanical contractor to accommodate the insulation without reducing the thickness or integrity of the valve insulation.
- G. All water test ports shall be accessible from the insulation. In addition, water flow measuring stations require access from insulation to verify sizes and model.
- H. Extend piping insulation without interruption through pipe hangers, walls, floors and similar piping penetrations, except where otherwise indicated.
- I. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" (75 mm) wide vapor barrier tape or band over the butt joints. If using pipe hangers, follow manufacturer's instructions for installation.
- J. All exposed pipe insulation, including fittings, above 8' - 0" (2400 mm - 0 mm) of finished floor shall have 8 oz. (227 g) fire retardant canvas cover neatly cut and parted seams shall be sealed.
- K. All exposed pipe insulation, including fittings, within 8' - 0" (2400 mm - 0 mm) of finished floor or within a stairwell, shall be provided with aluminum or PVC protective covers. All edges shall be hemmed and all seams shall be concealed.
- L. For all insulated piping 2-1/2" (63 mm) and larger, provide insulated saddles as follows:
 - 1. For heating water, provide the following:
 - a. Minimum 3.5 pcf, non-compressive, rigid, phenolic foam insulation. Fire and smoke rating shall be 25/50 or below per ASTM 84.
 - b. The phenolic foam system shall have a K factor of 0.16 at a mean temperature for 75°F (24°C) and comply with ASTM Standard C1126.
 - c. Provide visible inspection sticker at the bottom of each saddle.
 - d. Pipe insulation saddles shall be Tru-Balance CoolDry Saddles as manufactured by Buckaroos, Inc. or equivalent.
 - e. Armacell Armafix Pipe Hangers may be used for cold water piping with flexible elastomeric insulation.

3.5 INSTALLATION OF DUCTWORK INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
 - 1. Insulation materials shall not be applied until systems have been witnessed, documented, and submitted to meet pressure testing requirements indicated throughout these specifications.
 - 2. Install insulation materials with smooth and even surfaces.
 - 3. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
 - 4. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage. Seal all joints with vapor barrier material.
 - 5. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.
- B. Lined Ductwork: Is not acceptable.
- C. Corner Angles: Install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.
- D. All balancing damper handles shall be exposed and visible on externally insulated ductwork.

3.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division-23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

3.7 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.

3.8 EXISTING INSULATION REPAIR/REPLACEMENT

- A. Repair damaged sections of existing mechanical insulation, either previously damaged or damaged during this construction period. Insulation shall be as specified herein.
- B. Provide new insulation on existing mechanical piping where existing insulation has been removed due to damage, repair or abatement of existing hazardous materials.

3.9 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 230700

SECTION 230800 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 COMMISSIONING AGENCY

- A. The commissioning agency (CA) has been contracted through the general contractor for this project. The CA has overall responsibility for planning and coordinating the commissioning process. However, commissioning involves all parties to the design and construction process, including the contractor.

1.2 CONTRACTOR RESPONSIBILITY

- A. This Section of the specifications defines the contractor's responsibilities with respect to the commissioning process. Each contractor and sub-contractor shall review this Section, and shall include in their bids for carrying out the work described, as it applies to each Division and Section of these specifications, individually and collectively.

1.3 DESCRIPTION OF WORK

- A. The purpose of the commissioning process is to provide the Government of the facility with assurance that the mechanical systems have been installed according to the contract documents, and operate within the performance guidelines set out in the design intent documents (DID) and these specifications. The CA will provide the Government with an unbiased, objective view of the system's installation, operation, and performance. The commissioning process does not take away or reduce the responsibility of the installing contractors to provide a finished product, installed and fully functional in accordance with the contract documents.
- B. Commissioning is intended to enhance the quality of system start-up and aid in the orderly completion and transfer of systems for beneficial use by the Government. The CA will be the leader of the commissioning team, planning and coordinating all commissioning activities in conjunction with the design professionals, construction manager, subcontractors, manufacturers, and equipment suppliers.
- C. The General Contractor, Mechanical Contractor, and all Division-23 sub-contractors shall be responsible for cooperating, and coordinating their work, with the CA. They shall also be responsible for carrying out all the physical activities required for installation of components and systems, and operating them during the commissioning process as required in this Section.

1.4 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions, general mechanical provisions and applicable Division 23 specification sections, apply to work of this section.

1.5 REFERENCES

- A. Associated Air Balance Council Commissioning Guideline.

PART 2 - PRODUCTS

2.1 HVAC SYSTEMS TO BE COMMISSIONED

- A. HVAC systems installed under this contract are to be inspected, tested signed off as complete and operational, and operated for commissioning agency verification as described in Part 3 of this Section. This includes, but is not necessarily limited to the work listed for each system. The foregoing includes all the following:
 - 1. Duct and Air Handling Systems: Work includes installation inspections and checks; confirmation of flow balancing completion; leak testing as applicable; seismic restraints installation certification.
 - 2. Supply, Return, and Exhaust Fans: Work includes checks on existing installation (including dampers, magnehelic gauges and other accessories), rotation sound levels, motor current draw, and airflows and pressures.
 - 3. Air Handling Units: Work includes existing installation inspections and checks ; rebalancing and checkout and startup as specified; documented capacity tests for heating, cooling, air flow and static pressures; fan and associated adjustable frequency drive operation, operation of all controls.
 - 4. Air Terminal Devices: Work includes installation inspections and checks; for newly installed and existing VAV units, flow adjustments and calibration coordinated with controls and air balancing; controls operation including flow modulation, reheat, controls responses.
 - 5. Fume Hoods & Wet Benches: Work includes re-certifications of all existing Fume Hoods and Wet Benches to meet current ISO standards. Re-certification of existing Fume Hoods & Wet Benches shall be completed on a unit cost basis and coordinated with COR. Refer to section 230593 for requirements.
 - 6. Cleanroom Recertification: Work includes verification and re-certification of cleanroom including, checks of Class 100 & Class 1,000 space pressurization. Work shall also include particle counts, ceiling HEPA filter integrity testing, room air exchange rate documentation, room air volume documentation, room air velocity uniformity tests, room air flow parallelism tests. Refer to Specification Section 130003 "Cleanroom Certification" for requirements.
 - 7. Controls Air Compressor: Work includes conformation of all existing pneumatic connections to air handling units, exhaust fans, actuators (dampers & valves) are secured and clear of any blockages. Contractor shall repair and correct all damaged tubing.
 - 8. Direct Digital Controls System: Work includes inspections and checks of installation and operation of all devices; complete operation of all controls sequences, in coordination with commissioning of all controlled systems.
- B. The contractor shall be responsible for carrying out all work required for commissioning these systems that is defined as a contractor responsibility in Part 3 of this Section.

2.2 SYSTEM VERIFICATION CHECKLISTS

A. This specification contains the system verification checklists as listed below:

1. SVC#1, Supply fan
2. SVC#2, Return fan
3. SVC#3, Exhaust fan
4. SVC#4, Air handling unit, liquid heat/cool
5. SVC#5, VAV terminal units
6. SVC# 6, Fume Hood & Wet Bench
7. SVC# 7, Cleanroom Recertification

2.3 FUNCTIONAL PERFORMANCE TEST CHECKLISTS

A. This specification contains functional performance test checklists as listed below:

1. FTP#1, VAV system, liquid heat/cool air handling unit
2. FPT#2, Air make-up and exhaust system
3. FPT#3, Cleanroom Recertification

2.4 MEMBERS OF THE COMMISSIONING TEAM

A. The commissioning team will consist of representatives of the following:

1. COR
2. End user (if applicable)
3. Mechanical design engineer
4. Commissioning agency (CA)
5. Clean Zone Director
6. General contractor [or construction manager]
7. Mechanical (Division-23) contractor (M)
8. Controls contractor (ATC)
9. Sheet metal contractor
10. Testing, adjusting and balancing agency (TAB)
11. NIST's O & M staff

B. During the commissioning process, participation of team members will generally be required as noted in the following table (with abbreviations as noted in brackets in the preceding list of team members). The mechanical contractor, indicated by "M", includes all mechanical sub-contractors or suppliers whose participation is required for commissioning a particular system or piece of equipment.

EQUIPMENT/SYSTEM DESCRIPTION	Team Members			
	CA	M	TAB	ATC
Supply fan	X	X	X	X

Return fan	X	X	X	X
Exhaust fan	X	X	X	X
Air handling unit	X	X	X	X
VAV terminal unit	X	X	X	X
Fume Hood & Wet Bench	X	X	X	X
Cleanroom	X	X	X	X

PART 3 - EXECUTION

3.1 COMMISSIONING RESPONSIBILITIES – NON-CONTRACTOR TEAM MEMBERS

- A. Introduction: As noted in Part 2, a multi-disciplinary team carries out the commissioning. The commissioning responsibilities of some non-contractor team members during the construction and acceptance phases of the project are provided here for information, to provide some context for the overall process.
- B. Commissioning Agency Responsibilities: The commissioning agency will:
 1. Plan, organize and implement the commissioning process as specified herein;
 2. Prepare the commissioning plan, and ensure its distribution for review and comment;
 3. Revise the commissioning plan as required during construction;
 4. Chair commissioning meetings, and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting;
 5. In conjunction with the General Contractor, coordinate commissioning activities among all contractors, sub-trades and suppliers;
 6. Monitor system verification checks, and ensure the results are documented as the checks are done;
 7. Monitor controls point-to-point checks done by the controls contractor, and ensure the results are documented as the checks are done;
 8. Observe all start-ups and initial system operation tests and checks;
 9. Direct the contractors to operate equipment and systems as required to ensure that all required functional performance tests are carried out for verification purposes;
 10. Witness all functional performance tests and document the results;
 11. Prepare and submit a Commissioning Report which documents all checks and tests done throughout the commissioning process, and the results obtained from each; and
 12. Ensure all required O & M manuals, instructions and demonstrations are provided to the COR's designated operating staff.
- C. Mechanical Engineer Responsibilities:
 1. The Mechanical Engineer will review the Commissioning Plan, and will participate, as appropriate, in on-site commissioning meetings.
 2. During the acceptance phase of the commissioning process, the Mechanical Engineer may

be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance.

D. COR's Responsibilities:

1. The COR will ensure the availability of operating staff for all scheduled instruction and demonstration sessions. This staff will possess sufficient skills and knowledge to operate and maintain the installation following attendance at these sessions.
2. The COR will be present for all functional performance testing. Schedule and coordination shall be coordinated with COR.

3.2 COMMISSIONING RESPONSIBILITIES – GENERAL CONTRACTOR

- A. The General Contractor has the responsibility to ensure the overall completion of the work. In this regard, he shall:
1. Participate as required in the HVAC commissioning process,
 2. Ensure the Mechanical Contractor performs all assigned HVAC commissioning responsibilities as specified in 3.3,
 3. Ensure the testing, adjusting and balancing agency performs HVAC commissioning responsibilities as listed in 3.4,
 4. Ensure the cooperation and participation in the HVAC commissioning process of all other sub-contractors as applicable.
- B. The General Contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the General Contractor as they relate to the organization and scheduling of HVAC commissioning. The representative shall facilitate communications among all contractors and suppliers and other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.
- C. In the event that any scheduled equipment or system start-ups or functional performance tests are terminated because the CA or Mechanical Engineer discover deficient or incomplete work, or due to the non-attendance of required contractor or supplier personnel, the contractor or sub-contractors responsible for the termination shall also be responsible for paying reasonable costs of time and travel expenses of any or all of the following representatives who were physically present for the purpose of witnessing the start-up or the FPT: the CA, the Mechanical Engineer, and the COR. The COR may provide a statement to the General Contractor identifying the specific activity that was terminated, the scheduled date, and a list of those in attendance, along with their reasonable time and travel expense costs.

3.3 COMMISSIONING RESPONSIBILITIES – DIVISION-23 (MECHANICAL) CONTRACTOR

- A. The mechanical contractor, and all the sub-contractors and suppliers within Division -23, shall cooperate with the commissioning agency (CA), and other commissioning team members, to facilitate the successful completion of the commissioning process.

- B. The Contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the mechanical contractor as they relate to the organization and scheduling of HVAC commissioning. The representative shall ensure communications between Division-23 contractors and suppliers and all other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.
- C. The Mechanical Contractor, and all mechanical sub-contractors and suppliers, shall cooperate with the Commissioning Agency in carrying out the HVAC commissioning process. In this context, the Mechanical Contractor shall:
1. Each contractor and sub-contractor in this division shall include in their quotes the cost of participating in the commissioning process as specified herein.
 2. Ensure the automatic temperature controls (ATC) contractor performs HVAC commissioning responsibilities as listed in 3.5.
 3. Provide instruction and demonstrations for the COR's designated operating staff, in conjunction with the Commissioning Agency and Mechanical Engineer, and with the participation of qualified technicians from major equipment suppliers and the controls contractor.
 4. Include requirements for submittal data, O & M data, and training information in each purchase order or sub-contract written.
 5. Ensure cooperation and participation of specialty sub-contractors such as sheet metal, and piping, as applicable.
 6. Ensure participation of major equipment manufacturing in appropriate start-up, testing and training activities.
 7. Attend HVAC commissioning meetings scheduled by the CA.
 8. Notify the CA a minimum of two (2) weeks in advance of scheduled equipment and system start-ups, so that the CA may witness system verifications, and equipment and system start-ups.
 9. Provide sufficient personnel to assist the CA as required during system verification and functional performance testing.
 10. Prior to start-up, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe start-up.
 11. Notify the CA a minimum of two (2) weeks in advance of the time for start of the TAB work. Attend the initial TAB meeting for review of the TAB procedures.
 12. Provide equipment and systems start-up resources as specified and required. If during an attempted equipment or system start-up, deficient or incomplete work is discovered that would preclude safe operation, the start-up shall be aborted until corrective action has been taken. Ensure such action is taken and verified before re-scheduling a new start-up. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.2 of the Section.
 13. Carry out performance checks to ensure that all equipment and systems are fully functional and ready for the CA to witness formal functional performance tests (FPTs).
 14. Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning agency. If improper functionality, incomplete work, or

other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.2 in this Section. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the ATC contractor and other applicable sub-contractors, carry out functional performance checks to confirm correct operation before applying to the CA to reschedule the FPTs for the system in question.

15. Prepare preliminary schedule for mechanical system orientation and inspections, O & M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up TAB, and task completion for use by the CA. Update schedule as appropriate throughout the construction period.
16. Attend Initial O & M staff training session.
17. Conduct mechanical system orientation and inspection at the equipment placement completion stage.
18. Update drawings to as-built condition and review with the CA.
19. Gather O & M data on all equipment, and assemble in binders as required by the commissioning specification. Submit to CA prior to the completion of construction.
20. Participate in, and schedule vendors and contractors to participate in the O & M staff training sessions as set up by the CA.
21. Provide written notification to the General Contractor and CA that the following work has been completed in accordance with the contract documents and the equipment, systems and sub-systems are operating as required.
 - a. HVAC equipment including all fans, air handling units, ductwork, dampers, terminals and all Division-23 equipment.
 - b. That the building control system is functioning to control mechanical equipment and smoke control systems as specified.
22. Provide a complete set of as-built drawings and O & M manuals to the CA.

