The University of Vermont

Burlington, Vermont

SPECIFICATIONS

for the Construction of

COSMOGENIC NUCLIDE LABORATORY AT DELEHANTY HALL
DEPARTMENT OF GEOLOGY

ISSUED FOR CONSTRUCTION - CONFORMED

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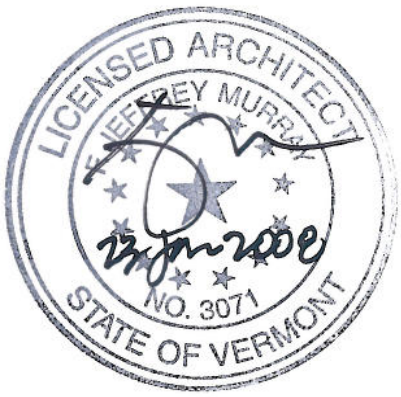
IDC ARCHITECTS
Pittsburgh, Pennsylvania
January 23, 2008



Project No. 364972

SECTION 00075

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SECTION 01000

GENERAL TECHNICAL REQUIREMENTS

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2.0 SITE DESIGN CRITERIA

A. Provide equipment, components, structures, and paving in accordance with the following design criteria unless otherwise specified:
   1. Location: University of Vermont – Trinity Campus, Delehanty Hall, 180 Colchester Avenue.
      a. State: Vermont.
      b. County: Chittenden.
      c. City: Burlington.
   2. Altitude: 201 feet ASL.
   3. Seismic Zone: 2A.
      a. Importance Factor: 1.0.
   4. Temperature (Indoors): 75 degrees F summer maximum and 72 degrees F winter minimum.
   5. Wind Loading: 70 mph, exposure B
   6. Snow Loading: 40 psf, plus 10 psf collateral loading.
   7. Rainfall (Maximum): 4 inches per 24 hours.
   8. Temperature and Humidity:
      a. Summer: 88 degrees F dry bulb and 71 degrees F wet bulb.
      b. Winter: 0-grain-per-pound moisture and -10 degrees F dry bulb.

3.0 DEFINITIONS

A. Owner:

The University of Vermont & State Agricultural College
C/O Facilities Design and Construction
Marsh Hall, Suite 10
31 Spear Street
Burlington, Vermont 05405
Contact: Myron Wheeler
Phone: 802-656-3291 Fax: 802-656-8410

B. IDC:

CH2M HILL doing business as IDC / IDC Architects
200 Corporate Center Drive
Pittsburgh, Pennsylvania 15108
Contact: Michael Warren, AIA
Phone: 412-269-2535 Fax: 412-269-4525

C. Construction Manager: ReArch Company

30 Community Drive
Suite #8
South Burlington, Vermont 05403
Contact: Bert Delabruere
Phone: 802-863-8727 x1 Fax: 802-863-8734

1. An agreement between Owner and the above organization has been executed to provide construction management services.
2. Duties and responsibilities of the Construction Manager with regard to the Contract Document are as follows: The Construction Manager is appointed as the Owner's representative for work performed under this Contract. Where the Specifications require Owner review, authorization, approval, investigation, concurrence, or other action the Construction Manager shall provide such action. Where the Specifications require Contractor to submit to, notify, report to, cooperate with, or otherwise provide information to the Owner, the Contractor shall provide such information to the Construction Manager. In general, the rights and obligations of the Owner under this Contract will be administered by the Construction Manager.

D. Vendor: the authorized distributor or agent of the manufacturer to make direct sale of the specified products and entering into an agreement with Owner. Wherever the word "Contractor" appears in Division 1 through Division 16 of the Specifications as it relates to the furnishing of items summarized in Section 01110, Summary of Work, it shall be synonymous with "Vendor" unless otherwise defined.

E. Changes: Modifications to the Contract.
1. Change Orders: Changes to the scope of work which impact the Contract sum or Contract time require a fully executed change order.
2. Construction Change Directive: written order prepared by IDC and signed by the Owner directing Contractor to make changes to the scope of work which may or may not impact Contract sum or Contract time, but is evidence that the parties expect that the construction change directive will be incorporated into a subsequently issued change order.
3. Field Orders: Changes to the scope of work not requiring change in Contract sum or Contract time will be made by a field order. If Contractor believes a field order impacts Contract sum or Contract time, Contractor shall notify Owner in writing within 3 calendar days and before starting the field order change, except in an emergency.

F. Hazardous Materials: hazardous substances as defined in the Comprehensive Environmental Response, Compensation, and Liability Act, hazardous waste as defined in the Resource Conservation and Recovery Act, and similar terms as used in

applicable federal, state, and local statutes, rules, and regulations to include carcinogenic, acutely toxic, flammable, or explosive materials in any form.

4.0 CORRESPONDENCE

A. Communications:
   1. Direct communications, correspondence, and submittals for the project to the Owner at the address above.
   2. Maintain log of communications and correspondence.
   3. Limit letters or faxes to a single subject and identify by a transmittal number correlated to the correspondence log.
   4. Confirm telephone conversations in writing.
   5. Progress Reports: Provide monthly report to include, as a minimum, the following.
      a. Activity during past month.
      b. Confirmation of schedule.

B. Language: Prepare and submit Contract Documents including but not limited to submittals, correspondence, RFIs, and O & M manuals in English. If otherwise required by the Contract prepare a translated copy in the language of the country where the project is located. To the maximum extent permitted by the governing law of the Contract, the English version shall govern if there is any inconsistency or conflict between the two translations.

5.0 MANUFACTURER'S REPRESENTATIVE REQUIREMENTS

A. Specifications may require a manufacturer's representative be provided for specified functions on site for a stated period of time. The daily rate to be charged for providing the manufacturer's representative beyond the stated period of time as may be required to complete the specified activities is shown in the Contract. The daily rate for the additional services shall be the same rate that will be used to reduce the Contract sum to account for fewer days spent than the number stated in the Specifications.

B. During subsequent work activities by the installing workers, the manufacturer's representative shall provide periodic, timely inspection and counseling to ensure system complies with factory requirements and the specifications and that it will operate at the specified level of performance.

C. The manufacturer’s representative shall submit a written report listing tasks performed, observations, and finished results.

6.0 CONFLICTS WITH OR WITHIN THE CONTRACT DOCUMENTS

A. If, during the performance of the work, the Contractor discovers conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and provisions of laws or regulations applicable to the performance of the work, or of standards, specifications, manuals, codes, or of instructions of manufacturers or vendors, notify the Owner in writing immediately. Do not proceed with the work affected by the conflict (except in an emergency) until an amendment or supplement to the Contract Documents has been issued.

7.0 SUBMITTALS

A. General:
   1. Submittals shall be accompanied by a transmittal that lists attachments.
   2. Review of submittals by IDC will be for the purpose of checking for conformance with information given and the design concept expressed in the Contract Documents, and shall not relieve Contractor from responsibility for errors or omissions contained in the submittals. IDC may make changes or corrections to the submittals, reproduce copies for its own use and return a marked up copy to the Contractor. If major revisions are required, the submittal will be returned to the Contractor to correct and resubmit. If Contractor proceeds with ordering materials or equipment without a completed IDC review, it does so at its sole risk.
   3. Submittals will be acted upon by IDC as promptly as possible and returned to the Contractor no later than 10 working days after receipt.
   4. Mark submittals with the following, as a minimum:
      a. Specification section number.
      b. Project identification.
      c. Intended use or location for submittal items.
      d. Purchase order number, if issued.
      e. Owner's tag or identification number for products, instruments, and equipment.
      f. Line number(s) on piping drawings.
      g. Date of issue.
      h. When submitting product data sheets where multiple items are listed, indicate the specific items being submitted with an arrow.
   5. Revisions to documents previously submitted shall be clearly identified as to which items specifically were revised.
   6. The quantity of submittals required, at a minimum, is:
      a. Product Data (Submittals That can be Duplicated on a Copy Machine, Usually 8-1/2-Inch by 11-Inch Size): six copies.
      b. Shop Drawings: one reproducible set and three black line sets.
      c. Samples: three sets.