3.4 COMMISSIONING RESPONSIBILITIES – TAB AGENCY

A. With respect to HVAC commissioning, the TAB agency shall:

1. Include costs for HVAC commissioning requirement in the quoted price.
2. Attend commissioning meetings scheduled by the CA prior to, and during, on-site TAB work being done.
3. Submit proposed TAB procedures to the CA and Mechanical Engineer for review and acceptance.
4. Attend the TAB planning meeting scheduled by the CA. Be prepared to discuss the procedures that shall be followed in testing, adjusting and balancing the HVAC system.
5. At the completion of the TAB work, submit the final TAB report to the General Contractor, with copies to the COR, CA and Mechanical Engineer.
6. Participate in verification of the TAB report by the CA for verification of diagnostic purposes. This will consist of repeating a sample (normally 10% to 20%) of the measurements contained in the TAB report as directed by the CA.
7. Participate in O & M personnel training sessions as scheduled by the CA.

3.5 COMMISSIONING RESPONSIBILITIES – CONTROLS CONTRACTOR

- A. With respect to HVAC commissioning, the controls contractor shall:
1. Include cost for commissioning requirements in the quoted price.
 2. Review design for controllability with respect to equipment selected for the project:
 - a. Review and confirm in writing that a proper hardware specification exists to permit functional performance testing as required by specification and sequence of operation.
 - b. Review and confirm in writing that proper safeties and interlocks are included in design.
 - c. Ensure the proper sizing of control valves and actuators, based on design pressure drops. Ensure that control valve authority will result in capacity control as specified. Include valve sizing and authority information in submittal to Mechanical Engineer.
 - d. Ensure the proper sizing of control dampers. Ensure damper authority to control air flows as specified. Review and confirm in writing proper damper positioning for mixing to prevent stratification. Ensure correct actuator vs. damper movement for smooth operation. Include damper sizing, control authority and actuator selection data in submittal to Mechanical Engineer.
 - e. Ensure the proper selection of sensor ranges, and include data with submittal to Mechanical Engineer.
 - f. Clarify all questions concerning sequences of operation with the Mechanical Engineer.
 3. Attend commissioning meetings scheduled by the CA.
 4. Provide the following submittals to the CA for review:
 - a. Hardware and software submittals, if submitted.
 - b. Control panel construction shop drawings.
 - c. Diagrams showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access, all superimposed on diagrams of the physical equipment.
 - d. Narrative description of all control sequences for each piece of equipment controlled.
 - e. Logic diagrams showing the logic flow of all control sequences.
 - f. A list of all control points, including analog inputs, analog outputs, digital inputs and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.
 - g. A complete control language program listing including all software routines employed in operating the control system. Also provide a program write-up, organized in the same manner as the control software. This narrative shall describe the logic flow of the software and the functions of each routine and sub-routine. It should also explain individual math or logic operations that are not clear from reading the software listing.
 - h. Hardware operation and maintenance manuals.
 - i. Application software and project applications code manuals.
 5. Inspect, check, and confirm the proper installation and performance of controls/BAS hardware and software provided by others. Provide COR with twenty-one (21) days of trending data points to demonstrate control, tolerance ranges and alarms to confirm function performance testing.
 6. Integrate installation and programming scheduling with construction and commissioning schedules.
 7. Inspect, check and confirm the correct installation and operation of input and output field

- points and devices through documented and signed off point-to-point checkouts.
8. Provide thorough training to operating personnel if any modifications to the existing hardware operations and programming, and the application program for the system are required.
 9. In conjunction with the mechanical contractor, demonstrate system performance to the CA including all modes of system operation (e.g. occupied, unoccupied, emergency) during the functional performance tests (FPTs). If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.2 in this Section.
 10. Provide control system technician to assist during system verification and functional performance testing.
 11. Provide support and coordination with TAB contractor on all interfaces between controls and TAB scopes of work. Provide, at no addition cost to the TAB and commissioning agencies, all devices, such as portable operator's terminals and all software for the TAB agency to use in completing TAB procedures.

END OF SECTION 230800

SECTION 230900 - AUTOMATIC CONTROL SYSTEMS (ELECTRIC-ELECTRONIC)

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: The extent of automatic controls work is indicated on the drawings and schedules and by the requirements of this Section, and all other Division-23 sections. The work includes, but is not limited to the following:
1. The provision of a complete and operational control system, including all devices necessary to perform the functions herein described or indicated on the drawings.
 2. The ATC contractor shall furnish and install all electrical wiring and conduit from power source, including termination, to all required ATC related power connections including, but not limited to, DDC controllers (provide low voltage controllers for air terminal units including transformers and disconnect switches as required), sensors, air flow monitors, ATC panels, etc. The ATC contractor shall obtain a separate electrical permit as required by the local authority. The ATC contractor shall be wholly responsible for all power requirements necessary for a complete installation from the power source to all ATC related connections. The intended power source shall be located in field in coordination with engineer.
 3. The ATC contractor shall interface with fire alarm devices as required to accomplish equipment shutdown, alarms, etc. indicated in sequences.
 4. The ATC contractor shall coordinate and verify that all controllers, devices, and accessories are provided as required to accomplish all control functions and sequences indicated in the contract documents. Where control related devices are not provided by an equipment manufacturer, it shall be the responsibility of the ATC contractor to provide the control devices required to accomplish the functions and sequences indicated.
 5. All drilling, cutting and patching associated with the installation of control systems.
- B. Types: Provide automatic control systems of the following types:
1. Where existing pneumatic controls are installed, contractor shall maintain and reconnect as required.
 2. The automatic temperature control system shall remain in full operation for extent of project and be modified as required for verification or replacement input, output and alarm points.

1.2 QUALITY ASSURANCE

- A. Systems Engineering: The systems engineering phase shall include the selection and integration of components into a complete system which will meet the performance and prescriptive requirements of the Contract, together with drawings, specifications, descriptions of operation, diagrams and other materials listed under "Submittals" paragraph of this Section.
- B. Testing and Adjusting During and After Installation:

1. The testing and adjusting includes the submission of a test plan which shall describe in detail the method by which each component, subsystem, and system will be tested, calibrated, adjusted, and retested after installation in accordance with the specified sequences of operation and other characteristics of the control system. A report on test results, including set points and operating ranges of all components shall be submitted.
 2. The testing specified in this paragraph shall not replace the testing specified in "Commissioning Tests and Verification" article of this Section.
- C. Commissioning Testing and Verifications: The final phase of the quality assurance program of the project is the commissioning testing and verifications. This phase is to assure that the project is fully completed and that the systems are performing in accordance to specifications from end to end of the control systems. Demonstrations of the automatic control systems to the commissioning team in accordance with the requirements specified in Part 3 of this Section are required. A report on test results, including set points and operating ranges of all components, shall be submitted.
- D. Testing: The testing phase of quality assurance includes the submission of a test plan which shall describe in detail the method by which each component, subsystem, and system will be tested, calibrated and retested after installation to perform in accordance with the specified sequences of operation and other characteristics of the control system.
- E. Reporting and Demonstration: This phase shall include the submission of a written report describing the "actions taken during the testing" phase and including the set points and operating ranges of all equipment and a demonstration that the system performs in accordance with contract requirements.
- F. Operating Instructions and Training: This phase of quality assurance includes the training of operating personnel utilizing written operating instructions prepared and approved under the "Submittals" paragraph of this Section, and the mounting of laminated control diagrams where directed.
- G. Maintenance Manuals: This phase includes the submission of four hard bound copies of all new manufacturers' cuts, maintenance and operating instructions, test reports and demonstration material, copies of control diagrams, and copies of the manufacturers' certifications.

1.3 SUBMITTALS

- A. Shop Drawings: For each system to be controlled, prepare a drawing which includes a system flow diagram, control diagram, sequence of operation and schedule of components. Control diagrams shall be complete with end-to-end connections of piping and wiring from component terminal.
- B. Manufacturer's Data: For each manufactured device or subsystem submit manufacturers' specifications and printed photograph of the proposed device or subsystem. Include engineering descriptions, principle of operation and application, and proposed model, style or size clearly indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The automatic temperature controls shall be furnished, installed, commissioned and warranted by an approved provider, Alerton Envision.
- B. No distributors, wholesalers or manufacturers' representatives other than those approved by NIST will be acceptable. In addition, manufacturers not listed above will not be acceptable.

2.2 SYSTEMS INTEGRATION

- A. Control Loop Characteristics: Carefully evaluate the characteristics of each control loop, the time constants, equipment characteristics, control accuracy, and reliability and provide a system which will operate smoothly, without hunting, and within the accuracies specified.
- B. System Components: Select components including sensors, transmitters, controllers, control devices, actuators, and instrumentation considering such factors as hysteresis, relaxation time, span, limits, and response time.

2.3 CONTROLLERS

- A. System Accuracy: Provide system accuracy in accordance with the following.
 - 1. Each local system shall maintain end-to-end accuracy for one year from sensor to controlled device for the applications specified.
 - 2. ATC contractor shall verify the accuracy of currently installed devices and sensors of according to their current air handling unit or exhaust fan sequence to confirm whether devices are within expected tolerances. All devices out of conformance shall be reported to COR immediately.
- B. Accuracy and Stability: Equipment shall be selected for the appropriate range of the application. Equipment selected with ranges in excess of the application will be replaced at the Contractor's expense.

2.4 DAMPERS

- A. Actuators: All existing actuators at AHUs, variable air volume terminals, exhaust branch dampers, and exhaust tools shall be verified for functionality. If found to be non-function or broken actuator shall be repaired or replaced at a unit cost.
- B. Operators: Damper operators shall have sufficient pneumatic pressure to open and close the dampers and limit the leakage to the specified rate. Pneumatic tubing shall be extended to operator by this contractor.
- C. Linkages: Confirm existing linkages to uniformly transmit damper operating forces to each damper blade.

1. Construct linkages of galvanized or cadmium plated steel or stainless steel.
2. Bearings and joints shall be ball and socket or sleeve bearings of brass, bronze or stainless steel, with plated bolts and locking nuts.

2.5 AUTOMATIC VALVES

- A. Standards: For heating water provide valves conforming to ANSI B16.15, "Cast Bronze Threaded Fittings," Class 125 copper bearing steel, bronze, or ANSI B16.1, "Cast Iron Pipe Flanges and Flanged Fittings," Class 125 cast iron. Select valve pressure class minimum 150 percent of maximum working pressure.
- B. End Connections: Provide valves with end connections as follows:
 1. For heating water provide valves with flanged connections on sizes 2-1/2 inches (65 mm) and larger and threaded connections on valves 2 inches (50 mm) and smaller.
- C. Small Water Valves (1" and Smaller): For valves controlling hot water sizes one inch and smaller, bodies shall be bronze, cast iron or stainless steel with screwed, union or flare connections.
- D. Valve Trim: Provide valve trim as follows:
 1. Stems shall be 316 stainless steel.
 2. Disk and stuffing boxes may be bronze or 316 stainless steel.
 3. For all valves 1-1/2-inch (40 mm) and larger, stems, disks, and seats shall be 316 stainless steel.
 4. All non-metallic parts of hot water valves shall be designed for minimum 250°F (121°C) or 100°F (38°C) above system design temperature.
 5. Leakage: Control valves shall provide tight shut off in the closed position at 150 percent of maximum working pressure.
- E. Valve Characteristics: Select valves to provide equal percentage control of water and linear control of steam. Modulating valves for steam shall have V-port skirts, tapered plugs for water.
 1. Butterfly valves that do not have "equal flow characteristics" will not be acceptable for modulating control.
 2. For two-position, water application action, butterfly valves may be used, provided the differential pressure across the valve does not exceed 25 pounds per square inch (170 kPa).
- F. Sizing: Provide valves of sizes indicated, or as herein specified.
 1. Size water valves with a maximum differential pressure not greater 10 feet (480 Pa) or 1/2 the loss through the controlled apparatus, whichever is greater.
- G. Actuators: Provide actuators, sized by the manufacturer, of sufficient size and pressure to operate the valve under all conditions and to close the valve tight against maximum differential pressure.
 1. Provide pilots for sequence operations, and cases where valve spring ranges have been increased to close off against system pressure.
 2. Comply with requirements of "Actuators" paragraph of this Section.

2.6 PNEUMATIC ACTUATORS

- A. General: Provide pneumatic actuators (operators) arranged "Fail Safe" in the event of power failure. Unless indicated otherwise, the fail position of each valve shall be the "last position" or "current position" at the time of failure. Design operators to be quiet in operation and function within a range 85 to 100 percent input power potential.
- B. Pneumatic Operators: Provide piston or diaphragm type operators with full range or split range spring to provide the required sequence specified and fail safe operation.
 - 1. Provide pilot positioners when indicated or when necessary, to prevent overlap of heating and cooling or the sequenced control functions.
 - 2. Diaphragms shall be easily replaceable.
 - 3. Piston rods shall be plated steel with cadmium plated steel or bronze locknuts and linkages.
- C. Damper Operator Mounting: Mount damper operators where accessible for maintenance.
 - 1. If located outside the duct or casing, mount operators on a 14 gauge (2.0 mm) reinforced support plate arranged to allow insulation between the support plate and the face of the duct or casing.
 - 2. Brace damper operators rigid to show no deflection or movement over the full range of the damper stroke.

2.7 SYSTEM DIAGRAMS

- A. Mounting: Mount modified control diagrams shall be mounted within existing controls cabinet.
 - 1. Control diagrams shall include system one-line diagram, system control diagram, sequence of operations, and schedule of control devices.
 - 2. Diagrams shall be hermetically sealed in laminated 16 gauge (1.6 mm) plastic.
 - 3. Diagrams shall be permanent, black on white background, not subject to fading when subjected to artificial or natural light. Diazo prints are not acceptable.
 - 4. Diagrams shall represent the current, "as-built" status of the control system, after acceptance by the representative of the Owner.
 - 5. Obsolete, out of date, or field modified diagrams shall be removed, and new current diagrams furnished.
 - 6. Diagrams and devices on local control panels shall be identified with engraved phenolic nameplates, white on black, minimum 1/4-inch (6 mm) high block capital lettering, screwed or bolted to panel or mounting plate face. Adhesive attachments are not acceptable.

2.8 WIRING

- A. General: Provide a complete system of electric wiring for temperature control apparatus including control power transformers and wiring to the transformer primary.
- B. All wiring shall be installed in conduit. MC cable is prohibited in all locations.
- C. Wiring: Wire for low voltage AC shall be minimum 300 volt insulated copper No. 18 AWG or

larger conforming to NFPA 70, Type MTW, THHN or TFFN, installed in accordance with Division-26 of these specifications.

1. For low voltage DC and an electronic circuit carrying less than 0.5 amperes, cables of two or more conductors not smaller than No. 18 AWG solid copper or No. 18 AWG solid copper if not shielded may be used in lieu of individual wires.
 2. Cables carrying analog signals shall be shielded, if required by the manufacturer.
 3. Cables shall be terminated in solder or screw type terminal strips.
 4. Cables shall not be tapped at any intermediate points.
 5. All wire shall be color coded or numbered for identification. Identify as indicated on shop drawings and "as-built" drawings.
 6. Wire terminating in screw type terminal strips shall have pressure connectors conforming to UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," or UL 486B, "Wire Connectors for Use with Aluminum Conductors."
 7. Wire terminations without connectors or traveling pressure pads will not be accepted.
- D. The contractor shall in no case combine control wiring (line or low voltage) with power wiring in the same conduit.