7. The practice of submitting incomplete or unchecked submittals is not acceptable. Submittals which, in the opinion of IDC, clearly indicate that they have not been stamped, dated, and checked by Contractor will be considered as not complying with the intent of the Contract Documents and will be returned to Contractor for resubmission in the proper form.

B. Operating and Maintenance Manuals:
   1. When the individual specifications require operating and maintenance manuals provide one copy with shipment and six copies of the manuals within sufficient time to allow for training of Owner's personnel. Provide in three-ring, side-entry binders with durable plastic covers containing a detailed table of contents with tab dividers for major sections and special equipment and including:
      a. Description of the system provided.
      b. Handling, storage, and installation instructions.
      c. Detailed description of the function of each principal component of the system or equipment.
      d. Operating Procedures:
         1) Prestartup activities required.
         2) Startup.
         3) Normal operation.
         4) Emergency shutdown.
         5) Normal shutdown.
         6) Troubleshooting guide.
      e. Maintenance:
         1) Complete Lubrication Requirements: type and source of lubricant, interval between lubrication, etc.
         2) Preventative and repair maintenance procedures.
         3) Complete spare parts list with cross-reference to original equipment manufacturer's part numbers.
      f. Control and Alarm Features:
         1) A schematic of control systems.
         2) Control loop electric ladder diagrams.
         3) A listing of controller operating set points.
         4) A listing of settings for alarms and shutdown systems.
      g. Safety and environmental considerations.
   2. Executed warranty documents.

C. Cost of Submittals:
   1. Preparation, assembly, review, and acceptance of substitutions, schedules, shop drawings, lists of materials, samples, mock-ups, and procedures submitted by Contractor shall be included in the Contract sum.
   2. Additional costs, which may result from providing submittals, shall be solely the obligation of Contractor.

D. General Submittal Requirements: are provided in Part 12 of this Section.

8.0 CODES AND STANDARDS

A. Comply with the latest codes and other legal requirements applicable to the materials, equipment, and services provided in accordance with the Contract, even if an applicable code or legal requirement is not referenced in the project specifications.

B. Promptly submit written notice to IDC of observed variances between the Contract Documents and legal requirements.

C. Materials, fasteners, piping systems, and equipment shall conform to ANSI and other U.S. standard dimensional requirements unless otherwise specifically required by the Specifications.

9.0 PRODUCT REQUIREMENTS

A. General:
1. Products shall comply with the project specifications, referenced standards, and applicable regulatory requirements.
2. Like items of equipment and distinct materials provided shall be from one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.
3. Provide manufacturer's standard finish and color unless specified otherwise.
4. Products shall be new and suitable for the intended use.
5. Do not install previously used products, except as specifically required or allowed by Contract Documents.
6. The use of asbestos or other hazardous substances in any product is prohibited unless specifically approved by Owner.

B. Product Options:
1. Products specified by referenced standards or by description only shall meet the standards and applicable requirements of the Contract Documents.
2. Where products are specified by brand name or model number with one or more listed acceptable manufacturers but is not classified as sole source, products from other manufacturers may be considered for substitution. Submit requests for substitution in accordance with the requirements specified below.

C. Substitutions:
1. Provide each request in writing to IDC with complete data substantiating compliance of proposed substitution with the Contract Documents.
2. Substitution requests may be submitted either before the Bid or any time during construction. Prebid approval of substitute products is not required.

Requests for substitutes during the Bid period will not be acted upon by IDC prior to Bid. Submit Bid prices based only on approved products.

3. Request for substitution constitutes a representation that Contractor:
   a. Has investigated proposed product and determined that it meets or exceeds the specified product.
   b. Shall provide the same warranty for the substitution as for the specified product.
   c. Shall coordinate installation and make other changes that may be required for work to be complete.
   d. Waives claims for additional costs that may subsequently become apparent due to the substitution.
4. IDC will determine acceptability of proposed substitution and, except for requests submitted prior to Bid, will notify Contractor of acceptance or rejection in writing within 10 working days of receipt of the written request.
5. The use of substitute materials is not allowed without prior written approval by IDC.

D. Delivery, Storage, and Handling:
   1. Package and transport products by methods to avoid damage during shipment and storage prior to installation. Deliver in undamaged condition in manufacturer's unopened containers or packaging, unload and store in a dry and clean condition. Take special care to protect products that may become pitted, rusted, corroded, or which may deteriorate during shipment or storage. Machinery shall have a wrapping of heavy-duty weatherproof plastic. Protect sealed interiors from moisture damage through the use of silica gel or similar desiccants. Fragile components, instruments, controls, and other delicate parts shall be packaged separately to reduce the possibility of damage during shipment and shall be conspicuously marked FRAGILE. Handling and storage instructions shall accompany the shipment.
   2. Handle products as recommended by the manufacturer with approved equipment and in a manner that will prevent damage. Clearly mark sling posts, lifting lugs, or other material handling devices. Products shall be suitably crated, skidded, boxed, sealed, or otherwise protected and shall be properly braced against movement during shipment. Instructions for removal of bracing shall accompany the shipment.
   3. Provide adequate weather protection such as waterproof tarpaulins, dunnage, or platforms above ground level and housings as required to protect the equipment and materials from weather. Provide temporary heating as necessary to protect covered equipment such as electrical gear from condensation where such could cause damage.
   4. Inspect shipments promptly to ensure that products comply with requirements, quantities are correct, and products are undamaged. Notify the Owner of evident discrepancies or damage.

10.0 SUPPORTING FROM BUILDING STRUCTURE

A. The following are guidelines for supporting mechanical, electrical, plumbing, or architectural items from the building structure. Coordinate load requirements from other contractors so no combination of loads exceeds the limitations provided in subparagraph G below.

B. At both the floor and the roof, attachments may be at concrete beams and slabs, and steel framing if present..

C. At floor and roof members (Beams, and girders), hang loads greater than 500 pounds concentric.

D. Comply with the Specifications for support and load requirements and restrictions. Coordinate and confirm support and load requirements with IDC. IDC will coordinate load requirements submitted by other contractors so combination loads do not exceed project structural design criteria limitations.

E. Support loads hung from concrete structure with cast-in-place inserts unless drilled-in anchors are specifically shown or approved by IDC in writing.

F. The above load restrictions and limitations shall apply to the substructure as well.

11.0 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	NO. OF WEEKS	AS INDICATED
01000-001	Exceptions to the Bid document requirements	X		
01000-002	Preliminary project schedule showing equipment delivery and work completion times, starting with execution of agreement	X		
01000-003	Specific condition or delivery time period for equipment or special material that may adversely affect the stated project completion and equipment delivery time period	X		
01000-004	Product handling, storage, assembly, installation, or adjustments required that impact design or installation of other work	X		
01000-005	List of spare parts with delivery time longer than 1 month	X		
01000-006	Contractor's construction safety and health plan	X		
01000-007	Identify hazardous substances, as defined in paragraph 3.0 F above that will be provided in any form with deliverables	X		
01000-008	Executed warranty documents			Before Substantial Completion
01000-009	Manufacturer's representative statement of system compliance with factory and specification requirements			Before Substantial Completion

END OF SECTION

SECTION 01001

GENERAL CONSTRUCTION REQUIREMENTS

1.0 CONTENTS

2.0 ADMINISTRATIVE REQUIREMENTS

A. Cost Controls: Within 5 working days after award of the Contract, submit a resource-loaded or cost-loaded (as requested by the Owner), time-scaled CPM schedule that is to a level of detail that permits the accurate assessment of progress. The schedule shall take into account the coordination of scheduling requirements of other contractors working on the project. This schedule is subject to the approval of the Owner and shall be the project schedule upon approval. Adjustments must be made in a timely manner so as not to impact the project coordination. Include a program for updating and reporting progress against the approved schedule.

B. Preconstruction Meeting:
   1. Within 5 days after the notice to commence construction or the start date specified in the Contract, the Owner will schedule and administer a preconstruction meeting with the Contractor and other contractors as Owner deems appropriate.
   2. The preconstruction meeting shall include representatives from the Owner, IDC, Contractor's project manager and field superintendents, and such other contractors, subcontractors, major suppliers, and others as Owner deems appropriate.
   3. The following items shall be included in the meeting agenda:
      a. Designation of representatives for each party and their authority.
      b. Scope of work review.
      c. Construction schedule review, including delivery/storage of Owner-furnished equipment/material.
      d. Facilities and equipment review, including specific items to be provided by the Owner, IDC, or another contractor.
      e. Paperwork requirements, including proof of workers' compensation insurance and certificates of liability insurance.
      f. Design drawing transmittal and review process.
      g. Shop drawing submittal process and schedule.
      h. Proposal submittal process.
      i. Extra work process.
      j. Design clarifications and information requests process.
      k. Progress billing process, including lien waivers.
      l. Connections to construction utilities.
      m. Special construction procedures requirements; e.g., cleanroom protocol.
      n. Parking and access requirements.
      o. Safety and security requirements, including accident reporting.
      p. Working hours of crews, including procedures for overtime.
      q. Work site work rules.
      r. QA/QC discussion.
      s. Use of client's facilities.

t. Maintaining as-built documents.
u. Hazardous materials control procedures.

C. Weekly Construction Meetings:
1. Provide an authorized representative to attend Owner's weekly construction progress meeting for the purpose of coordinating all phases of the work with other contractors and material suppliers, discussion of safety issues, and for preparation of detailed weekly work schedules including expediting requirements. To the extent commitments and schedules developed in these meetings do not constitute a change, they shall be binding upon the Contractor to the same degree as the approved scope and schedule.
2. Attendance by a Contractor's representative is mandatory when work is in progress.

D. Project Documents - Maintain at the work site one copy of the following Contract Documents available at all times for inspection by Owner:
1. The Contract, including addenda, amendments, field orders, change orders, and other modifications to the Contract.
2. Project specifications.
3. Project drawings provided by IDC, including additional drawings that may have been provided as a result of addenda, amendments, requests for information, clarifications, field orders, or change orders.
4. Reviewed shop drawings, product data, and samples.
5. Manufacturer's certificates, operation and maintenance manuals, warranties, inspection certificates and reports, field test records, permits, licenses, and other documents required by individual specification sections.

E. Work Limitations:
1. Perform work during normal working hours unless otherwise mutually agreed upon with the Owner.
2. Provide as little inconvenience as possible to Owner occupants of existing structures.
3. Schedule work in existing facilities and buildings with the Owner sufficiently in advance to enable Owner to make arrangements as may be required.
4. Perform overtime work when defective work would result if deferred until the next regular-time work period and when emergency circumstances involving public welfare and safety or protection of property arise.
5. Cameras or use of cameras on the property without permission of Owner is prohibited.
6. Public Right-of-Way:
a. No roadway, street, alley, emergency fire lane, or public passageway shall be closed or obstructed except as required by the work and then only after approval of those having jurisdiction over same.

b. Use of streets and passageways shall be in accordance with directives from the Owner.
c. Private rights-of-way (e.g., Owner traffic patterns) shall not be interrupted without authorization from the Owner.

3.0 CONSTRUCTION ENVIRONMENT, HEALTH, AND SAFETY

A. Construction Safety Program:
1. Provide Contractor's Construction Safety and Health Program with the Bid including Contractor's policies, procedures, and practices that demonstrates:
a. Management commitment and leadership.
b. Assignment of safety responsibility.
c. Identification and control of hazards.
d. Employee education and training.
e. Incident analysis and record keeping.
f. Emergency planning and procedures.
g. Conformance with applicable OSHA regulations (29 CFR Part 1926 or State program equivalent) including:
1) Subpart A – General.
2) Subpart B – General Interpretations.
3) Subpart C – General Safety and Health Provisions.
4) Subpart D – Occupational Health and Environmental Controls.
5) Subpart E – Personal Protective and Lifesaving Equipment.
6) Subpart F – Fire Protection and Prevention.
7) Subpart G – Signs, Signals and Barricades.
8) Subpart H – Materials Handling, Storage, Use, and Disposal.
9) Subpart I – Tools – Hand and Power.
10) Subpart J – Welding and Cutting.
11) Subpart K – Electrical.
12) Subpart L – Scaffolds.
13) Subpart M – Fall Protection.
14) Subpart N – Cranes, Derricks, Hoists, Elevators, and Conveyors.
15) Subpart O – Motor Vehicles, Mechanized Equipment, and Marine Operations.
16) Subpart P – Excavations.
17) Subpart Q – Concrete and Masonry Construction.
18) Subpart R – Steel Erection.
19) Subpart S – Tunnels and Shafts, Caissons, Cofferdams, and Compressed Air.
20) Subpart T – Demolition.
21) Subpart U – Blasting and Use of Explosives.
22) Subpart V – Power Transmission and Distribution.
23) Subpart W – Rollover Protective Structures, Overhead Protection.

24) Subpart X – Stairways and Ladders.
25) Subpart Y – Commercial Diving Operations.
26) Subpart Z – Toxic and Hazardous Substances.

B. Hazardous Materials Control Plan:
1. Submit to Owner, prior to bringing hazardous materials on the work site but no later than 30 days after the notice to proceed, Contractor's Hazardous Materials Control Plan. This plan shall coordinate with Owner's environmental program, if any, address the criteria applicable to Contractor's work, and include provisions for the following:
a. List of hazardous materials and material safety data sheet for each item listed.
b. Personnel safety procedures to be instituted for handling hazardous materials.
c. Measures to be instituted for material storage, labeling, dispensing, accidental discharge, spill prevention, and containment.
d. Disposal methods for such materials.
e. Cleanup measures, materials, or structures, necessary to prevent environmental contamination by such material in the event of a spill or accidental discharge.
f. Name and contact information for Contractor's resources responsible for responding to an emergency involving hazardous materials.
2. Hazardous materials include any substances or mixtures which are:
a. Carcinogenic.
b. Toxic.
c. Corrosive.
d. An irritant.
e. Strong sensitizer.
f. Radioactive.
g. Explosive.
h. Pyrophoric.
i. Flammable.
j. Combustible.
k. Reactive.
l. Generate pressure through decomposition or heat.

C. Project Environment, Health, and Safety Requirements:
1. Contractor shall:
a. Perform work in a safe manner, comply with safety, health, and environmental requirements of the Contract Documents as issued by the Owner and comply with applicable laws, codes, ordinances, rules, regulations, and lawful orders of public authorities.

b. Attend, prior to beginning work, a project safety orientation conducted by Owner.

c. Have and exercise, full legal responsibility for compliance to safety, health, and environmental rules and regulations by itself, its agents, employees, material suppliers, vendors, and subcontractors with respect to its portion of the work on the project; and directly receive and respond to, defend, and be responsible for any citation, fine, or penalty by reason of Contractor's failure or failure of Contractor's agents, employees, material suppliers, vendors, and subcontractors to so comply.

d. Have a representative on the work site when a lower tier subcontractor is performing any work, even if no work is being performed by Contractor's direct work forces. This representative shall be responsible for assuring that applicable safety, health, and environmental rules and regulations are observed and in addition shall be responsible for responding to medical emergencies related to subcontractor's employees or sub-subcontractors.

e. Uniformly enforce a policy that states the disciplinary action to be applied when employees violate safety and environmental rules. This policy will be consistent with Owner's safety and environmental enforcement policy, if any.

f. Provide first aid and medical treatment for its employees.

g. Provide safety and environmental training for its employees at its own expense, and document such training and provide copies to the Owner. Safety training shall include, but not be limited to:

1) Orientation to the safety and environmental policies and rules stipulated by the Owner, if any, prior to each employee's initial work assignment on the project.

2) Orientation of supervisors to the safety and environmental policies and rules and their responsibility to enforce them.

3) Weekly toolbox talks on an appropriate safety and environment subject for all employees.

4) Hazardous materials training.