2.9 PNEUMATIC TUBING

- A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.
- B. Control Air Piping: Accessible tubing is defined as that tubing run in mechanical equipment rooms; inside mechanical equipment enclosures, such as heating units, instrument panels, etc.; in pipe chases, or suspended ceilings with easy access. Inaccessible tubing is defined as that tubing run in concrete slabs; or ceilings with no access.
1. Provide copper tubing with maximum unsupported length of three feet, zero inches, for an accessible tubing run exposed to view. Polyethylene tubing may be used in lieu of above, when run within adequately supported, rigid enclosure, such as metallic raceways. Terminal single-line connections less than 18 inches (450 mm) in length may be copper tubing, or polyethylene tubing run inside flexible steel protection. Accessible tubing run in concealed locations, such as pipe chases, suspended ceilings with easy access, etc. may be copper or polyethylene bundled and sheathed tubing.
 2. Provide copper or polyethylene tubing for inaccessible tubing, other than in concrete pour. If polyethylene tubing is used, install in EMT or vinyl-jacketed polyethylene tubing.
 3. Pressure test control air piping at 30 psi (210 kPa) for 24 hours. Test fails if more than 5 psi (34 kPa) loss occurs.
 4. Fasten flexible connections bridging cabinets and floors, neatly along hinge side and protect against abrasion. Tie and support tubing neatly.
 5. Number-code or color-code tubing, except local individual room control tubing, for future identification and servicing of control system.

2.10 AIRFLOW MEASUREMENT SYSTEMS (AIRFLOW MONITORS)

- A. The airflow measurement system (AFMS), including airflow monitor, sensors, controllers, transmitters, etc., indicated on the plans shall be capable of continuously monitoring airflow rates

at each measurement location. The system shall consist of one or more airflow measuring devices and a single microprocessor based transmitter. The number of sensing points shall be as per manufacturer's recommendation for the specified application. The AFMS shall not require recalibration or adjustment over the life of the equipment.

- B. The manufacturer shall provide for approval and verification a written copy of the following:
1. 16 point NIST traceable report of calibration used for the reference standard.
 2. UL/cUL 873 report listing the AFMS as a complete assembly.
 3. Independent laboratory test report results of 100% survival rate in a 30 day saltwater and acid vapor test.
- C. The AFMS shall produce a single, linear, analog output signal for airflow, which can be measured by the host control system. The system shall have the ability to perform self-diagnostics and automatic zeroing to adjust the signal to zero at pre-determined time intervals, which eliminates all output signal drift due to thermal, electronic and mechanical effects. In the event of sensor failure, the system shall ignore the failed sensor(s), average the remaining sensors and continue to operate.
- D. The total accuracy from the airflow measurement to the host controls, including sensing point averaging error, the sum of the sensor and electronic (transmitter) errors, etc. shall not exceed +/- 2% of reading at both minimum and maximum airflow rates based on the manufacturer's published performance specifications for all devices. In addition, total system performance including sampling error, shall not exceed +/-5% of actual airflow. The installed accuracy, in accordance with manufacturer's recommendations, without field adjustment shall be as follows throughout the operating range:
1. Ducts and plenums: +/- 3% of reading
 2. Outside air intakes: +/-5% of reading
 3. Fan inlets: +/- 10% of reading
- E. The sensors and electronics shall operate over a temperature range of -20 to 120°F for ducted supply or return applications and -20 to 120°F for outside air applications. The sensors and electronics shall operate at a relative humidity range of 0 to 95% (non-condensing) for ducted supply and return applications and 0-99% (non-condensing) for outside air applications. Each sensor node shall be individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard and have an accuracy of $\pm 2\%$ of reading over the entire calibrated airflow range of 0 to 5,000 FPM for ducted applications. Upon request, a working demo shall be provided to the design team to display that the system can work at low flows.
- F. For laboratory exhaust applications, provide stainless steel sensors with stainless steel casing. Each sensor probe shall be provided with an integral, FEP jacket, plenum rated CMP/2CL2P, UL/cUL listed cable rated for exposures from -67°F to 392°F (-55°C to 200°C) and continuous and direct UV exposure. Plenum rated PVC jacket cables are not acceptable. Devices that have electronic signal processing components on or in the sensor probe are not acceptable. Where the electronics are installed in a location exposed to potential wind driven rain or snow (including outside air plenum) provide a NEMA 4 enclosure for all electronics. In addition, a visual display shall be provided to illustrate airflow (L/S) and temperature. The transmitter must also be able to display individual sensor reading and each individual flow for each fan.

- G. Analog signal capability shall include two output terminals: the first (AO1), shall provide the total airflow rate; while the second output (AO2) shall be field configurable to provide one of the following: temperature, low and/or high airflow user-defined set point alarm, individual fan alarm or system status alarm.
- H. Airflow measuring devices shall be UL listed as an entire assembly. The transmitter shall include fused protection.
- I. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans for conformance with installed accuracy requirements. A written report shall be submitted to the COR if any measurement locations will not result in specified installed accuracy requirements.
- J. Prior to purchase or installation of the air flow monitor (AFM), the Contractor and/or AFM Product Representative shall review each equipment and/or duct mounted location to verify suitability for installation. Should there be any discrepancy regarding installation or performance, the Contractor shall notify the COR immediately.
- K. Provide all necessary power and control wiring as required for a complete and operational air flow measurement system interlocked with the building EMCS. Network communications RS 485 (BACnet MS/TP) or Ethernet (BACnet Ethernet, and Modbus TCP) shall provide: the average airflow rate, temperature, high and/or low airflow set point alarm, system status alarm, individual sensor node airflow rates and individual sensor node temperatures.
- L. Airflow measurement system manufacturers shall be limited to the following:
 - 1. Ebtron (Gold)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wiring and Conduit: Provide wiring and conduit to connect the automatic control system components for an operational system.
 - 1. Provide wiring in accordance with requirements indicated in this section.
 - 2. Run conduit in straight lines, parallel to the lines of the building, and rack on factory furnished mounting blocks attached to the building structure. Where run buried in slabs provide long sweep rigid conduit bends extending 6 inches (150 mm) above the slab at slab penetrations.
 - 3. Do not bury or conceal wiring beneath building insulation.
 - 4. Locate wiring clear of access doors, accessible ceilings, lighting fixtures, walkways, or any location subject to damage or abrasion.
- B. Identification: Label or code each field wire at each end, and each controller and controlled device.
 - 1. Identification shall be permanent, robust, not subject to fading, and flameproof.
 - 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 (3 mm) height, on 1-1/2-inch (40 mm) by 1-inch (25 mm) 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. Pipe Work: Mount strap-on sensors using helical screw stainless steel band clamp for strap-on thermostats, aquastats and other temperature switches on new piping for unit heaters and fan coil units after the pipe is cleaned to bright metal. Strap-on sensor may be used on piping up to 2-1/2-inch (65 mm) diameter. On pipe 3 inches (80 mm) and larger use pipe wells.
- D. Pipe Wells: Install pipe wells above the horizontal to retain liquid heat transfer fluid in the well.
- E. Valves: Install valves in piping with stems as vertical as possible but in no case less than 45 degrees from vertical. For soldered or welded connections, remove valve internals before mounting.
- F. The ATC contractor shall interface with smoke detectors, smoke dampers and fire alarm devices as required to accomplish equipment shutdown, alarms, etc., as indicated in sequences.
- G. For single phase motors, provide relays and/or contactors of appropriate horsepower and voltage rating as required to energize/de-energize equipment as indicated in sequences.

3.2 TEST PLAN

- A. Test Plan: Prepare a written test plan indicating in a step-by-step, logical fashion, the procedures by which the automatic control system will be tested, adjusted, and checked.
- B. Pre-Approval: Not less than six (6) weeks prior to testing, provide four (4) copies of the proposed test plan for approval. Meet and discuss the test plan, and make agreed changes to the written plan.
- C. Content: Plan shall include, as a minimum, for each system and sub-system of the automatic control work the following:
1. System name.
 2. List of devices with brief description of functional purpose of each.
 3. A description of the expected signal values transmitted by the sensor.
 4. A description of the expected signal values transmitted by the controller to the control device or actuator.
 5. A description of the expected values of the control medium from limit-to-limit.
 6. A description of the instrumentation required to test the system.
 7. A description of the expected field adjustments for transmitter, controller, and control actuator should control parameters fall outside of expected values.
 8. A log sheet or sheets on which expected, and field read values will be recorded and final field read values indicating that the system is operating in accordance with contract requirements.

3.3 TESTS DURING AND AFTER INSTALLATION

A. Instrumentation and Control: Calibration test each controller as follows:

1. Disconnect the sensor input signal to the controller and provide a compatible test signal generator.
2. Simulate expected transmitter values and input to the controller. Record controller branch line values.
3. Examine control device and determine that the device is responding.
4. Simulate maximum and minimum transmitter signal values and verify minimum and maximum controller output values and control device minimum and maximum stroke range.
5. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedule, proportional relationship, reset relationship, and derivative reaction.
6. When the controller and control device portion of each loop are responding as designed, reconnect the sensor transmitter input line.
7. After mechanical equipment control becomes operational, perform an operational test of each control loop recording sensor, transmitter, controller input, controller output and control medium parameter.
8. Entire test shall be witnessed by an owner's representative.
9. Upon satisfactory test a copy of final test results shall be bound in the operating and maintenance manual.

3.4 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION

- A. General: In addition to the tests required during and after installation of all mechanical systems, as well as any other formal commissioning requirements, the Contractor shall perform functional performance tests to verify that all systems are designed, installed, calibrated and adjusted to perform as required in the Contract.
- B. Comply with all applicable specification sections including, but not be limited to, "Basic HVAC Requirements", "Testing, Adjusting and Balancing", "Automatic Temperature Controls" and "Commissioning", where applicable.
- C. Prior to functional performance testing, all indicating, recording and control devices shall be calibrated. A calibration verification report shall be provided with the final test report.
- D. Provide functional performance testing to verify proper operation of each and every control sequence indicated throughout the contract documents.
- E. Failure of Tests: Should any test, verification, or demonstration fail to meet the specification requirements, the component of the system causing the failure shall be repaired, replaced or readjusted. The failed test, verification, or demonstration shall then be repeated.
- F. A "Functional Performance Test Verification Form" is included at the end of this section. This form (electronic version is available upon request) shall be completed for all mechanical equipment provided under this contract. This shall include, but not be limited to each air handling unit, fan, VAV terminal, etc.
- G. Test Report: Upon satisfactory verification of calibration and functional performance tests, a copy

of the final test results shall be bound in the operations and maintenance manual. The final report shall also include a full compliance statement, on company letterhead, indicating that all systems are installed and functioning per the contract requirements including drawings, specifications, control sequences and accepted submittals.

- H. The mechanical systems shall not be considered complete until all functional performance verification forms, calibration reports and compliance statement have been submitted and reviewed. Submit in accordance with the submittal requirements indicated elsewhere in these specifications.

3.5 DEMONSTRATION AND TRAINING

- A. Demonstration: After completion of testing as hereinbefore specified, provide demonstration and training of designated operating personnel (refer to Division-1).
 - 1. Demonstration shall be performed.
 - 2. Demonstration shall include the operation of the entire mechanical system under the control of the Contractor and shall include the start-up, operation, and shutdown of the system in accordance with the sequence of operation.
 - 3. The operation of each device shall be performed in accordance with the written instructions contained in the operation and maintenance manual, a copy of which shall be available ten (10) working days prior to the test. No deviation from procedures in the operating manual will be permitted.
- B. Failure to Perform: Should the system fail to perform in accordance with the requirements of the operation and maintenance manual, the system shall be repaired, recalibrated, retested as necessary, and a second demonstration performed.
 - 1. Subsequent demonstrations shall occur until the automatic control system and all associated mechanical and electrical equipment are operating in accordance with contract requirements.
 - 2. All testing, retesting, and recalibration shall be at no additional expense. The Contractor shall reimburse the expenses of the commissioning team for each test after the first.

3.6 INSTRUCTING OPERATING PERSONNEL

- A. Instructors and Superintendent: Upon completion of the work and acceptance by the representative of the Owner, provide the services of an Instructor, who together with the superintendent specialist shall instruct designated operating personnel in the operation and maintenance of the automatic control system.
 - 1. The services of the Instructor shall be available for not less than four 4-hour days of instruction.
 - 2. The services of the superintendent specialist shall be available for not less than two 4-hour days.
 - 3. Instructions shall be based upon the use of the operating and maintenance manual together with copies of the laminated control diagrams affixed adjacent to each local control panel.
 - 4. Training and instruction will be witnessed. The witness shall monitor the entire training

program and prepare a written report on the competency and effectiveness of instructors and the level of expertise of designated operators. A report will be submitted recommending additional training at additional cost, if such is deemed necessary.

3.7 BUILDING MANAGEMENT AND CONTROL SYSTEM DEVICES AND POINTS

- A. Provide all building management and ATC system controllers, devices, points, etc. as required to accomplish and verify existing control sequences and equipment functions indicated throughout the contract documents, including drawings and specifications. In addition, provide all controllers, devices, points, etc. as required to control, operate, monitor and alarm all equipment and devices indicated on the contract documents (including but not limited to: air handling units, fans, variable frequency drives, air volume terminal units, valves, dampers, flow measuring devices, sensors, etc.). All points shall be available through the Energy Management Control System (EMCS). See attached points list (where applicable).
- B. Building management and control system features for equipment and devices shall include, but not be limited to, the following where applicable: runtime, trend data, optimal start, scheduling, paging, system graphics, and internet access to graphic and text-based displays.
- C. ATC contractor shall notify COR of all existing issues with control sequences, function testing or hardware & software issues that prevent the systems to operation as designed. Additional ATC diagnostics shall utilize set allowance upon COR approval.

END OF SECTION 230900

bkm

FUNCTIONAL PERFORMANCE TEST VERIFICATION FORM

Project _____

Name: _____

FUNCTIONAL VERIFICATION FOR: _____ (Insert Equipment Name, i.e. Chiller, Boiler, AHU, Fan, Pump, VAV, etc.)							
SEQUENCE OF OPERATION		Controlling Specified (Y/N)	as	ATC Initials	Technician	Date	Notes
	(Insert complete sequence of operation as indicated in approved ATC submittal)						
	Example: Air Handling Unit Control						
	1. General:						
	1.1 Supply and return fans shall be interlocked. Fans shall operate continuously in the occupied mode. HOA switch shall be in the AUTO position.						
	1.2 Occupied-Unoccupied shall be as determined by the EMCS.						
	2. Temperature Control:						
	2.1 Occupied						
	A. When the outside air enthalpy is above the return air enthalpy, D-1, D-2 and D-3 shall modulate as follows:						

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of hydronic piping work is indicated on drawings and schedules, and by requirements of this section and all other Division-23 sections.
- B. Applications for hydronic piping systems include the following:
 - 1. Heating water supply and return

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of hydronic piping products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Installer's Qualifications: Firm with at least five (5) years of successful installation experience on projects with hydronic piping work similar to that required for project.
- C. Codes and Standards:
 - 1. ASME Compliance: Fabricate and install hydronic piping in accordance with ASME B31.9 "Building Services Piping".