5) Special safety training for those affected; such training shall include but not be limited to confined space entry, control of hazardous energy sources (electrical lockout/tagout), welding and cutting permit procedures, excavation and shoring, fall protection, scaffolding, etc.

6) Specific instructions to its employees regarding the use of personal protective equipment, personal safe work practices, employee's obligations and rights under the Contractor's safety and environmental policies. The Contractor will provide at its own expense, required personal protective equipment for its employees and required safety equipment and supplies as needed.

h. Conduct safety meetings with its employees and or supervision as necessary to ensure that safety and environment is adequately addressed in its work planning and execution. The Contractor will provide prior written notification of the time, place, and subject of the meetings and provide the Owner the opportunity to observe it. The Owner reserves the right to require changes necessary to comply with the project's safety rules and regulations.

i. Provide to the Owner copies of material safety data sheets (MSDS) for hazardous materials that Contractor brings on the work site, prior to the arrival of the materials on the work site. When requested by Owner, provide training to the Owner's employees and employees of other parties who may be routinely exposed to the materials used by Contractor. Such training will be at no additional cost to the Owner.

j. Provide a job safety analysis (JSA) identifying hazards before commencing each major phase or activity at the work site. The analysis will describe the plans and assign responsibility for hazard prevention or control of identified hazards.

k. Provide Contractor's safety representative to accompany Owner's safety representative during periodic inspections of Contractor's work and safety activities and take prompt action to correct identified deficiencies. Satisfactory compliance shall be made within a specified time. If Contractor refuses to correct deficiencies, the Owner shall initiate appropriate actions in accordance with the Contract provisions and may take one or more of the following steps:
   1) Cease the operation or a portion thereof (particularly in the case of an imminent danger).
   2) Correct the situation and back charge the Contractor.
   3) Stop or hold up payment for the work being performed.
   4) Invoke Contract penalties and/or terminate the Contract.

l. Attend a weekly site safety coordination meeting that will address results of periodic inspections, the safety or environmental related incidents, or injuries of the previous week, if any, and the necessary corrective measures including a plan for upcoming work and the related safety or environmental considerations.

m. Provide notification to the Owner as follows:
   1) Promptly report injuries or illnesses recorded on its OSHA 200 log, accidents resulting in property damage and environmental incidents, and follow up in writing within 24 hours. Within 2 working days, provide a written report documenting the identified cause(s) of the accident or incident and action(s) taken, or planned to preclude recurrence. A copy of each first report of injury shall be provided.

2) A weekly summary of occupational injuries, illnesses and environmental incidents including man-hours.

3) Immediately report fatal or serious occupational injuries or illnesses. Notify the Owner in writing if an injury or illness results in lost work time and the Contractor desires not to provide continued employment, on a modified basis, for its employees who sustain an on-the-job partially disabling injury or illness. This notification must be provided a minimum of 24 hours prior to the discontinuance of employment. This reporting is in addition to any reporting responsibilities that the Contractor may have to OSHA or any other agency. The Owner reserves the right to conduct an independent investigation at no additional cost to the Owner.

4) Immediately report OSHA inspections and provide the Owner an opportunity to observe the inspection. Provide a copy of citations received and Contractor responses issued as a result of such inspections within two working days of receipt or issuance.

n. Protect the safety and convenience of the general public including residents adjacent to the work.

1) Perform work as necessary to protect the general public from hazards.

2) Construct and maintain satisfactory and substantial barriers with warning lights, lanterns, and proper signs as necessary or required for safety.

o. Ensure that these Contractor safety, health, and environment requirements are passed on to its subcontractors. The Contractor shall hold the subcontractor responsible for compliance with these requirements.

p. Appoint an employee who is qualified and authorized to supervise and enforce compliance with the safety program.

2. The duties of the Owner or IDC do not include a review or approval of the adequacy of the Contractor's safety supervisor, the safety program, or safety measures taken in, on, or near the construction site.

4.0 WORK SITE SECURITY

A. Work site security is the responsibility of Owner. Cooperate with Owner’s security force, enforce security measures with employees and subcontractors. Take reasonable precautions against theft of tools, equipment, and materials stored on site.

B. No employee of Contractor, nor of its subcontractors, shall go to or be present in an area where the employee is not actively engaged in work, except when traveling between work location. Such travel shall be by a direct route. Use of any Owner facilities such as cafeteria, office space, restrooms is prohibited. Contractor’s

employees will not be permitted to use Owner's parking facilities and shall park in areas designated by the Owner.

C. Do not drive privately owned or leased vehicles inside the work site fenced area. Work site access passes for authorized vehicles will be limited and will be restricted to company vehicles. Passes will be issued by Owner and will be subject to applicable rules and regulations.

D. Workers or visitor identification badges must be prominently displayed by all personnel when entering, working on, or leaving Owner's premises. Issue a badge to every employee or visitor when entering the site and collect the badge upon departure. Badges for workers will be picture identification badges issued by Owner designating the employer's name and the employee's identification number. Provide a current index showing each authorized employee when requested by Owner. Advise Owner when an employee is terminated from the project and no longer have access to the work site.

E. Ensure that employee hard hats clearly identify the employer's company.

5.0 QUALITY CONTROL

A. Develop and maintain a quality control (QC) manual to support compliance with the Contract Documents. Maintain quality control over suppliers, manufacturers, products, services, work site conditions, and workmanship to produce work of specified quality.

6.0 COORDINATION

A. Coordination:

1. Cooperate with the Owner, other contractors, and utility companies on site in scheduling and coordination of activities in a manner that will provide the least interference of others' work and cooperate in the interfacing and connection of the separate elements of the overall project. The Owner and other contractors have the same obligation to cooperate and coordinate their work with Contractor. The Owner will issue such instruction as necessary. Abide and support the Owner's decision.
2. Coordinate the planned interruption of any services including, but not limited to, water, gas, oxygen, electric lights or power, and drainage systems, with the Owner. Advise Owner of the time, duration, extent, and type of any planned interruptions. Provide detailed plan in accordance with Owner's safety and operation and maintenance procedures. Make such interruption only after Owner has approved the plan.

3. Coordinate work of the various sections of the Specifications and Drawings to ensure efficient and orderly sequence of installation of construction elements with provisions for accommodating items installed later.
4. Locations of existing utility mains, trees, etc. are shown diagrammatically on the Drawings. Accuracy and completeness of this information is not guaranteed. Verify the size and location of utility lines, conduit, surface, or subsurface structures, etc., that may affect the work.
5. Coordinate work with other contractors and subcontractors and share information with the other contractors to enable you and them to coordinate openings, relationship to structure, ducts, pipe, conduit, and other items as required.
6. Coordination meetings are mandatory in laying out pipe and duct runs and equipment locations. Review these layouts with other contractors, IDC, and the Owner prior to installation.
7. Submit proposed method of support for review by IDC prior to fabrication of hanging or other support systems not specifically detailed on the Drawings.
8. Verify that characteristics of elements of interrelated operating equipment are compatible; coordinate work with other contractors having interdependent responsibilities for installing, connecting to, and placing in service such equipment.
9. Do not endanger the work of other contractors by cutting, excavating, or otherwise altering their work. Prior to penetrating load-bearing walls or structural members not detailed in the Contract Documents, submit written notice thereof and obtain permission from the Owner and IDC before such work can proceed.
10. Coordinate space requirements and installation of mechanical and electrical work that is indicated on the Drawings. Follow routing shown for pipes, ducts, and conduit as closely as practicable; make runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, maintenance, and repairs.
11. Provide clear access to equipment spaces. Do not obstruct placement or removal of equipment with conduit, ducts, utilities, or other facilities.
12. In finished areas, except as otherwise shown, conceal pipes, ducts, and wiring in the construction. Coordinate locations of fixtures and outlets with finish elements.
13. During the progress of construction, it is expected that minor field relocations of the work will be necessary. Such relocations shall be made only by direction of the Owner. If the Contractor shall fail to so notify the Owner and proceed without such direction, Contractor shall do so at its own risk.

B. Cutting and Patching:
1. Cut, fit, or patch work as required to make its several parts fit together properly, to uncover work, to provide for installation of ill-timed work, to

remove samples of work as specified for inspection and testing, and to install work in existing construction.

2. Except as specifically permitted in the Contract Documents, do not cut or alter the work of another contractor except with the written consent of the Owner.
3. Coordinate requirements of openings for ducts, piping, conduit, and other penetrations required by construction with the Owner. Unless otherwise specified, such openings shall be provided by the contractor that performs the initial construction. In the event of the Contractor's failure to supply the Owner with information regarding the size and location of openings it requires in advance, cutting and patching that may be required shall be done at the expense of the negligent party.
4. Unless otherwise specified by the Owner, each contractor shall do cutting, fitting, or patching of its work that may be necessary to make said work coordinate with the work of other contractors, as shown or reasonably implied from the Contract Documents. In cases where the completion of the work of the Contractor is dependent upon work of various contractors, the timing of the work of each contractor will be determined by the Owner.
5. Seal penetrations through nonfire-rated construction with permanently flexible material per Section 07900, Joint Sealers. Oversized openings in nonrated construction, where the annular space around penetrants exceeds 1 foot, shall be closed by the contractor responsible for the initial construction, at the expense of the responsible party.
6. Close penetrations through or between fire rated walls, floors, and roofs in accordance with Section 07840, Firestopping. Provide sleeving, coring, or cutting of fire-rated construction as described in the approved, UL-listed firestop assembly. Sleeving, cutting, or coring not provided as so described shall be corrected at no cost to the Owner. Installation of firestopping material shall be performed using an approved method or system and by personnel approved by the manufacturer.
7. Permission to patch or repair damaged areas or items of work shall not constitute a waiver of the Owner’s right to require complete removal and replacement of work if, in the Owner's opinion, the patching or repairing does not satisfactorily restore the quality or appearance of the work.

7.0 TEMPORARY FACILITIES AND CONTROLS

A. Temporary Construction Facilities:

1. Before moving onto the work site, submit for approval a layout of the site showing location of security fencing, office areas, storage areas, workshops, and other temporary facilities consistent with Owner guidelines.
2. Confine operations at the work site to areas permitted by law, ordinances, permits, and the Contract Documents. Provide and locate or erect temporary buildings (change houses, trailers, plan rooms, offices, etc., but not major

storage yards, layout and fabrication yards, equipment repair facilities, or Contractor personnel parking) within the indicated limits of construction with the approval of the Owner. Such temporary buildings, together with the necessary utilities, shall remain the property of the Contractor.

3. Do not unreasonably encumber the work site with materials or equipment. Operations of the Contractor (including storage of materials and equipment upon the work site) shall be confined to the area shown on the Drawings or where otherwise approved in writing by the Owner. No unauthorized or unwarranted entry, passage through, or storage or disposal of materials shall be made upon the premises. Move stored products that interfere with the operations of other subcontractors.
4. Confine traffic to the rights-of-way of the work site and repair damage resulting from Contractor traffic to the satisfaction of the Owner. Road usage must be shared and coordinated among all users. Use assigned gates only. Always maintain Owner's access to its property. Maintain your temporary laydown areas. Keep work areas, walkways, roadways, and laydown areas that are under your control free from snow and ice.
5. Locate major storage yards, layout and fabrication yards, equipment repair facilities, etc., in space assigned by the Owner. Provide temporary improvements including, but not limited to, site drainage, fencing, lighting, electric power, etc., as required. Obtain and pay for the use of additional offsite storage or work areas needed for the Contractor's construction activities.
6. Provide break area for Contractor's personnel including adequate waste containers for food waste and garbage. Instruct personnel and subcontractor personnel that Owner's vending machines are not to be used, and take other necessary action to ensure that instructions are followed. Provide vending machines near break area as desired.

B. Temporary Utilities:
   1. Electricity and Lighting:
      a. Provide distribution of temporary electrical power from the source to the point of use including necessary extension cords, transformers, and protective devices.
      b. Owner will provide and pay for temporary electrical power from those sources described in paragraph 1.a above, except those requirements beyond the capability of Owner's permanent system and the sources described above. Electrical requirements such as welders and requirements too far removed from the source will be Contractor's responsibility.
      c. Temporary installations shall meet applicable OSHA, state, and local codes, regulations and other requirements. Do not plug into permanent

receptacles without specific permission or instruction from Owner. Any unplanned service interruption on Owner's facility is unacceptable.

d. If the permanent electrical power system is not available for use at the time of Contractor's mobilization, provide electrical power required by its operations until such time that Owner authorizes connection and use of the permanent electrical power system. For this purpose, provide an alternative mobilization cost for establishing the means to provide temporary electrical power and an alternative daily cost for providing and maintaining temporary electrical power until such power is available from the permanent system.

e. Provide lighting necessary for construction activities and to satisfy safety and security requirements.

2. Heat and Ventilation:

a. Provide as required to maintain specified conditions for construction operations, worker comfort, and to protect materials and finishes from damage due to temperature or humidity. Provide power to temporary units in a safe and efficient manner until an acceptable power source is available from others.

b. Provide ventilation of enclosed areas to cure materials, to disperse humidity, and to prevent accumulations of dust, fumes, vapors, or gases.

c. Associated costs shall be paid by the Contractor.

3. Water: Water service does exist on site.

a. Construction Water: Owner will provide and pay for water from Owner identified sources within the facility. Provide temporary connections as required including hoses, nozzles, buckets, etc. Observe good housekeeping practices in the area of the connection point at all times.

b. Potable Water: Furnish containers, ice, distribution system, etc., for potable water as required for Contractor's personnel and its field office. No Contractor personnel (or any of its subcontractors' employees) are permitted to use permanent wash rooms, drinking fountains, or locker rooms of the Owner.

4. Sanitary Facilities: Coordinate use of sanitary facilities by Contractor personnel with Owner.

a. Waste Management: Provide for disposal of garbage and debris in accordance with regulatory and Owner requirements. Provide and enforce the use of proper receptacles for disposal of food wrappers and containers, empty daily. Segregate food related trash from construction-related trash and debris.

5. Telephone Services: Arrange and pay for individual telephone and fax service, if desired, at the field office.

6. Gases: Provide compressed air, oxygen, welding gases, and other expendables required in the performance of work.

C. Protection of Property and Risk of Loss:

1. Until final acceptance of work, the Contractor shall be responsible for the care, custody, control, safekeeping, and preservation of work and materials, equipment, supplies, and other things relating to work furnished by the Owner. Promptly repair or replace such if damaged or lost.
2. Provide temporary protection for installed products. Continuously maintain adequate protection of work and work in progress from loss and damage in a manner satisfactory to the Owner. Work and work in progress includes goods, materials, and equipment furnished by others, whether in storage on or off the work site or otherwise handled in a way that is under the care, custody, or control of the Contractor or its subcontractors.
3. Place and operate construction equipment, tools, and facilities in such a manner that new and existing work will not be damaged by vibration, smoke, dust, water, falling debris, concrete, or any other cause. Protect sidewalks, steps, and ramps from heavy equipment traffic. Repair damage to roads, walks, and structures caused by your equipment or personnel.
4. Adequately protect adjacent private and public property as provided by terms of permits, applicable laws, rules and regulations, and the Contract Documents. Provide temporary protection of occupied and operating areas of Owner's existing plant or facilities. Protect other property at the work site or adjacent thereto, including, but not limited to, trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities from damages caused by work.
5. Provide protection of work from freezing, rain, wind, and other elements of the weather that would be harmful to it. Furnish fuel, protective shelters, or temporary buildings and temporary heating as required for the prosecution and protection of work and keep work areas free of water. Coal and kerosene-type salamander stoves, pots, and open fires will not be permitted.
6. Provide protection coverings at walls, projections, jambs, sills, and soffits of openings. Protect finished floors and stairs from traffic, movement of heavy objects, and storage.
7. Prohibit traffic and storage on waterproofed and roofed surfaces, lawn, and landscaped areas. When unavoidable, protect surfaces from puncture, burn, or other damage when working above or on such surfaces. Pick up screws, nails, metal scraps, and other objects that may damage the surface.
8. Provide shoring, bracing, and supports as necessary to maintain the structural integrity of the project to the extent threatened or potentially threatened by work. Excavating required shall be performed by methods that will prevent damage to other work. Provide and maintain adequate temporary supports, shores, and bracing as necessary to maintain the structural integrity of the project and to keep work safe from failure or damage due to loads that may be imposed on structures during construction. Excavating required shall be performed by methods that prevent damage to other work or existing facilities.
9. Do not load structures with weight that will endanger it.