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for hydronic piping, materials and products.
- B. Shop Drawings: Submit scaled layout drawings as required by Division-23 Section, "Basic HVAC Requirements".
- C. Record Drawings: At project closeout, submit record drawings of installed hydronic piping and piping products.
- D. Maintenance Data: Submit maintenance data and parts lists for hydronic piping materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual.

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ASME B31.9 Code for Building Services Piping where applicable, base pressure rating on hydronic piping systems maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in hydronic piping systems. Where more than one type of materials or products is indicated, selection is Installer's option.

2.2 BASIC IDENTIFICATION

- A. General: Provide identification complying with Division-23 section "Identification for HVAC Piping and Equipment".

2.3 BASIC PIPES AND PIPE FITTINGS

- A. General: Provide pipes and pipe fittings complying with Division-23 section "Pipe, Tube and Fittings for HVAC Systems", in accordance with the following listing:
- B. Hydronic Piping:
 - 1. Tube Size 2" (50 mm) and Smaller: Copper tube; Type L, hard drawn temper; wrought-copper fittings with solder-joints.
 - 2. Pipe Size 2-1/2" (65 mm) and Larger: Black steel pipe; Schedule 40; wrought-steel butt welding fittings with welded joints.

2.4 BASIC PIPING SPECIALTIES

- A. General: Provide piping specialties complying with Division-23 section "Piping Specialties for HVAC Systems", in accordance with the following listing:
 - 1. Pipe escutcheons
 - 2. Pipeline strainers
 - 3. Dielectric fittings

2.5 BASIC HANGERS AND SUPPORTS

- A. General: Provide hangers and supports complying with Division-23 section "Hangers and Supports for HVAC Piping and Equipment", in accordance with the following listing:
 - 1. Adjustable steel clevises, adjustable pipe saddle supports, single pipe rolls, and adjustable roller hangers, for horizontal piping hangers and supports.
 - 2. Two-bolt riser clamps, for vertical-piping clamps.

3. Steel turnbuckles, for hanger-rod attachments.
4. Concrete inserts, C-clamps, malleable beam clamps, and steel brackets, for building attachments.
5. Protection saddles, for saddles and shields.

2.6 BASIC VALVES

- A. General: Provide valves complying with Division-23 section "Valves for HVAC Piping", in accordance with the following listing:
1. Sectional Valves:
 - a. 2" (50 mm) and Smaller: Ball valves.
 - b. 2-1/2" (65 mm) and Larger: Butterfly valves.
 2. Shutoff Valves:
 - a. 2" (50 mm) and Smaller: Ball valves.
 - b. 2-1/2" (65 mm) and Larger: Butterfly valves.
 3. Balancing Valves:
 - a. Combination shut-off/balance valve with venturi type flow meter fitting with integral readout ports and memory stop. Provide ball valve for 2" (50 mm) and smaller, butterfly valve for 2-1/2" (65 mm) and larger.
 - b. See Division-23 section "Hydronic Specialties" for balance valve specification.
 4. Drain Valves:
 - a. 2" (50 mm) and Smaller: Ball valves.
 5. Check Valves:
 - a. All sizes: Swing check valves.

2.7 BASIC METERS AND GAUGES

- A. General: Provide meters and gauges complying with Division-23 section "Meters and Gauges for HVAC Piping".

2.8 BASIC VIBRATION CONTROL

- A. General: Provide vibration control products complying with Division-23 section "Vibration Isolation for HVAC Piping and Equipment".

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which hydronic piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been

corrected.

3.2 INSTALLATION OF BASIC IDENTIFICATION

- A. General: Install mechanical identification in accordance with Division-23 section "Identification for HVAC Piping and Equipment".

3.3 INSTALLATION OF HYDRONIC PIPING

- A. General: Install hydronic piping in accordance with Division-23 section "Pipe, Tube and Fittings for HVAC Systems".
- B. Install eccentric reducers where pipe is reduced in size in direction of flow, with tops of both pipes and reducer flush.
- C. Connect branch-feed piping to mains at horizontal center line of mains, connect run-out piping to branches at horizontal center line of branches.
- D. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

3.4 INSTALLATION OF PIPING SPECIALTIES

- A. Install piping specialties in accordance with Division-23 section "Piping Specialties for HVAC Systems".

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install hangers and supports in accordance with Division-23 section "Hangers and Supports for HVAC Piping and Equipment".

3.6 INSTALLATION OF VALVES

- A. Install valves in accordance with Division-23 section "Valves for HVAC Piping".
- B. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves two (2) or more hydronic terminals or equipment connections, and elsewhere as indicated.
- C. Shutoff Valves: Install on inlet and outlet of each mechanical equipment item, control valves, strainers and elsewhere as indicated.
- D. Balancing Valves: Install on outlet of each hydronic terminal, and elsewhere as indicated.
- E. Drain Valves: Install on each mechanical equipment item and locate to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain hydronic piping system.

3.7 INSTALLATION OF METERS AND GAUGES

- A. Install meters and gauges in accordance with Division-23 section "Meters and Gauges for HVAC Piping".

3.8 EQUIPMENT CONNECTIONS

- A. General: Connect hydronic piping system to mechanical equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated. Install shutoff valve and union/flange connection on supply and return, and drain valve on drain connection.
- B. Hydronic Terminals: Install hydronic terminals with hydronic terminal valve and union on inlet and outlet. Install manual air vent valve on element in accordance with manufacturer's instructions. Locate valves and balancing cocks behind valve access doors for ease of maintenance. Where indicated, install automatic temperature control valve with unions between valve and element on supply line.

3.9 FIELD QUALITY CONTROL

- A. Piping Tests: Test hydronic piping in accordance with testing requirements of Division-23 section "Testing, Adjusting and Balancing."

3.10 CLEANING

- A. Cleaning, Flushing, and Inspecting: Clean, flush, and inspect hydronic piping systems in accordance with requirements of Division-23 section "Pipe, Tube and Fittings for HVAC Systems".

END OF SECTION 232113

SECTION 232115 - HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of hydronic specialties required by this section is indicated on drawings and schedules, and by requirements of this section and all other Division-23 sections.
- B. Types of hydronic specialties specified in this section include the following:
 - 1. Balancing Valves
 - 2. Air Vents

1.2 QUALITY ASSURANCE

- A. Hydronic Specialty Types: Provide hydronic specialties of same type by same manufacturer.
- B. Codes and Standards:
 - 1. ASME Compliance: Manufacture and install hydronic specialties in accordance with ASME B31.9 "Building Services Piping".
 - 2. UL and NEMA Compliance: Provide electrical components of hydronic specialties which are listed and labeled by UL, and comply with NEMA standards.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of hydronic specialty. Include pressure drop curve or chart for each type and size of hydronic specialty. Submit schedule indicating manufacturer's figure number, size, location, rated capacities, and features for each required hydronic specialty.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weights, required clearances, and method of assembly of components.
- C. Maintenance Data: Submit maintenance data and spare parts lists for each type of hydronic specialty. Include this data, product data, and shop drawings in Maintenance Manual.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include the following (unless otherwise noted):

1. Bell and Gossett
2. Taco
3. Amtrol
4. Flow Design, Inc.

2.2 HYDRONIC SPECIALTIES

- A. General: Provide factory-fabricated hydronic specialties recommended for use in service indicated. Provide hydronic specialties of types and pressure ratings indicated for each service, or if not indicated, provide proper selection as determined to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option, but more than one type cannot be used on project.

2.3 BALANCING VALVES

A. General:

1. Manual balancing devices shall be venturi type as defined by ASHRAE. Devices shall have a precision machined throat and have a stated catalog accuracy of 3% full scale and have an actual accuracy of $\pm 5\%$ of actual reading down to 10 in. w.c. pressure differential across the metering device. The induced differential reading (flow signal) shall be greater than two feet water column at the design flow with the valve in the wide open position. The permanent pressure loss at design flow shall not exceed two feet of water in the wide open position. The valves shall have differential readout ports fitted with check valve and protective cap, and are to have a memory stop to allow complete shut-off and return to set position without losing the setpoint.

B. Construction:

1. Valves 2" and Smaller: Brass ball valve, blowout proof stem, virgin Teflon seats, brass stems, stem seals and steel handles.
2. Valves 2-1/2" and Larger: Cast iron butterfly valve, full-lug type with EPDM seat, 416 stainless steel stem, bronze sleeve bearing and bronze disk. Valves 4" and smaller shall have manual lever.

C. Minimum Ratings:

1. Devices with sweat or NPT connections: 400 psig (2760 kPa) at 250°F (121°C).
2. Devices with flanged connections: 125 psig (862 kPa) at 250°F (121°C) suitable for the system for which it is installed.

D. Readout Meter Kit:

1. Provide a portable readout meter kit by the manufacturer of the balancing devices. The meter shall be permanently mounted in a durable case complete with two 10' (3 m) color coded hoses with shutoff valves at the end that connects to the balance valve so that water does not drain out between readings. Meter shall have a 6" (150 mm) diameter face and 1.75% full rated accuracy. Meter for the venturi type devices shall be provided with a

removable transparent face indicating flow directly in GPM for each size device furnished. Meter shall have a three valve manifold for over-range protection.

E. Installation:

1. The straight pipe required to achieve 3% full scale accuracy shall be incorporated as an integral part of the venturi and valve assembly. No additional straight piping shall be required.
2. Install in accordance with the manufacturer's instructions.
3. Check connections after installation for leaks.

F. Balancing valves shall be Flow Set model UA (2" and smaller) or EF (2-1/2" and larger) as manufactured by Flow Design or equivalent.

2.4 AIR VENTS

- A. Manual Air Vents: Provide manual vents designed to be operated manually with screwdriver or thumbscrew, 1/8" (3 mm) N.P.T. connection.

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which hydronic specialties are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to COR.

3.2 INSTALLATION OF HYDRONIC SPECIALTIES

- A. Balancing Valves: Install venturi type balance valves at all hydronic coils and terminals including, but not limited to, fan coil units, unit ventilators, baseboard radiation, convectors, unit heaters, cabinet heaters, heating coils, cooling coils, etc. For four-pipe terminal units such as fan coil units and unit ventilators, provide balance valves at heating and cooling coil.

B. Air Vents:

1. Manual Air Vents: Install manual vents on each hydronic terminal at highest point, and on each hydronic piping drop in direction of flow for mains, branches, and runouts, and elsewhere as indicated. In addition, provide 1/2" ball valve with hose end connection, cap and chain at all high points within the piping system to accommodate manual venting of trapped air.

- C. Low Point Drains: Provide a ball valve with hose end connection, cap and chain at all low points within the piping system to accommodate manual draining of water from the system. Drain valves shall be sized in accordance with the following criteria:

1. For pipes smaller than 3", provide 3/4" ball valve.

CLEANROOM REBALANCE
NIST

100% RELEASE FOR CONSTRUCTION
JUNE 29, 2021

END OF SECTION 232115

SECTION 233113 - LOW PRESSURE DUCTWORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of low pressure ductwork is indicated on drawings and in schedules, and by requirements of this section and all other Division-23 sections. Low pressure duct systems shall be defined as those duct systems which have an external static pressure (E.S.P.) of less than two-inches (2") water gauge (wg) (500 Pa). See schedules on drawings for external static pressure information.
- B. Types of low pressure ductwork which may be required for this project include the following:
 - 1. Return air ductwork
 - 2. Outdoor air ductwork (conditioned or unconditioned)
 - 3. Exhaust ductwork
 - 4. Supply air ductwork (downstream of air terminal units or systems without air terminal units)
 - 5. Air transfer ductwork
 - 6. Make-up air ductwork
- C. Pressure Classification:
 - 1. All ductwork provided under this section shall be "Duct Pressure Class 2" as defined by SMACNA Standards.

1.2 QUALITY ASSURANCE

- A. Installer: A firm with a minimum of five (5) years of successful installation experience on projects with low pressure ductwork systems similar to that required for project.
- B. SMACNA Standards: Comply with latest edition of SMACNA Standards for fabrication, storage and installation of low pressure ductwork. In addition, all new ductwork shall comply with SMACNA's "Duct Cleanliness for New Construction Guidelines." The "Duct Cleanliness Level" for all ductwork shall meet the requirements of the "Advanced Level."
- C. ASHRAE Standards: Comply with ASHRAE Standards for fabrication and installation of low pressure ductwork.
- D. NFPA Compliance: Comply with ANSI/NFPA 90A "Standard for the Installation of Air-Conditioning and Ventilating Systems" and ANSI/NFPA 90B "Standard for the Installation of Warm Air Heating and Air-Conditioning Systems."
- E. Field Reference Manual: Have available at project field office, copy of SMACNA Standards - latest edition.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications on manufactured products used for work of this section.
- B. Shop Drawings: Submit dimensioned layouts of ductwork showing both the accurately scaled ductwork and its relation to space enclosure as required by Division-23 Section, "Basic HVAC Requirements". Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced.
- C. Record Drawings: At project closeout, submit record drawings of installed ductwork, duct accessories, and outlets and inlets.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect shop-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.
- B. All ductwork shall be shipped to the site with covered ends. The ductwork shall be covered with 3-mil (minimum) shrink wrap, with a minimum 2-inch overlap on all sides, to provide a water-tight seal at each opening. The covered ends shall remain intact until installation.
- C. Store ductwork, accessories and purchased products inside and protect from weather.
- D. Ductwork fittings and accessories stored on site for installation shall be covered with protective tarps and elevated a minimum of four inches until installed.
- E. Provide periodic (weekly) photographs of the jobsite storage to document that the ductwork is stored in accordance with the criteria outlined in this specification section.
- F. Lined ductwork not stored in accordance with the above criteria shall be replaced in its entirety. Unlined ductwork not stored in accordance with the above criteria shall be cleaned and inspected by the COR prior to installation. Contractor shall clean unlined ductwork to the satisfaction of the COR, or replace at the COR's discretion.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS

- A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains and discolorations, and other imperfections, including those which would impair painting. Provide interior lining or double wall duct as indicated on the drawings and/or these specifications.
- B. Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ANSI/ASTM A 527, lockforming quality, with ANSI/ASTM A 525, G90 zinc

coating.

- C. Stainless Steel Sheet: Where indicated (S/S), provide stainless steel complying with ANSI/ASTM A 167; AISI Type 302/304/316 with No. 4 directional polish where exposed to view in occupied spaces. Protect finished surfaces with mill-applied adhesive protective paper, maintained through fabrication and installation.
- D. Aluminum Sheet: Where indicated (Al-), provide aluminum complying with ANSI/ASTM B 209, Alloy 3003, Temper H14.

2.2 MISCELLANEOUS DUCTWORK MATERIALS

- A. General: Provide miscellaneous materials and products of types and sizes indicated. Provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
- B. Duct Liner: Duct liner not acceptable.
- C. Duct Sealant: Non-hardening, non-migrating, oil based mastic or liquid elastic sealant (type applicable for fabrication and installation) as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork. Sealant shall be solvent (oil) based, water based or silicone based as follows:
 - 1. Solvent (oil) based sealant shall be used for indoor applications on all new construction installations. In addition, for indoor renovation projects, solvent (oil) based sealant shall be included in the contractor's bid and utilized wherever the sealant odor is not objectionable to the COR. Contractor shall coordinate with the COR prior to the duct installation.
 - 2. Water based sealant shall be utilized for indoor renovation applications where the odor from solvent (oil) based sealant is objectionable to the COR. Contractor shall coordinate with the COR prior to the duct installation.
 - 3. Silicone based solvent shall be utilized for all outdoor duct installation applications.
 - 4. Regardless of duct sealant type, maximum duct leakage requirements outlined in these Division-23 specifications shall be maintained.
- D. Duct Cement: Non-hardening migrating mastic or liquid neoprene based cement (type applicable for fabrication/installation detail) as compounded and recommended by manufacturer specifically for cementing fitting components, or longitudinal seams in ductwork.
- E. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
 - 1. Except where space is indicated as "High Humidity" area, interior support materials of not less than 1/4" (6 mm) diameter or 3/16" (4.8 mm) thickness may be plain (not galvanized).
 - 2. For exposed stainless steel ductwork, provide matching stainless steel support materials.
 - 3. For aluminum ductwork, provide aluminum support materials except where materials are electrolytically separated from ductwork.

2.3 FABRICATION

- A. Shop fabricate ductwork in 4 (1200 mm), 8 (2400 mm), 10 (3000 mm) or 12-foot (3600 mm) lengths, unless otherwise indicated or required to complete runs. Pre-assemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for reassembly and coordinated installation.
- B. Shop fabricate ductwork of gauges and reinforcement complying with SMACNA Standards - latest edition.
- C. Shop fabricate ductwork of gauges and reinforcement complying with ASHRAE Standards.
- D. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to one and one-half times the associated duct width; and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers.
- E. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division-23 section "Ductwork Accessories" for accessory requirements.
- F. Fabricate ductwork with duct liner in each section of duct where indicated. Laminate liner to internal surfaces of duct in accordance with instructions by manufacturers of lining and adhesive, and fasten with mechanical fasteners.
- G. Low pressure rectangular ductwork, fittings, etc., shall be constructed, installed and supported in accordance with current SMACNA Standards of gauges not less than the following:

<u>Maximum Side</u>	<u>Minimum Gauge</u>
Up to 12" (Up to 300 mm)	26 (.5 mm)
13" to 30" (325 mm to 750 mm)	24 (.7 mm)
31" to 60" (775 mm to 1500 mm)	22 (.8 mm)
61" to 84" (1525 mm to 2100 mm)	20 (1.0 mm)
Over 84" (Over 2100 mm)	18 (1.3 mm)

- H. All factory or shop fabricated ductwork shall be constructed as required to meet the testing requirements indicated in this section and Division-23 section "Testing, Adjusting and Balancing."

2.4 SPIRAL DUCTWORK

- A. Spiral duct shall have locked seams equivalent to United McGill "Uni-Seal," so made as to eliminate any leakage under the pressures for which this system has been designed. Spiral duct shall be manufactured of galvanized steel meeting ASTM A-527 by the spiral lockseam method and in the minimum gauges listed:

<u>Diameter</u>	<u>Minimum Gauge</u>
-----------------	----------------------

3" thru 26" (75 mm thru 650 mm)	26 (.5 mm)
28" thru 36" (700 mm thru 900 mm)	24 (.7 mm)
38" thru 50" (950 mm thru 1250)	22 (0.8 mm)
52" thru 60" (1300 mm thru 1500)	20 (1.8 mm)
62" and larger (1550 mm and larger)	18 (1.2 mm)

1. 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 26" (75 mm thru 650 mm)	24 (.7 mm)
28" thru 36" (675 mm thru 900 mm)	22 (1.0 mm)
38" thru 50" (950 mm thru 1250)	20 (1.0 mm)
52" thru 60" (1300 mm thru 1500)	18 (1.2 mm)
62" and larger (1550 mm and larger)	16 (1.4 mm)

2. Branch fittings supplying linear bar diffusers shall be "lo-loss" conical type saddle taps.
3. All 90 degree tees and 45 degree laterals, either full size or reducing, shall be conical pattern for 90 degree and straight pattern for 45 degree laterals, produced by machine or press forming. The entrance shall be free of weld build-up, burrs or irregularities. Provide tangential tees where required.
4. Elbows in diameters 3" (75 mm) through 12" (300 mm) shall be two 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 45°	2
46° thru 60°	2
Over 61°	3

5. The reduction of divided flow fittings shall be conical spun section in the thirty-six reductions in sizes 4" (100 mm) through 22" (550 mm).
6. Spun bellmouth connections shall be used at each round take-off from the high pressure plenum.
7. Offset fittings shall be constructed so that length of offset is not less than two (2) duct diameters.
8. Galvanized areas that have been damaged by welding shall be coated with corrosion resistant aluminum paint, minimum two (2) coats.
9. Supports and sealants shall conform to applicable portions of SMACNA.
10. Flexible ductwork shall be as previously specified for low pressure duct systems.

2.5 FLEXIBLE DUCTWORK

- A. General: Provide insulated flexible ductwork where indicated on drawings, as manufactured by Flex Master Type 6B, or equivalent. Flexible ductwork shall be in compliance with UL-181 Class 1 Air Duct, fabricated with an acoustically transparent nylon inner fabric.

1. Liner: Nylon fabric, mechanically locked without adhesives.
2. Helix: Corrosion resistant galvanized steel; formed and mechanically locked to fabric.
3. Vapor Barrier: Black fire retardant, polyethylene.
4. Insulation: 1" thick. R-value of 6.0.
5. Pressure Rating: 6" wg positive.

- B. Sound Attenuation: Flexible ductwork shall have sound attenuating capabilities as indicated below for nominal three feet of straight duct:

Duct Diameter	Insertion Loss (db)						
	63	125	250	500	1000	2000	4000
6	3	9	10	11	12	12	12
8	3	9	9	10	10	12	12
10	3	9	9	9	10	11	10
12	3	9	8	8	9	11	8

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTWORK

- A. General: Assemble, install, support and seal ductwork in accordance with recognized industry practices which will achieve air tight (not to exceed 1% leakage) and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum of joints. Align ductwork accurately at connections, within 1/8" (3 mm) misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling.
- B. Seal ductwork to SMACNA Standard Seal Class "A" and provide additional sealant as required to meet duct test requirements of this section.
- C. Install concrete inserts as required, for support of ductwork in coordination with formwork, as required to avoid delays in work.
- D. Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.
- E. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of building. Limit

clearance to 1/2" (13 mm) where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" (25 mm) clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

- F. Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
- G. Support ductwork in manner complying with SMACNA Standards - latest edition of hangers and supports section.
- H. Unless indicated otherwise, all stainless steel ductwork shall be welded.
- I. Provide gasketed duct access doors as required to provide maintainable access to the upstream side of coils, etc.

3.2 INSTALLATION OF FLEXIBLE DUCTWORK

- A. Where indicated, provide factory insulated flexible ductwork between low pressure supply ductwork and round inlet ceiling diffusers. Provide side take-off fitting with damper (Flexmaster USA, model STOD or equivalent) between the flexible duct and the low pressure supply ductwork. Extend rigid sheet metal ductwork between the fitting and the flexible ductwork as required. The maximum length of flexible duct shall be 3'-0" (915 mm).
- B. Connections to round neck diffusers shall include a rigid 45 degree sheet metal elbow at the diffuser inlet.

3.3 CLEANING AND PROTECTION

- A. Prior to installation, thoroughly clean ductwork internally of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or might interfere with painting or cause paint deterioration.
- B. Strip protective paper from stainless steel ductwork surfaces, and repair finish wherever it has been damaged.
- C. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, install sheet metal temporary closures which will prevent entrance of dust and debris until the time all connections are to be completed.
- D. Provide MERV 13 filter media at all return air inlet locations throughout the duration of construction. Filter media shall not be removed until final filters are installed in the air handling units.

3.4 DUCT TESTING

- A. Prior to the balancing of systems by the AABC certified balancing contractor, all low pressure ductwork shall be tested by the mechanical contractor for duct leakage. Duct leakage shall not exceed 1%. In addition, current SMACNA and AABC Standards shall apply, where applicable, to meet the maximum 1% leakage. Duct leakage shall not exceed 1% of design cfm for a duration of ten (10) minutes. Test pressures shall be not less than the following:
 - 1. Ductwork systems less than 2.0 in. wg E.S.P.: Test to 2 in. wg
- B. Insulation materials shall not be applied until systems have been witnessed, documented, and submitted to meet the above testing requirements.
- C. The balance contractor shall witness and certify all duct pressure tests.
- D. Contractor shall submit duct leakage test results to the A/E within 72 hours of completed tests. Only test results that meet the specified leakage requirements shall be submitted. Duct test results shall be recorded on the "Air Duct Leakage Test Summary Form" located at the end of Section 230593; no other forms will be accepted. In addition, the duct leakage submittals shall include 11x17 drawing(s) as required to clearly indicate the full extent of the duct test section (each duct test section shall be numbered and color coded).
- E. All duct leakage test results shall be included with the final TAB report and the O&M Manual. The orifice tube calibration chart shall also be included with the final duct leakage test report information.

3.5 BALANCING

- A. Refer to Division-23 section "Testing, Adjusting and Balancing" for air distribution balancing of low pressure ductwork; not work of this section.

END OF SECTION 233113

SECTION 233114 - HIGH PRESSURE DUCTWORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of high pressure ductwork is indicated on drawings and in schedules and by requirements of this section and all other Division-23 sections. High pressure duct systems shall be defined as those duct systems which have an external static pressure (E.S.P.) of two-inches (2") water gauge (wg) (500 Pa) or greater. In addition, all ductwork upstream of terminal units shall be classified as high pressure.
- B. Types of high pressure ductwork which may be required for this project include the following:
 - 1. Supply air ductwork (upstream of terminal units i.e. from air handling unit to air terminals).
 - 2. Exhaust ductwork.
- C. Pressure Classification
 - 1. For ductwork systems with external static pressure between 2.0 in. wg and 5.0 in. wg: Ductwork provided shall be "Duct Pressure Class 6" as defined by SMACNA Standards.
 - 2. For ductwork systems with external static pressure between 5.0 in. wg and 10.0 in. wg: Ductwork provided shall be "Duct Pressure Class 10" as defined by SMACNA Standards.

1.2 QUALITY ASSURANCE

- A. Installer: Work shall be performed by a firm with a minimum of five (5) years of successful experience on projects with high pressure ductwork systems similar to that required for project.
- B. SMACNA Standards: Comply with latest edition of SMACNA Standards for fabrication, storage, and installation of high pressure ductwork. In addition, all new ductwork shall comply with SMACNA's "Duct Cleanliness for New Construction Guidelines." The "Duct Cleanliness Level" for all ductwork shall meet the requirements of the "Advanced Level."
- C. ASHRAE Standards: Comply with ASHRAE Standards for fabrication and installation of high pressure ductwork.
- D. NFPA Compliance: Comply with ANSI/NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" and ANSI/NFPA 90B "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."
- E. Field Reference Manual: Have available at project field office copy of SMACNA Standards - latest edition.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications on manufactured products and factory-

fabricated ductwork used for work of this section.

- B. Shop Drawings: Submit dimensioned layouts of ductwork showing both the accurately scaled ductwork and its relation to space enclosure as required by Division-23 Section, "Basic HVAC Requirements". Show modifications of indicated requirements made to conform to local shop practice and how those modifications ensure that free area materials and rigidity are not reduced.
- C. Record Drawings: At project closeout, submit record drawings of installed ductwork, duct accessories, and outlets and inlets.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Protect shop-fabricated and factory-fabricated ductwork accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.
- B. All ductwork shall be shipped to the site with covered ends. The ductwork shall be covered with 3-mil (minimum) shrink wrap, with a minimum 2-inch overlap on all sides, to provide a water-tight seal at each opening. The covered ends shall remain intact until installation.
- C. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.
- D. Ductwork fittings and accessories stored on site for installation shall be covered with protective tarps and elevated a minimum of four inches until installed.
- E. Provide periodic (weekly) photographs of the jobsite storage to document that the ductwork is stored in accordance with the criteria outlined in this specification section.
- F. Lined ductwork not stored in accordance with the above criteria shall be replaced in its entirety. Unlined ductwork not stored in accordance with the above criteria shall be cleaned and inspected by the COR prior to installation. Contractor shall clean unlined ductwork to the satisfaction of the COR, or replace at the COR's discretion.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS

- A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains and discolorations, and other imperfections, including those which would impair painting. Provide interior lining or double wall duct as indicated on the drawings and/or these specifications.
- B. Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ANSI/ASTM A 527, lockforming quality with ANSI/ASTM A 525, G90 zinc coating.

- C. Stainless Steel Sheet: Where indicated (S/S), provide stainless steel complying with ANSI/ASTM A 167; AISI Type 302/304/316 with No. 4 directional polish where exposed to view in occupied spaces. Protect finished surfaces with mill-applied adhesive protective paper, maintained through fabrication and installation.

2.2 MISCELLANEOUS DUCTWORK MATERIALS

- A. General: Provide miscellaneous materials and products of types and sizes indicated. Provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
- B. Duct Liner: Duct liner not acceptable.
- C. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15° change of direction per section, unless specifically detailed otherwise. Use 45° straight type laterals and 45° elbows for branch take-off connections. Where 90° branches are indicated, provide conical type tees.
- D. Duct Sealant: Non-hardening, non-migrating, oil based mastic or liquid elastic sealant (type applicable for fabrication and installation) as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork. Sealant shall be solvent (oil) based, water based or silicone based as follows:
 - 1. Solvent (oil) based sealant shall be used for indoor applications on all new construction installations. In addition, for indoor renovation projects, solvent (oil) based sealant shall be included in the contractor's bid and utilized wherever the sealant odor is not objectionable to the COR. Contractor shall coordinate with the COR prior to the duct installation.
 - 2. Water based sealant shall be utilized for indoor renovation applications where the odor from solvent (oil) based sealant is objectionable to the COR. Contractor shall coordinate with the COR prior to the duct installation.
 - 3. Silicone based solvent shall be utilized for all outdoor duct installation applications.
 - 4. Regardless of duct sealant type, maximum duct leakage requirements outlined in these Division-23 specifications shall be maintained.
- E. Duct Cement: Non-hardening, migrating mastic or liquid neoprene based cement (type applicable for fabrication/installation detail) as compounded and recommended by manufacturer specifically for cementing fitting components or longitudinal seams in ductwork.
- F. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
 - 1. Except where space is indicated as "High-Humidity" area, interior support materials of not less than 1/4" (6 mm) diameter or 3/16" (4.8 mm) thickness may be plain (not galvanized).
 - 2. For exposed stainless steel ductwork, provide matching stainless steel support materials.