10. Provide barriers as required to prevent public entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations. Control traffic in immediate area to minimize damage.
11. Provide temporary, weathertight closures of openings in exterior surfaces to provide acceptable working conditions and protection for materials to allow for temporary heating and to prevent entry of unauthorized persons. The temporary closures shall be maintained until permanent doors and windows are in place and operational.

D. Pollution and Dust Control:
1. Provide methods, means, and facilities required to prevent contamination of soil, water, or the atmosphere by the discharge of noxious substances from Contractor's construction operations.
2. Provide equipment and personnel and perform emergency measures required to contain spillage and to remove contaminated soils or liquids.
3. Take special measures to prevent harmful substances from entering public waters. Prevent disposal of wastes, effluents, chemicals, or other such substances adjacent to ponds or in sanitary or storm sewers.
4. Equipment or material used for the construction of the project that produces toxic fumes may be used at times specified by the Owner.
5. Screen noisy equipment with temporary enclosures to shield adjacent areas as much as possible.
6. Provide scrubber devices on the exhaust of gas driven equipment used inside a building or other enclosed space.
7. Provide positive methods and apply dust control materials to minimize raising dust from construction operations and provide positive means to prevent airborne dust from dispersing into the atmosphere.
8. Burning or burying of waste materials on the work site is prohibited.

8.0 EXECUTION REQUIREMENTS

A. Site Investigation and Representation:
1. Contractor acknowledges satisfaction as to the nature and location of work; the general and local conditions, particularly those bearing upon availability of transportation, access to the work site, disposal, handling, and storage of materials, availability of labor, water, electric power, and roads, telephone communications waste and sewage disposal and uncertainties of weather or similar physical conditions at the work site; the conformation and conditions of the ground; the character of equipment and facilities needed preliminary to and during the prosecution of work; and other matters that can affect work or the cost thereof under this Contract.

2. Contractor further acknowledges satisfaction as to character, quality, and quantity of surface and subsurface materials to be encountered from its inspection of the work site and from reviewing available records of exploratory work furnished by the Owner or included in the Contract Documents. Failure by Contractor to become acquainted with the physical conditions of the work site and the available information will not relieve the Contractor from responsibility for properly estimating the difficulty or cost of successfully performing work.

B. Contractor's Responsibility for Utility Locations:
   1. Known utilities and structures adjacent to or within the limits of work are shown on the Drawings. The locations shown are taken from existing records and the best information available from existing utility plans; however, it is expected that there may be some discrepancies and omissions in the locations and quantities of utilities and structures shown.
   2. Where Contractor's operations could cause damage or inconvenience to telegraph, telephone, television, power, oil, gas, water, sewer, or irrigation systems, suspend operations until Contractor has made arrangements necessary for the protection of these utilities and services. Employ or secure services as necessary to locate or verify the location of utilities.
   3. Notify utility offices that could be affected by work at least 48 hours in advance. Do not expose utilities without first obtaining permission from the appropriate agency. Once permission has been granted, locate, expose, and provide temporary support for existing underground utilities.
   4. Neither the Owner nor its officers or agents shall be responsible to Contractor for damages as a result of Contractor's failure to locate and protect utilities encountered in work.
   5. Tag stubouts for underground utilities such as plumbing, mechanical, automatic fire sprinkler, and water with weatherproof identification tags.

C. Layout Data:
   1. Baselines:
      a. The Owner will provide two reference baselines and a single permanent benchmark to be used by the Contractors for layout work. Verify and agree to the accuracy of this data prior to commencing any layout work.
      b. Notify Owner, in writing, if an apparent error in survey locations furnished by Owner is discovered. Request resolution. In no case shall the Contractor claim delay due to an apparent error to Owner-furnished locations except for instances in which the Owner failed to provide prompt direction upon receipt of Contractor's notice of an apparent error.
      c. The responsibility for the accuracy of the layout of work obtained from these baselines and benchmarks is solely that of the Contractor.

d. Furnish, at Contractor's expense, stakes, spikes, steel pins, templates, platforms, equipment, tools, and materials and labor required to lay out the work from the benchmark and baselines established by Owner.
e. Maintain and preserve stakes and other markers established by Contractor until no longer required.
f. Replace, at Contractor's expense, the control points established at the site by Owner, if destroyed by or through Contractor's negligence prior to their authorized removal. Owner may require work to be suspended when horizontal or vertical control points established at the work site by Contractor are not adequate to permit checking the work. Such suspension will be withdrawn upon proper replacement of the control points.

2. Record Contractor's survey data in accordance with standard and approved methods. Make available field notes, sketches, recordings, and computations made by the Contractor in establishing horizontal and vertical control points during the progress of work for ready examination by the Owner.
3. Dimension Verification:
   a. Before ordering material or doing work, take or verify measurements as may be required for the proper fitting of Contractor's work or other adjoining work. The Contractor is responsible for the correctness of its figures and shall satisfactorily correct work that does not fit, and furnish new work, if necessary, without charge to the Owner. Extra charges will not be allowed on account of differences between actual dimensions and the measurements indicated on the Drawings.
   b. In case of a discrepancy or conflict with given data, notify Owner in writing prior to proceeding with the affected work.

D. Preservation, Restoration, and Cleanup:
1. Keep the work site orderly and neat on a daily basis. Maintain a level of cleanliness acceptable to Owner. Rubbish shall not be allowed to accumulate anywhere on the work site.
2. Provide for regular maintenance of temporary toilets and replacement of waste containers when full.
3. Keep the paved streets bordering the work site clean from material tracked off site. Wash and/or sweep the streets daily if material begins to accumulate.
4. Smoking and eating will be allowed on the work site only in designated areas. Owner will identify the areas after award of the Contract.
5. Remove temporary materials, equipment, services, and construction prior to substantial completion inspection. Clear areas used by the Contractor for temporary structures, rubbish, and waste materials and properly grade to drain and blend in with the abutting property. Finish areas used for the deposit of waste materials to properly drain and blend with the surrounding terrain. Clear and restore staging areas to the original condition when the Contractor moved

onto the work site. Correct damage, changes, or alterations, made by the Contractor to storage or laydown areas during construction prior to demobilization. Areas shall be returned to the condition that existed prior to arrival at the work site.

6. Clean and repair damage caused by installation or use of temporary facilities. Remove temporary underground installations. Grade site to drain.
7. Replace filters and clean system internals if permanent air-handling support equipment is used prior to acceptance by the Owner.
8. Thoroughly clean parts of the installation at the completion of work. Clean up and remove from the premises refuse material, crates, and rubbish arising from work.

9.0 CLOSEOUT PROCEDURES

A. General:

1. This Section contains requirements and procedures for submittal of pertinent data relating to closing out work upon completion of work. Detailed instructions elsewhere in these Specifications may require that certain items listed herein be submitted prior to the Substantial Completion date. Receipt and review of items specified in this Section are prerequisites for final payment.
2. At the completion of work, the site occupied by the Contractor shall be brought back to its original condition. With the written consent of the Owner, improvements made by the Contractor may be abandoned and not removed and will then become the property of the Owner.

B. Semifinal and Final Inspections:

1. When the Contractor is of the opinion that the project is substantially complete, request inspections as required by the Contract terms. Such notice shall be given at least 3 working days before the requested inspection date.
2. If because of acts or omissions of the Contractor, IDC is required to conduct more than one final inspection of the project, IDC may charge the Owner for the additional services required, and such costs will be deducted from the money still due the Contractor.
3. Submit the following project documents to the Owner for review by IDC prior to completing the punch list of incomplete or uncorrected items:
   a. Required operation and maintenance manuals.
   b. Warranties and bonds.
   c. As-built drawings.
4. When all items on the punch list are completed and corrected, send to the Owner a statement that the project is complete and request a final inspection. An acceptable final inspection by Owner is required before acceptance and final payment.

5. Schedule and conduct the final inspection at a time arrived at with the Owner. The final inspection shall include a complete checkout and test of mechanical and electrical systems, architectural and structural devices, etc. For this purpose, each trade concerned shall provide a skilled operating engineer or technician for a period of at least 1-day. Test all systems and devices and demonstrate the complete operation and required maintenance of each.
6. Make changes to the Contract Documents identified by the Owner and IDC and resubmit the final documents.

C. Contract Closeout:
1. At the conclusion of work, turn over to Owner and obtain signed receipts for keys to lockable doors, panels, gates, controls, etc., properly identified and tagged.
2. Submit final application for payment in accordance with the Contract.
3. Complete and deliver to the Owner the following items (as applicable) prior to final payment.
   a. Verification of completion of the punch list.
   b. Fully executed certificate of Substantial Completion.
   c. Local, state, or federal inspections and/or certifications.
   d. 1-year workmanship and materials guarantee.
   e. Roofing guarantee.
   f. Wood door guarantee.
   g. Major mechanical/electrical equipment guarantees.
   h. Operation and maintenance manuals (six sets).
   i. Project as-built documents.
   j. Contractor lien release.
   k. Consent of surety.
   l. Response to field orders.
   m. Change orders fully executed.
   n. Approval of final pay application.
   o. Spare parts and maintenance materials.

END OF SECTION

SECTION 01110C

SUMMARY OF WORK

1.0 GENERAL

A. The project consists of the construction of the Cosmogenic Nuclide Laboratory (Department of Geology) in Delehanty Hall at the University of Vermont Trinity Campus.

B. The project includes equipment and materials purchase packages and construction packages.

C. This work package consists of the following:
   1. Installation of Owner-furnished equipment described in the appendix attached to this Section.
      a. The Contractor shall inspect the Owner-furnished items upon receipt at the site, unload, and store the items until ready for installation and install, complete. The Contractor shall be responsible for damage to the items until the Owner accepts the Contractor's work and shall provide insurance coverage for the items to protect against damage or loss. The list of the items is provided in the appendix.
      b. The Owner-furnished items delivery shall be coordinated with the end-user or other Owner authorized personnel.
      c. The Owner may assign the purchase agreement for these items to the Contractor for expediting.
   2. Furnish and install Work as indicated on the Drawings and Specifications, and as clarified within this Summary of Work. Furnish and install complete the following:
      a. Architectural cleanroom partition assemblies, suspended ceiling systems, finishes, millwork and finish carpentry, laboratory equipment and casework.
      b. Mechanical supply air and exhaust equipment and appurtenant devices and DDC system.
      c. Electrical equipment, fixtures, appurtenant devices and telecommunications and data connections.
      d. Plumbing fixtures, equipment, specialties and devices for the laboratory suite. Exhaust duct washdown system as required for perchorate mitigation.
      e. Fire Protection systems for general laboratory suite and fume hood assemblies.

END OF SECTION

APPENDIX

OWNER-FURNISHED EQUIPMENT

Qty.	Item	Manufacturer	Model Number
4	Balance		
3	Centrifuge	IEC-Cl2	05-101-7
3	Drying Oven	Sheldon Mfg., Inc.	CE5G
3	Vortexer	VWR (75 watts)	12620-838
2	Ultrasound (Large)	Branson	8510
2	Heat Blocks (used in hood)	VWR	12621-088
1	Ionizer	METTLER TOLEDO U Ionizer and Point Ionizer	U Ionizer and power supply
5	Hot Plates	Most likely Presto, custom controller outside of hoods, mounted on hood wall	1000-1500 watts
1	Marble Table	VWR (700 pounds)	12568-004
2	Desk top PC	Macintosh	I-Mac 17” screen
2	Laser Printers	HP (Hewlett-Packard)	LaserJet 1020
1	Notebook PC	Macintosh	Powerbook G4
1	Stereo System	Sony	LBT-ZX8OD
1	Espresso Maker	Briel – Chamonix	ES35AFB
3	Task Lights	iHome / iPod Docking Speaker Desk Lamp	IHL10-Black

SECTION 01355

CLEAN ZONE GENERAL REQUIREMENTS

1.0 CONTENTS

2.0 WORK INCLUDED

A. This Section specifies the general requirements for persons who perform work or function within the Clean Zone.

B. The objective of this Section is to provide a controlled clean environment within which mechanical, electrical, cleanroom systems, and process piping will be installed:

1. Maintain a clean environment from the initial construction stage through final cleanroom certification.
2. Clean products brought into the Clean Zone meeting minimum cleanliness standards on both interior and exterior surfaces.
3. Establish and monitor personnel cleanliness levels and construction protocol standards for each construction stage.
4. Enforce active contamination controls consistent with each construction stage.
5. Monitor required level of cleanliness using spot checks at prescribed locations.

C. The boundaries of the Clean Zone and Cleanroom are established by this Section.

3.0 BOUNDARIES

A. The Clean Zone and Cleanrooms are shown on the Drawings.

4.0 STANDARDS

A. ISO 14644-1; Cleanrooms and Associated Controlled Environments – Part 1: Classification of Air Cleanliness.

5.0 DEFINITIONS

A. Refer to ISO Standard 14644-1 for a complete list of definitions appropriate to cleanrooms. Specific words and phrases used within these Contract Documents are defined below for easy reference.

B. As-Built Cleanroom: cleanroom which is complete and ready for operation with services connected and functional, but without production equipment or personnel within the room.

C. At-Rest Cleanroom: cleanroom which is complete and has production equipment installed and operating, but without personnel within the room.

D. Test and Balancing Contractor: the air and water systems testing, adjusting, and balancing contractor (TABC) retained by the Owner to assist and verify completion and performance of the operating systems.

E. Cleanroom Certification Contractor: the cleanroom testing and certifying contractor (CCC) retained by Owner to assist and verify final completion and performance of the cleanroom systems.

F. Classes of Cleanliness: statistically allowable number of particles of a given size per cubic meter of air.

G. Cleanroom: a defined clean area or room in which the concentration of airborne particles is controlled to specified limits. For this project, the cleanroom is the space bounded by the cleanroom structural floor slab below, the cleanroom filtered ceiling grid above, and the perimeter cleanroom walls, including spaces, products, and utilities within.

H. Clean Zone: a defined clean area in which the concentration of airborne particles is controlled to specified limits. The Clean Zone is the building space described above, in the paragraph Clean Zone Boundaries, bounded by the floor slab below, the deck

membrane above, and the perimeter fire, separation, and boundary walls, which encompass cleanrooms of any cleanliness classification, as well as any remote special rooms for cleanroom support equipment, including spaces, products, and utilities within.

I. Clean Zone Construction Stage: see stage.

J. Clean Zone Director: the person, hereinafter referred to as the Director, vested with authority by the Owner to supervise personnel working within the Clean Zone and to ensure requirements of the Contract Documents are met in completion of the Clean Zone construction, including spaces, products, and utilities within.

K. Interstitial: a defined clean area bounded by the plane of the cleanroom filtered ceiling below, the bottom of the building penthouse structural deck above, and the perimeter fire, separation, and boundary walls, including spaces, products, and utilities within.

L. 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.

M. Operating Cleanroom: cleanroom in normal operation with services functioning and with production equipment and personnel present and performing their normal work functions within the room.

N. Penthouse: a defined utility area bounded by the penthouse structural floor slab below, the bottom of the penthouse roof membrane above, and the perimeter fire, separation, and boundary walls, including spaces, products, and utilities within.

O. Products: materials, equipment, physical items, and packaged systems.

P. Quality Assurance Contractor: the quality assurance cleanroom certifying contractor retained by the Owner 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, as defined herein.