2.3 FABRICATION

- A. Shop fabricate rectangular ductwork in 4 (1200 mm), 8 (2400 mm), 10 (3000 mm) or 12-foot

(3600 mm) lengths, unless otherwise indicated or required to complete runs. Pre-assemble work in shop to greatest extent possible so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for reassembly and coordinated installation.

- B. Shop fabricate ductwork of gauges and reinforcement complying with SMACNA Standards - latest edition.
- C. Shop fabricate ductwork of gauges and reinforcement complying with ASHRAE Standards.
- D. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings, except as otherwise indicated. Fabricate elbows with center-line radius equal to one and one-half times the associated duct width. Limit angular tapers to 30° for contracting tapers and 20° for expanding tapers.
- E. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division-23 section "Ductwork Accessories" for accessory requirements.
- F. All factory or shop fabricated ductwork shall be constructed as required to meet the testing requirements of this section and Division-23 section "Testing, Adjusting and Balancing."

2.4 FACTORY-FABRICATED DUCTWORK

- A. General: Provide factory-fabricated duct and fittings as indicated, or as installer's option in lieu of shop fabricated duct and fittings.
- B. Round Ductwork: Construct of galvanized sheet steel complying with ANSI/ASTM A 527 by the following methods and in minimum gauges listed.

- | | | | |
|----|---|----------------------|------------------------------|
| 1. | <u>Duct Diameter</u> | <u>Minimum Gauge</u> | <u>Method of Manufacture</u> |
| | 3" to 14"
(75 mm to 300 mm) | 26 (.5 mm) | Spiral Lockseam |
| | 15" to 26"
(375 mm to 650 mm) | 24 (.7 mm) | Spiral Lockseam |
| | 28" to 36"
(700 mm to 850 mm) | 22 (.8 mm) | Spiral Lockseam |
| 2. | <u>Duct Diameter</u> | <u>Minimum Gauge</u> | <u>Method of Manufacture</u> |
| | 38" to 50"
(900 mm to 1250 mm) | 20 (1.0 mm) | Spiral Lockseam |
| | 52" and larger
(1300 and larger) | 18 (1.3 mm) | Spiral Lockseam |
| 3. | Provide locked seams for spiral duct; fusion-welded butt seam for longitudinal seam duct. | | |

4. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous welds along seams.

a. Duct Diameter Minimum Gauge

3" to 14" (75 mm to 300 mm) 24 (.7 mm)

15" to 26" (325 mm to 650 mm) 22 (.8 mm)

28" to 50" (700 mm to 1250 mm) 20 (1.0 mm)

50" to 60" (1250 mm to 1500 mm) 18 (1.6 mm)

62" and larger (1550 mm and larger) 16 (1.6 mm)

5. Inner Liner: Where indicated, provide inner liner, perforated with 3/32" (2.5 mm) holes for 22% open area. Provide metal spacers welded in position to maintain spacing and concentricity. Inner liner shall be as follows:

a. Ductwork: Up to 62" diameter, 26 gauge; over 62" diameter, 22 gauge.

b. Fittings: Up to 35" diameter, 24 gauge; over 35" diameter, 22 gauge.

- C. Flat-Oval Ductwork: Construct of galvanized sheet steel complying with ANSI/ASTM A 527 of spiral lockseam construction in minimum gauges listed.

<u>Duct Width</u>	<u>Minimum Gauge</u>	<u>Method of Manufacture</u>
Up to 24" (Up to 600 mm)	24 (.7 mm)	Spiral Lockseam
25" to 48" (625 mm to 1200 mm)	22 (.8 mm)	Spiral Lockseam
49" to 70" (1225 mm to 1750 mm)	20 (1.0 mm)	Spiral Lockseam
Over 70" (Over 1750 mm)	18 (1.3 mm)	Spiral Lockseam

1. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams.

a. Duct Width Minimum Gauge

Up to 36" (Up to 900 mm) 20 (1.0 mm)

37" to 60" (925 mm to 1500 mm) 18 (1.3 mm)

Over 60" (Over 1500 mm) 16 (1.6 mm)

2. Inner Liner: Where indicated, provide inner liner, perforated with 3/32" (2.5 mm) holes for 22% open area. Provide metal spacers welded in position to maintain spacing and concentricity. Inner liner shall be as follows:

a. Ductwork: Up to 60" duct width, 26 gauge; over 60" duct width, 22 gauge.

- b. Fittings: Up to 35" width, 24 gauge; over 35" width, 22 gauge.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTWORK

- A. General: Assemble, install and seal ductwork in accordance with recognized industry practices which will achieve air tight (not to exceed 1% leakage) and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum of joints. Align ductwork accurately at connections within 1/8" (3 mm) misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling.
- B. Supply ductwork serving the cleanroom shall not have duct liner.
- C. Round spiral ductwork shall be connected to the terminal units. Where duct diameter and box inlet differ, provide concentric factory fabricated high velocity adapters.
- D. Seal all ductwork in accordance with Seal Class "A" SMACNA Standards - Latest Edition, and provide additional sealant as required to meet duct leak test requirements of this section.
- E. Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.
- F. Locate ductwork runs except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or if not otherwise indicated. Run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2" (13 mm) where furring is shown for enclosure or concealment of ducts but allow for insulation thickness, if any. Where possible locate insulated ductwork for 1" (25 mm) clearance outside of insulation. Wherever possible in finished and occupied spaces conceal ductwork from view by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- G. Where ductwork is exposed to view in occupied areas, duct shall be double wall duct with internal lining, unless otherwise noted.
- H. Where ducts pass through interior partitions and exterior walls, conceal space between construction opening and duct or duct-plus-insulation with sheet metal flanges of same gauge as duct. Overlap opening on four (4) sides by at least 1-1/2" (40 mm).
- I. Coordinate duct installations with installation of accessories, dampers, coil frames, equipment controls and other associated work of ductwork system.
- J. Support ductwork in manner complying with SMACNA Standards - latest edition of hanging and supporting systems chapter.

- K. All exposed ductwork (in non-mechanical rooms) shall be primed and painted with paint appropriate for sheet metal surfaces. See architectural section "Painting".
- L. Unless indicated otherwise, all stainless steel ductwork shall be welded.

3.2 CLEANING AND PROTECTION

- A. Prior to installation, thoroughly clean ductwork internally of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or might interfere with painting or cause paint deterioration.
- B. Strip protective paper from stainless steel ductwork surfaces and repair finish wherever it has been damaged.
- C. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, install sheet metal temporary closures which will prevent entrance of dust and debris until the time all connections are to be completed.

3.3 DUCT TESTING

- A. Prior to the balancing of systems by the AABC certified balancing contractor, all high pressure ductwork shall be tested by the mechanical contractor for duct leakage. Duct leakage shall not exceed 1%. In addition, current SMACNA and AABC Standards shall apply, where applicable, to meet the maximum 1% leakage. Duct leakage shall not exceed 1% of design cfm for a duration of ten (10) minutes. Test pressures shall be not less than the following:

Ductwork systems between 2.0 in. wg and 5.0 in. wg E.S.P.: Test to 6 in. wg

Ductwork systems greater than 5.0 in. wg E.S.P.: Test to 10 in. wg

Insulation materials shall not be applied until systems have been witnessed, documented, and submitted to meet the above testing requirements.

- B. The balance contractor shall witness and certify all duct pressure tests.
- C. Contractor shall submit duct leakage test results to the A/E within 72 hours of completed tests. Only test results that meet the specified leakage requirements shall be submitted. Duct test results shall be recorded on the "Air Duct Leakage Test Summary Form" located at the end of Section 230593; no other forms will be accepted. In addition, the duct leakage submittals shall include 11x17 drawing(s) as required to clearly indicate the full extent of the duct test section (each duct test section shall be numbered and color coded).
- D. All duct leakage test results shall be included with the final TAB report and the O&M Manual. The orifice tube calibration chart shall also be included with the final duct leakage test report information.

3.4 BALANCING

- A. Refer to Division-23 section "Testing, Adjusting and Balancing" for air distribution balancing of high pressure ductwork; not work of this section.

END OF SECTION 233114

SECTION 233115 - LABORATORY EXHAUST SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Extent of Work: This section includes all work necessary to provide an exhaust system from the fume hood(s) to its point of discharge to the exterior including air moving device, and devices which are part of the duct system (but not including air cleaning filters or air monitoring devices).
- B. Types Included:
 - 1. Stainless steel without protective coating.

1.2 SYSTEM PERFORMANCE

- A. Exhaust systems must be capable of withstanding negative pressures of 10 inches w.g. (2490 Pa) while meeting criteria as subsequently described.

1.3 QUALITY ASSURANCE

- A. References: Forward to the Construction Engineer a list of not less than three (3) successful laboratory exhaust system installations stating location, date, size and person to contact as a reference.

1.4 SUBMITTALS

- A. Tests: Submit to the Contracting Officer a written certificate executed by the coating applicator stating that the chemical resistance tests and tests for coating thickness specified herein have been made and that the applied coating complies with contract requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original packages, containers or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and in a manner to keep them dry, protected from weather, direct sunlight, surface contamination, corrosion and damage from construction traffic and other causes.
- C. Handle to prevent damage to edges, ends or surfaces.

PART 2 - PRODUCTS

2.1 FLEXIBLE DUCT CONNECTORS

- A. Construct connectors from plasticized PVC material not less than 3/32 inch (2.5 mm) thick neoprene coated cloth, synthetic rubber or other suitable and approval material having corrosion resistance and temperature compatibility suitable for the environment. Reference SMACNA "Thermoplastic Duct (PVC) Construction Manual", 1st Edition, Fig. 1-1B.

2.2 HANGERS AND SUPPORTS

- A. Conform to Division-23 section "Low Pressure Ductwork".

2.3 FITTINGS

- A. Furnish type having a centerline radius of 1-1/2 times the width of the duct in the plane of turn except where indicated otherwise or with the approval of the Construction Engineer. Where space makes it impractical to maintain the prescribed radius, the radius at Contractor's option, be reduced to one times the width of the duct in the plane of the turn.
- B. Round Duct Elbows: Construct of not less than five (5) segments or be pressed formed in two halves and welded together while maintaining a centerline radius of 1-1/2 times the duct diameter.

2.4 DUCTWORK CONSTRUCTION

- A. General: Construct as follows:
 - 1. Internal Fittings: Construct of the same material as that specified for the ductwork.
 - 2. Joints of Flanged Construction: Construct as detailed in SMACNA "LOW PRESSURE DUCT CONSTRUCTION STANDARDS" manual and make air and water tight with corrosion resistant duct sealer of type used for high pressure duct systems.
 - 3. Seams: Use continuous butt-welding.
 - 4. Method of Fabrication: Fabricate as to minimize crevices conducive to corrosion and accumulation of solids and liquids from any effluent conveyed by the duct system.
 - 5. Approval: Acceptance of each section of the exhaust ductwork is subject to the approval of the Construction Engineer.
- B. Materials:
 - 1. Stainless steel sheets of not less than 18 gauge (1.3 mm), type 304, corrosion resisting steel (FS QQ-S-766). Use welding electrodes of AISI Type 308L corrosion resisting steel. Coating not required.
- C. Criteria for Construction:
 - 1. Metal: Conform to Division-23 sections "Low Pressure Ductwork" or "High Pressure Ductwork" as appropriate.

PART 3 - EXECUTION

3.1 AIR DISTRIBUTION SYSTEM, GENERAL

- A. Make duct system leak-proof by sealing all joints and seams by application of duct sealer, appropriate cement solvent or welding.
- B. General-Use Fume Hood System (other than perchloric acid hood system): Provide an air-dry epoxy-phenolic protective coating for the entire non-stainless steel exhaust system including all ductwork and such items a fan blades, interior of fan housing and dampers exposed to corrosive vapors emitted from laboratory fume hoods whether installed at time of system installation or at some future time.

3.2 FLEXIBLE DUCT CONNECTORS

- A. Install in conformance with applicable provisions of Division-23 section "Ductwork Accessories".

3.3 DUCT INSTALLATION

- A. General:
 - 1. Branch Entry: Enter branch or trunk duct at an angle of 45 degrees. Where space will not permit, use a conical fitting. See Fig. 2-10 SMACNA "LOW PRESSURE DUCT CONSTRUCTION STANDARDS".
 - 2. Do not position branch connections opposite each other. Stagger at least 1-1/2 duct diameters. Where this spacing can not be maintained, consult with Construction Engineer.
- B. Metal Ducts: Install in conformance with Division-23 sections "Low Pressure Ductwork" or "High Pressure Ductwork".

3.4 TESTING, ADJUSTING AND BALANCING

- A. Test, adjust and balance laboratory exhaust systems in accordance with Division-23 section "Testing, Adjusting and Balancing".

END OF SECTION 233115

SECTION 233300 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this section and all other Division-23 sections.
- B. Types of ductwork accessories required for project include the following:
 - 1. Dampers:
 - a. Low pressure manual dampers
 - b. Control dampers
 - c. Counterbalanced dampers
 - 2. Turning vanes
 - 3. Duct hardware
 - 4. Duct access doors
 - 5. Flexible connections
 - 6. Penetration seals
 - 7. Sound attenuators
- C. Duct Cleaning: Each of the following HVAC systems listed shall be cleaned and sanitized in their entirety:
 - 1. All existing supply ductwork
 - 2. All existing return ductwork
 - 3. All existing exhaust ductwork and fans
 - 4. All existing air handling units and associated fans

1.2 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. SMACNA Compliance: Comply with applicable portions of latest edition of SMACNA Standards. In addition, all duct accessories shall comply with SMACNA's "Duct Cleanliness for New Construction Guidelines." The "Duct Cleanliness Level" for all ductwork shall meet the requirements of the "Advanced Level."
 - 2. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
 - 3. UL Compliance: Construct, test, and label fire, smoke and combination fire/smoke dampers in accordance with UL Standards 555 and 555S.
 - 4. NFPA Compliance: Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.
- B. Duct Cleaning Contractor:

1. Duct cleaning contractor shall have been regularly engaged in commercial type duct cleaning services for a minimum of five (5) years of successful operation.
2. NADCA Certified: The duct cleaning contractor shall be certified by the National Air Duct Cleaners Association (NADCA).

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, materials of construction and installation instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.
- C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual.
- D. Duct cleaning contractor shall submit proposed approach, methodology and detailed cleaning and sanitizing process for each system listed above for approval prior to work being performed. In addition, provide documentation of NADCA certification, as well as five (5) years of successful performance.

PART 2 - PRODUCTS

2.1 DAMPERS

- A. Low Pressure Manual Dampers: Provide dampers of single blade type or multiblade type, constructed in accordance with the latest edition of SMACNA Standards. Provide damper extender rods as required to compensate for external duct insulation.
- B. Control Dampers: Refer to Division-23 section "Automatic Control Systems" for control dampers; not work of this section.
- C. Counterbalanced Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to relieve at indicated static pressure. Construct blades of 16-gauge (1.6 mm) aluminum. Provide 1/2" (13 mm) diameter ball bearings, 1/2" (13 mm) diameter steel axles spaced on 9" (230 mm) centers. Construct frame of 2" x 1/2" x 1/8" ((50 mm x 13 mm x 3 mm) steel channel for face areas 25 sq. ft. (2.3 m²) and under; 4" x 1-1/4" x 16-gauge (100 mm x 30 mm x 1.6 mm) channel for face areas over 25 sq. ft. (2.3 m²). Provide galvanized steel finish on frame with aluminum touch-up.

2.2 TURNING VANES

- A. Manufactured Turning Vanes: Provide turning vanes constructed of 1-1/2" (40 mm) wide curved blades set at 3/4" o.c. (20 mm), supported with bars perpendicular to blades set at 2" o.c. (50 mm), and set into side strips suitable for mounting in ductwork.

2.3 DUCT HARDWARE

- A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:
 - 1. Test Holes: Provide duct test holes in ductwork at fan inlet and outlet, and elsewhere as indicated, consisting of slot and cover, for instrument tests.
 - 2. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12" (300 mm). Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

2.4 DUCT ACCESS DOORS

- A. General: Provide duct access doors where required for duct accessory access. Provide access doors for fire dampers, smoke dampers and smoke detectors. Install access doors upstream of duct type smoke detectors.
- B. Construction: Construct of same or greater gage as ductwork served and provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork and extended frames for externally insulated duct. Provide one side hinged, other side with one handle-type latch for doors 12" (300 mm) high and smaller, 2 handle-type latches for larger doors.

2.5 FLEXIBLE CONNECTIONS

- A. General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flame retardant fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.

2.6 PENETRATION SEALS

- A. Provide seals for all openings through fire-rated walls, floors or ceilings used as passage for mechanical components such as ductwork. See Division-23 section "Basic HVAC Materials and Methods" for penetration seals and firestopping requirements.
- B. Provide seals for all openings through walls, floors or ceilings used as passage for mechanical components such as ductwork.

2.7 SOUND ATTENUATORS

- A. General:
 - 1. Sound attenuator manufacturer shall provide testing in accordance with ASTM E-477-2013.
 - 2. Sound attenuator inlet and outlet connection dimensions must be equal to the duct sizes shown on the drawings. Duct transitions at sound attenuators are not permitted unless

shown on the contract drawings.

B. Materials:

1. General:
 - a. Rectangular Attenuators: All rectangular attenuators shall be constructed with a 22 gauge galvanized steel outer casing and 26 gauge galvanized perforated steel inner wall.
 - b. Elbow Attenuators: All elbow attenuators shall be constructed with an 18 gauge galvanized steel outer casing and 22 gauge galvanized perforated steel inner wall. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow attenuators with a turning cross-section dimension greater than 48" shall have at least two half splitters and one full splitter.
 - c. Circular Attenuators: All circular attenuators shall be constructed based on the following constraints:
 - i. Silencers with a diameter less than 18 inches shall be constructed of no less than 22 gauge casing and 26 gauge perforated metal.
 - ii. Silencers with a diameter between 18 inches and 30 inches shall be constructed of no less than 20 gauge casing and 26 gauge perforated metal.
 - iii. Silencers with a diameter between 30 inches and 54 inches shall be constructed of no less than 18 gauge casing and 22 gauge perforated metal.
 - iv. Silencers with a diameter greater than 54 inches shall be constructed of no less than 18 gauge casing and 22 gauge perforated metal.
 - d. Access Doors: Where required, attenuators shall be supplied with an access door(s) to permit fire damper service. Access doors shall be supplied as an integral part of the attenuator by the attenuator manufacturer.
2. No-Media Silencers:
 - a. No-Media silencers shall not contain absorptive media of any kind. Attenuation shall be achieved with controlled impedance membranes and broadly tuned resonators.

C. Construction:

1. Sound attenuators shall be constructed in accordance with ASHRAE and SMACNA standards for the pressure and velocity classification specified for the air distribution system in which it is installed.
2. Material gauges noted in Paragraph B, are minimums.
3. Material gauges shall be increased as required for the system pressure and velocity classification. The attenuators shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.
4. Where required, silencer shall be constructed from stainless steel or aluminum.
5. Casings shall be lockformed and sealed, except as noted in Paragraph B, to provide leakage-resistant construction. Airtight construction shall be achieved by use of a duct-sealing compound supplied and installed by the contractor at the jobsite.
6. All perforated steel shall be adequately stiffened to insure flatness and form. All spot welds shall be painted.

D. Acoustic Performance:

1. Sound attenuator dynamic insertion loss shall not be less than that listed in the attenuator schedule.
 2. Sound attenuator generated noise shall not be greater than that listed in the attenuator schedule.
 3. Acoustic performance shall include dynamic insertion loss and generated noise for forward flow (air and noise in same direction) or reverse flow (air and noise in opposite direction) in accordance with the project's air distribution system requirements.
 4. All attenuator ratings shall be determined in a duct-to-reverberant room test facility which provides for airflow in both directions through the test attenuator in accordance with the ASTM E-477-06a test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.
- E. Aerodynamic Performance:
1. Attenuator pressure drops shall not exceed those listed in the attenuator schedule. Attenuator pressure drop measurements shall be made in accordance with the ASTM E-477-06a test standard. Tests shall be conducted and reported on the identical units for which acoustical data is presented.
- F. Submittals:
1. Provide acoustical system calculations for all duct systems with attenuators to demonstrate that the resultant ductborne sound levels of the equipment as measured in the occupied spaces meet the specified criteria. In the absence of specified background sound level criteria, the guidelines as expressed in Table 34 of Chapter 47, "Sound and Vibration Control" of the 2003 ASHRAE Handbook - HVAC Applications, shall be used.
 2. The manufacturer shall supply certified test data for each scheduled attenuator. The data shall include dynamic insertion loss, generated noise and pressure drop for forward or reverse flow, matching the project's air distribution system requirement. All ratings shall be conducted in the same facility and shall utilize the same attenuator.
- G. Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work shall be limited to Vibro-Acoustics or Semco.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

- B. Provide fire dampers where ducts penetrate a floor slab, and elsewhere as indicated.
- C. Install balancing dampers where indicated, and at each ducted air inlet and outlet. Dampers are not required where a single air outlet occurs downstream of an air terminal (VAVs, etc.).
- D. Install turning vanes in square or rectangular elbows (45 degrees and greater) in supply, return and exhaust air systems, and elsewhere as indicated.
- E. Install airtight access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter. Duct access panels shall be adequately sized to provide access to all fire and/or smoke damper fusible links.
- F. All electrical connections to smoke damper actuators and smoke detectors (duct or ceiling mounted) shall be provided by the ATC contractor.
- G. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 DUCT CLEANING

- A. Prior to cleaning or sanitizing ductwork/equipment, all equipment utilized to perform those processes shall be sanitized. Examine ductwork/equipment prior to performing work and provide new duct openings where required to provide visual inspection of the duct interior.
- B. Unless indicated otherwise, the systems shall be cleaned and sanitized in the following order:
 - 1. Exhaust systems
 - 2. Return systems
 - 3. Air handling unit(s)
 - 4. Air handling unit supply systems
- C. Duct cleaning of the above systems listed shall include air devices, terminal reheat units, etc.
- D. Cleaning Process:
 - 1. General:
 - a. Systems shall be de-energized while duct cleaning and sanitizing are in progress.
 - b. HEPA filter vacuums shall be used to keep room air clean. Ceiling tile shall be handled with care, and repaired or replaced as required to restore to the original condition.
 - 2. Air Handler Cleaning Procedures:
 - a. Vacuum completely, beginning with the area upstream of the filters. Filters shall be replaced at the completion of the work.
 - b. Vacuum the fan and fan chamber.
 - c. Wash/degrease fan blades as required.
 - d. Wash/degrease chamber upstream of the coils as required.
 - e. Clean coils.
 - f. Sanitize.
 - 3. Coil Cleaning Procedure: The procedure shall be customized to the situation encountered.

The most heavily soiled coils may take a more complicated procedure of solution/pressure spraying. Most require only low pressure application of special cleaning solution and rinsing after they are first fully vacuumed.

4. Furniture Coverage from Incidental Dirt: As required, drape surrounding instruments, computers and areas with plastic to protect them from any incidental dirt generated during the cleaning process. Work environment shall be clean at all times. Floor shall be vacuumed as needed.
5. Duct Cleaning: Cleaning shall be accomplished by mechanical means in conjunction with the use of High CFM HEPA style vacuums and three (3) filtered canister vacuums. Mechanical means may include vacuum brushing of the duct interior, auger style mechanical devices, or high pressure air activated in duct cleaning devices to scrape off any dirt adhered to duct walls. Cleaning may be accomplished by a combination of these methods. Where possible, clean a full run or section before beginning another to insure full cleaning coverage. All material in the vacuum shall be disposed of daily after being treated with a sanitizer.
6. Sanitizing Process: Sanitizing shall be accomplished in two stages. First, it shall be done as each section of the air system is cleaned. The sanitization process shall be repeated again after the complete system has been cleaned. All sanitizing shall be completed before access is sealed. Diffusers shall be cleaned and sanitized. EPA recognized/registered sanitizers only shall be used. MSDS information shall be supplied for materials selected. Sanitizers/encapsulants shall not be used as a substitute for proper cleaning.
7. Clean Tests: Tests for bacteria/fungi shall be performed after all cleaning and sanitizing is completed to insure the clean standards have been met. This shall be done while the system is in operation and shall be a minimum of forty-eight (48) hours after the last sanitation has been completed.
8. Closing and Sealing: Provide galvanized sheet metal plate(s) to be used as access for the majority of locations. Square cut 22 gauge metal shall be used with each plate to lap its edges by one inch all around. Screws shall be placed at four inch (100 mm) intervals and the plate shall be sealed with a water-based fireproof sealant to ensure proper seal of the system to match existing pressure classification.
9. Encapsulation: There may be times when it is necessary to use an encapsulant on interior lined duct. It should be used only if circumstances require it (for example, the lining may be breaking down), and shall be agreed to in advance by the client. It shall not be used as a substitute for cleaning.
10. Duct cleaning shall be performed by Applied Building Technologies, Inc. or equivalent.

3.4 FIELD QUALITY CONTROL

- A. Operate installed duct accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

3.5 ADJUSTING AND CLEANING

- A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper operation.
 1. Final positioning of manual dampers is specified in Division-23 section "Testing, Adjusting and Balancing."

- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- C. Provide MERV 13 filter media at all return air inlet locations throughout the duration of construction. Filter media shall not be removed until final filters are installed in the air handling units.

END OF SECTION 233300

SECTION 233600 - AIR TERMINALS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of air terminals work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of air terminals specified in this section include the following:
 - 1. Air Terminals
 - a. Single Duct Variable Air Volume (VAV)

1.2 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. ARI Compliance: Provide air terminals which have been tested and rated in accordance with the most current version of ARI Standard 880 "Industry Standard for Air Terminals" and bear ARI certification seal. Sound level adjustment factors shall be based on the most current version of ARI Standard 885. Coils shall be ARI 410 rated and certified.
 - 2. NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A "Air Conditioning and Ventilating Systems".

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including performance data for each air terminal furnished; schedule showing drawing designation, room location, number furnished, model number, size, Noise Criteria (NC) levels for discharge and radiated sound, static pressure loss, and accessories furnished. Also, provide installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Wiring Diagrams: Submit ladder-type wiring diagrams for electric power and control components, clearly indicating required field electrical connections.
- D. Maintenance Data: Submit maintenance data and parts list for each type of air terminal; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and maintenance data in maintenance manual.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver air terminals wrapped in factory-fabricated fiberboard type containers. Identify on

outside of container type of air terminal and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in boxes.

- B. Store air terminals in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work shall be limited to the following:
 - 1. Titus
 - 2. Krueger
 - 3. Price
 - 4. Nailor
 - 5. Anemostat
 - 6. ETI

2.2 SUPPLY AIR TERMINALS

- A. General: Provide factory-fabricated and tested air terminals as indicated, selected with performance characteristics which match or exceed those indicated on schedule.
- B. Under base bid supply air terminal controller to be replaced only, under add alternate entire air terminal shall be replaced, refer to construction documents for quantities and additional requirements.
- C. Casing/Insulation: Unit casing shall be 22 (.8 mm) gauge galvanized steel, internally insulated. Insulation shall be as follows:
 - 1. Insulation shall be 3/4-inch thick non-porous Engineered Polymer Foam Insulation (EPFI), closed foam insulation. Thermal conductivity shall meet or exceed 0.25 BTU-in./hr. ft.² @ 75°F (.036 W/meter kelvin). Insulation shall retain zero moisture providing no support for bacterial or fungal growth and shall comply with UL 181, UL 723, NFPA 255 (25/50), NFPA 90A, ASTM C177, ASTM E84 and ASTM E96. Insulation shall be listed by Factory Mutual Research for compliance with all codes and standards previously listed.
- D. Leakage: Construct casings and dampers such that when subjected to 3.0-in w.g. (747 Pa) pressure, total leakage does not exceed maximum values indicated below. Casing leakage rate shall include leakage from the entire terminal unit assembly from inlet connection through a factory mounted reheat coil (where applicable).

<u>Inlet Size</u>	<u>Casing Leakage</u>	<u>Damper Leakage</u>
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5, 6	4 cfm (1.9 L/s)	5 cfm (2 L/s)
8	6 cfm (2.8 L/s)	5 cfm (2 L/s)
10	8 cfm (3.8 L/s)	5 cfm (2 L/s)
12	9 cfm (4.3 L/s)	5 cfm (2 L/s)

- E. Air Dampers: Construct of non-corrosive heavy gauge metal with shaft rotating on self-lubricating bearings. Provide mechanism to vary air volume from minimum to maximum in response from signal from thermostat.
- F. Provide a factory mounted control enclosure.
- G. Provide an access panel in bottom of air terminal.
- H. Controls: Unit controls shall reset supply air volume to within 5% of design air flow regardless of system pressure.
 - 1. Units shall have pressure independent control. Air flow limiters will not be accepted.
 - 2. Terminal units with electronic controls shall provide the following features:
 - a. Setting for normally open or normally closed.
 - b. Setting for direct acting or reverse acting mode.
 - c. Setting for minimum and maximum air flow.
 - d. Setting for reset start point.
- I. Identification: Provide label on each unit indicating size designation, CFM range and CFM factory-setting.
- J. Sound: The manufacturer shall furnish certified sound power levels, and associated Noise Criteria (NC) levels, for both discharge and radiated sound, tested in accordance with the most current ASHRAE standards and ARI standard 880. The tests shall be conducted in an ARI-ADC approved sound facility. The following sound adjustment factors shall be utilized for each terminal unit to determine resulting sound levels within the occupied spaces:

dB reduction (2nd thru 7th octave bands)

	2	3	4	5	6	7
Discharge: 5" inlet	16	12	9	7	8	9
6" inlet and above	18	13	11	10	11	12
Radiated: 5" inlet and above	17	18	19	25	30	33

The above attenuation values include environmental adjustment factor, branch power division, end reflection, space effect, ceiling tile loss, etc. Additional attenuation factors shall not be used and will not be acceptable. Where lined (fiberglass) ductwork is indicated on the drawings, attenuation reduction values indicated in the most current version of ARI standard 885 can be utilized up to a maximum of five (5) feet of lined ductwork.

Maximum Noise Criteria (NC) levels, indicated on the mechanical drawings, shall not be exceeded in the 2nd thru 7th octave bands at the design inlet static pressure indicated on the schedule (typically 1.5 in. w.c.). Where required, provide sound attenuators for discharge noise

control, and/or GWB backed acoustical ceiling tile (gypsum wall board with 3-1/2" batt insulation attached to ceiling tile) for a radius of 15 feet from the VAV terminal for radiated noise control, to obtain Noise Criteria (NC) levels indicated on the drawings. Sound attenuator shall be manufactured such that fiberglass is not exposed to the airstream.

- K. Hot Water Reheat Coils: Provide heating coils constructed of copper tubes and aluminum fins. Coils shall be internally mounted in the casing at the factory. Heating coils shall be by terminal unit manufacturer. Unless specifically indicated otherwise, provide minimum 2-row coils for all air terminals.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which air terminals are to be installed. Do not proceed with work until satisfactory conditions have been corrected.

3.2 INSTALLATION OF AIR TERMINALS

- A. General: Install air terminals as indicated, and in accordance with manufacturer's installation instructions.
- B. Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.
- C. Code Clearance: The installation shall provide adequate clearances in accordance with the latest edition of the National Electrical Code (NEC) for all components associated with the air terminal units.
- D. Duct Connections: The sheet metal contractor shall provide a minimum of three (3) duct diameters, but not less than three feet (3'), of straight, rigid duct upstream of the terminal unit inlet.
- E. Insulation: The Contractor shall insulate all external portions of the coil and /or coil section to prevent condensation.

3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals and duct connections to air terminals are leak-tight.
- B. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

3.4 CLEANING

- A. Clean exposed factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 233600

SECTION 23 36 10 - EXHAUST AIR VALVES

PART 1 - GENERAL

1.1 OVERVIEW

- A. The intent of this Specification is to define the requirements for the bladder-type airflow valve control system. The system specified shall be based on factory-mounted current-to-pressure transducer control valves used on the acid, solvent and hydride exhaust from the cleanroom space.
- B. All control equipment required to fulfill this Specification shall be manufactured and provided by the exhaust airflow control system equipment manufacturer.
- C. It shall be understood that the Drawings and Specifications describe the approximate locations of the work. Do not scale the drawings to determine exact positions and clearances. Obtain from Engineer, Commissioning Agent or the COR any dimensions not shown.
- D. Details of construction and of workmanship where not specifically described herein or indicated on the drawings shall be subject to the Engineer's or COR's approval. It is the intent of these Specifications to provide complete systems, left in good working order, ready for operation, including necessary labor and materials, whether or not specifically shown on the Drawings or mentioned herein.
- E. Before submitting proposals, examine the Specifications and all Drawings relating to the work and become fully informed as to the extent and character of the work and the relation of the work to that of other Sections. Examine the Drawings of other Sections to become familiar with all the problems and details of the building construction and to note conditions, which affect the work.
- F. Any changes required in the ductwork, or any other mechanical systems, which would be required for the application of any proposed exhaust airflow equipment other than the specified "Base Bid" or "Basis of Design" shall be the responsibility of the Airflow Valve Control system supplier. Any additional engineering, sheet metal or mechanical equipment (i.e. upsized exhaust systems) costs other than that as required by the "Basis of Design" shall be borne by the airflow control valve supplier. All changes shall be subject to prior approval by the Architect/Engineer.
- G. Only those devices specifically named under "acceptable manufacturers" or through addendum shall be considered for approval. Other devices submitted after the bid opening will be returned without review.
- H. Being listed herein as an approved manufacturer does not permit the manufacturer to provide standard manufactured equipment which does not comply with the performance and/or physical characteristic requirements of the Contract Documents.
- I. All substitutions must be included in the Base Bid, and must be accompanied by a letter of equivalency certifying the products equivalency in all performance and physical characteristics to the products listed herein. The proposed substitutions shall be all inclusive of all cost and physical implications throughout the project. Under no circumstances should the substitution

result in added cost to the project. Project specifications/documents shall not be revised to reflect the substitution should the substitution be approved by contracting office.

1.2 DESCRIPTION OF WORK

- A. Furnish exhaust airflow control valves as listed in schedule and on drawings. All installation labor shall be as stated below under .
- B. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and shall not be custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use.

1.3 GUARANTEE

- A. The Exhaust Airflow Valve System contractor shall provide five (5) years standard warranty. Warranty shall commence upon date of shipment.

1.4 QUALITY ASSURANCE

- A. Exhaust Airflow Valve System contractor shall provide written approvals and certifications after installation has been completed.
- B. Exhaust Airflow Valve System airflow control valve contractor must prove that they have been engaged in the provision, installation and service of this type of equipment for at least five (5) years and has a fully equipped, factory trained and authorized service organization.
- C. For any equipment submitted for approval other than "Basis of Design", the Exhaust Airflow Valve System contractor shall state what, if any, specific points of the system operation differ from these Specifications.
- D. The Exhaust Airflow Valve System contractor shall continue to bear the liability for replacement of accepted substituted equipment in the event that the equipment fails to perform as specified, or to meet approval of all authorities having jurisdiction, within five (5) years after beneficial use by the Government.

PART 2 - PRODUCTS AND SYSTEMS

2.1 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers are:
 - 1. Accutrol / T-PRD-5000 Airflow Control Valves (Basis of Design)

2.2 GENERAL

- A. The airflow control valves shall include the following components:

1. Exhaust Air Valves (VAV)
 - a. Consists of bladder-type airflow control valve with integrated factory-mounted current-to-pressure transducer.

2.3 EXHAUST AIRFLOW CONTROL VALVES

- A. Airflow control valves shall be of the linear type and shall operate with a turndown ratio greater than 50 to 1. The control valves shall utilize inflatable EPDM bladders. Valves shall incorporate 304 stainless steel airfoil bladder covers and casings.
- B. Airflow control valves shall operate without linkages, springs, levers, or bearings, and shall exhibit no deadband or hysteresis. Airflow control valves shall be fail-safe to the open position. Airflow control valves shall be capable of operating with pressure drops as low as 62 Pa and as high as 2000 Pa.
- C. Pressure drop through the airflow control valves shall not exceed 100 Pa with a face velocity of 10 m/s. Where airflow control valves are to be combined with pressure transmitter shall be installed at the factory, and calibrated in an NIST traceable wind tunnel, to provide one complete assembly.
- D. The airflow control valves shall have a removable end-panel for servicing.
- E. The airflow control valve shall be duct-mounted and consist of pneumatically controlled airfoils within valve body.
- F. The valve shall be provided with 138 kPa clean, dry instrument air supply to operate.
- G. The valve shall be capable of operating within -40C to 93C in non-condensing environments.
- H. The shutoff leakage shall be less than 3% of rated airflow at 10 m/s, with 90 kPa applied to the valve.
- I. Airflow control valves shall be NC rated by an independent testing agency. Airflow Control Valves shall meet the following criteria, at 1" pressure drop across valve:

Size	L/S hz:	Sound Power Level (in decibels) for octave bands (hz)							
		63	125	250	500	1000	2000	4000	8000
36x12	3000	67	72	70	73	76	73	65	57

PART 3 - EXECUTION

3.1 WORK BY OTHERS

- A. The Building Automation System (BAS) contractor shall be responsible for the following:
 1. Coordination with installation of airflow measurement stations shall be performed by the BAS contractor.

2. Provision, installation and final termination of all control wiring, including airflow control valves, and network communications wiring. (Refer to BAS section for control wiring specifications.)
3. Provision and installation of pneumatic tubing to all airflow control valves as required.

B. The sheet metal contractor shall:

1. Install all exhaust airflow control valves.
2. Provide and install all standard fittings, hangers, and ancillary devices required to install duct devices shall be provided by this contractor.

C. The air balancing contractor shall:

1. Verify airflow volume readings and control points in each control mode.

3.2 SYSTEM TURNOVER

- A. The exhaust air terminal control system shall be commissioned by the commissioning agent, mechanical contractor and control system contractor.

END OF SECTION 23 36 10

SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section and all other Division-23 sections.
- B. Types of air outlets and inlets required for project include the following:
 - 1. Ceiling air diffusers
 - 2. Registers and grilles

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
 - 1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".
 - 2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
 - 3. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".
 - 4. ADC Seal: Provide air outlets and inlets bearing ADC Certified Rating Seal.
 - 5. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
 - 1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, Noise Criteria (NC) levels, static pressure loss, and accessories furnished.

2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
 3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.
- C. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.
- B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work shall be limited to the following:
1. Titus
 2. Krueger
 3. Price
 4. Nailor
 5. Anemostat
 6. Metal Air

2.2 CEILING AIR DIFFUSERS

- A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide ceiling air diffusers that have, as a minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent

ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

- D. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule. The following requirements shall apply to nomenclature indicated on schedule:
- E. Diffuser Materials:
 - 1. Aluminum Construction: Manufacturer's standard extruded aluminum frame and adjustable blades.
- F. Diffuser Faces:
 - 1. Square: Square housing, core of square concentric louvers, square or round duct connection. (See drawings).
- G. Diffuser Finishes:
 - 1. Aluminum Enamel: Air-dried aluminum enamel prime finish.
 - 2. White Enamel: Semi-gloss white enamel prime finish.
 - 3. Aluminum Anodize: Aluminum etched and anodized, covered with clear lacquer finish.

2.3 REGISTERS AND GRILLES

- A. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide registers and grilles that have, as a minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Surface Compatibility: Provide registers and grilles with border styles that are compatible with adjacent surfaces, and that are specifically manufactured to fit with accurate fit and adequate support. Refer to general construction drawings and specifications for types of construction which will contain each type of register and grille.
- D. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule. The following requirements shall apply to nomenclature indicated on schedule:
 - 1. Register and Grille Materials:
 - a. Aluminum Construction: Manufacturer's standard extruded aluminum frame and adjustable blades.
 - 2. Register and Grille Faces:
 - a. Horizontal Fixed Blades: Horizontal blades, fixed at 35 degrees, with 3/4" (20 mm) spacing. Blades shall be parallel to long dimension.

3. Register and Grille Patterns:
 - a. Single Deflection: 1-set of blades in face.
4. Register and Grille Finishes:
 - a. Aluminum Enamel: Air-dried aluminum enamel prime finish.
 - b. White Enamel: Semi-gloss white enamel prime finish.
 - c. Aluminum Anodize: Aluminum etched and anodized, covered with clear lacquer finish.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install air outlets and inlets in accordance with manufacturer's written instructions. Air outlets and inlets shall be independently supported from the structure at two (2) locations and in accordance with recognized industry practices to ensure that products serve intended functions. The ceiling or ceiling grid shall not be considered as a means of support.
- B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.
- C. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling modules.
- D. Provide MERV 13 filter media at all return air inlet locations throughout the duration of construction. Filter media shall not be removed until final filters are installed in the air handling units.

END OF SECTION 233700

SECTION 234000 - AIR CLEANING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of air cleaning work required by this section is indicated on drawings and schedules, and by requirements of this section and all other Division-23 sections.
- B. Types of air cleaning equipment specified in this section include the following:
 - 1. Air Filters:
 - a. High efficiency particulate air (HEPA)
 - 2. Filter Gauges

1.2 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. NFPA Compliance: Comply with applicable portions of NFPA 90A and 90B, and NEC pertaining to installation of air filters and associated electric wiring and equipment.
 - 2. UL Compliance: Comply with UL Standards pertaining to safety and performance of air filter units.
 - 3. ASHRAE Compliance: Comply with provisions of ASHRAE Standard 52 for method of testing, and for recording and calculating air flow rates.
 - 4. ARI Compliance: Comply with provisions of ARI Standard 850 pertaining to test and performance of air filter units.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data including, dimensions, weights, required clearances and access, flow capacity including initial and final pressure drop at rated air flow, efficiency and test method, fire classification, and installation instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for filter rack assemblies indicating dimensions, materials, and methods of assembly of components.
- C. Maintenance Data: Submit maintenance data and spare parts lists for each type of filter and rack required. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual.

PART 2 - PRODUCTS

2.1 AIR FILTERS

- A. High Efficiency Particulate Air (HEPA) Terminal Filters: Provide 4" direct replacement factory-fabricated high efficiency particulate air filters with holding casing; where shown, in sizes indicated to fit existing modular ceiling system. Provide glass fiber media, rated UL Class 1 and with dustspot efficiency of not less than 99.99%, when tested with 0.3 micron particles in accordance with MIL-F-51068, and with static pressure drop of not greater than (100 Pa at 0.508 m/s face velocity), when clean and operating at rated capacity. HEPA shall be equipped with knife edge gel seal channel compatible with existing HEPA filter housing. Filter shall be replaceable without removing housing from ceiling. Cam-Fil Part Number 5053828 HEPA Filter, or approved equal by Cleanroom International or Flanders.
- B. Reinstall or replace any loose or damaged hanging clips during the replacement of filters and repair of housing supply connections. Hanging clips shall be extruded aluminum and clear anodized after cutting to length capable of support a 180 kg concentrated load.

2.2 FILTER GAGES

- A. Provide magnehelic filter gauges for each filter bank graduated to read from 0 to 3" w.g. (0 to 750 Pa).

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which air filters and filter housings will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

- A. General: Comply with installation requirements as specified elsewhere in these specifications pertaining to air filters housing/casings and associated supporting devices.
- B. Prior to the installation of new HEPA filters the existing housing shall be cleaned, resealed, if required, and all existing gel seal removed.
- C. All HEPA filters shall be tested prior to installation, refer to Section 130003 for certification requirements.
- D. Install air filters and holding devices of types indicated, and where shown; in accordance with air filter manufacturer's written instructions and with recognized industry practices; to ensure that filters comply with requirements and serve intended purposes.
- E. Locate each filter unit accurately in position indicated, in relation to other work. Position unit

with sufficient clearance for normal service and maintenance.

- F. Coordinate with other work including ductwork and air handling unit work, as necessary to interface installation of filters properly with other work.
- G. Install filters in proper position to prevent passage of unfiltered air. Filters shall be installed and tested for integrity for certification. Damaged filters or filters with failures to integrity test shall be replaced with new HEPA filters at no additional cost to NIST. Refer to recertification requirements for additional specifications.
- H. Install magnehelic gauges upstream and downstream of filters to indicate air pressure drop through air filter. Mount filter gauges on outside of filter housing or filter plenum, in accessible position. Adjust and level inclined gauges if any, for proper readings.

3.3 FIELD QUALITY CONTROL

- A. Operate installed air filters to demonstrate compliance with requirements. Test for air leakage of unfiltered air while system is operating. Correct malfunctioning units at site, then retest to demonstrate compliance, otherwise, remove and replace with new units, and proceed with retesting.

3.4 EXTRA STOCK

- A. Provide ten (10) complete extra set of HEPA filters of standard size. Obtain receipt of delivery from COR that new filters have been received.

END OF SECTION 234000