6.0 GENERAL CLEAN ZONE CONSTRUCTION PROCEDURES

A. The following activities are prohibited inside the Clean Zone:
   1. Eating or drinking foodstuffs.

2. Smoking of cigarettes, cigars, or pipes.
3. Spitting.
4. Standing, walking, or sitting on electrical conduit and bus duct, HVAC ductwork, fire sprinkler piping, or other building utility piping.
5. Standing, walking, or sitting on process high-purity or double-contained specialty gas piping.
6. Standing, walking, or sitting on ceiling cleanroom filter modules or packaged ceiling modules, whether boxed in storage or installed in the ceiling grid.
7. Breaking open any clean products specially sealed and wrapped for protection until the product is installed.
8. Cutting, grinding, or sanding of products and materials known to contain Boron.
9. Operating any propane-, acetylene-, diesel-, gas-, or oil-fueled tool, high-lift, or other construction equipment.
10. Applying or spilling oil, stain, paint, sealant, caulking, or other diffusing product onto the structural floor before application of specified sealers and paints.
11. Entering or working inside the Clean Zone in garments and footwear that are not in compliance with written Clean Zone cleanliness protocol posted for the construction stage.

B. Mandatory procedures for persons entering and working in the Clean Zone:
1. Walk on all sections of tacky mat provided at entry to the Clean Zone.
2. Wipe down or vacuum off construction materials, tools, and accessories.
3. Wipe up spills of caulking, sealant, filter gel, paint, and similar products immediately.
4. Dispose of tie-straps, plastic seal wraps, and other product-protecting devices in trash receptacles.
5. Provide continuous 99.99 percent efficient at most penetrating particle size HEPA-filtered vacuum pickup during drilling, coring, cutting, or similar particle-generating work activities after construction Stage.
6. Provide construction tools that are cleaned, stored, and used only within the designated Clean Zone.
7. Attend jobsite safety training classes conducted by the Contractor.
8. Follow safety rules as taught in the Contractor's safety class and follow normal safety discipline enforced by each employer as standard procedure for the trade, worker experience, and type of work required.
9. Complete the Boron contamination training sessions conducted by the Owner.

C. Disciplinary Procedure:
1. The Owner or Director will remove:
   a. Persons performing a prohibited activity immediately from the jobsite.

b. Persons not following the mandatory procedures immediately from the jobsite.

2. Prohibit repeat violators from entering the jobsite.

7.0 CONSTRUCTION STAGE ACTIVITIES

TABLE 1 – Construction Stage Activities

Activity	Stage[1]				
	1	2	3	4	5
Mechanical, electrical, plumbing and process systems involving grinding, welding, cutting or other process of metallic products including but not limited to piping and duct systems.	X	X	X		
Insulation of mechanical, plumbing and process systems.	X				
Air Handlers installed.	X				
Equipment rooms enclosed with access openings.	X				
Clean Zone perimeter walls complete.		X			
Fire barriers complete.		X			
Upper zones of fire protection complete.		X			
Building structure airtight.		X			
Mechanical, electrical, plumbing and process systems complete, except for ceiling grid, cleanroom walls, and access flooring.		X			
Clean Zone perimeter boundary enclosed.		F	S		
Raised floor complete and level.			X		
Resilient floor material laid and sealed.			X		
Protective temporary floor cover complete.			X		
Ceiling assembly complete and level.			X		
Interior walls erected.			X		
Doors installed and operable.			X		
Fire sprinkler system installed and tested.			X		
Permanent lighting complete and operable.			X		
Smoke detectors installed and tested.			X		
Exhaust system ductwork complete and tested.			X		
Supply air ductwork complete and tested.			X		

TABLE 1 – Construction Stage Activities					
Activity	Stage[1]				
	1	2	3	4	5
Control devices complete.			X		
Cleanroom walls, floors, and ceiling assembly completed.			F	S	
Fire sprinkler system charged and operable.				X	
Smoke detectors operable.				X	
Control devices operable and tested.				X	
Safety systems installed and tested.				X	
Protective covers removed from floor, ceiling and walls.				X	
Final cleaning finished inside the cleanroom.				F	S
Control systems tested and calibrated.					X
Air systems tested and balanced.					X
Contamination levels stabilized at levels required by project design.					X

Table 1 notes:
1. S – Start activity of construction stage, F – Finish activity of construction stage, X – activity occurring during construction stage.

8.0 TRAINING AND SECURITY

A. Hazardous Material Safety Training:
   1. Special Safety Classes: by the Owner to familiarize workers with hazardous gases, chemicals, products, and fluids referred to as hazardous production materials (HPM) to be found on the site during this stage of construction.
   2. Evacuation: workers required to demonstrate safe emergency evacuation.
   3. Required: as defined for workers in Table 2.

TABLE 2 – Training and Security Requirements					
Description	Stage				
	1	2	3	4	5
Protocol Training –by Director.[2]	X[1]	X	X	X	X
Construction Safety Training:					
Job site safety classes: by the Contractor.	X	X	X	X	X

TABLE 2 – Training and Security Requirements					
Description	Stage				
	1	2	3	4	5
Hazardous Material Safety Training	X	X	X	X	X

Table 2 notes:
1. Mandatory for workers entering the clean zone.
2. Training sessions developed and reviewed with the Owner.

9.0 CLEAN ZONE ENTRY REQUIREMENTS

TABLE 5 – Clean Zone Entry Requirements					
Equipment:					
Clean equipment prior to entry into clean zone.	X	X	X	X	X

10.0 DELIVERY, STORAGE, AND HANDLING

A. Delivery:
   1. Ship Clean Zone components with an approved multi-layered protective covering, packaged to prevent transit and construction dust from contaminating the surfaces.
   2. Return material or equipment to the manufacturer for recleaning and repackaging where the original shipping protective wrap was torn or defective.

B. Storage:
   1. Materials shall be sealed in their original unopened packages.
   2. Seal open ends of ducts and pipes with moisture proof barrier until product is being connected during installation.
   3. Store products and components to prevent damage or intrusion of foreign matter. Conspicuously mark rejected on any materials that have been damaged and remove them from the job site.

4. Store products within the building in controlled space designated by the Owner.
5. Do not store products in the staging area in excess of that used in 1 day's work.
6. Do not store contaminated materials in the staging areas or Clean Zone.

C. Handling:
1. Handle components with extreme care to prevent damage.
2. Remove or strip packaging inside the designated equipment staging room outside the cleanroom per Director's instructions.

END OF SECTION

SECTION 02070

SELECTIVE DEMOLITION

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to execute:
   1. Protection of adjacent existing facilities in operation from selective demolition work.
   2. Demolition and removal of selected portions of a building.
   3. Removal and capping of existing utilities.
   4. Patching and repairs.
   5. Patching of fire rated partitions after demolition.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for selected demolition:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 07840 - Firestopping.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DEFINITIONS

A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Owner's property.

B. Remove and Salvage: Items indicated to be removed and salvaged remain the Owner's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to Owner's designated storage area.

C. Remove and Reinstall: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in the same locations or locations indicated.

D. Existing to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by IDC, items may be removed to a suitable, protected storage location during selective demolition and then be cleaned and reinstalled in their original locations.

1.4 WARRANTY

A. Existing Special Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1.5 REGULATORY REQUIREMENTS

A. Comply with governing EPA notification regulations before starting selective demolition.

B. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.6 QUALITY ASSURANCE

A. Predemolition Conference: Conduct conference at project site to review construction procedures, schedule of the work, salvage of materials, and coordination of demolition work with other trades. Review demolition schedule with regard to minimizing disruption to Owner's operations.

1.7 QUALIFICATIONS

A. Demolition Contractor: minimum of 3 years successful experience executing selective demolition work similar to that required for this Project.

1.8 COORDINATION

A. Owner will occupy portions of the building immediately adjacent to selective demolition area. Schedule and execute selective demolition work so that Owner's operations will not be disrupted. Provide not less than 72 hours notice to Owner of activities that will affect Owner's operations.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Owner assumes no responsibility for actual conditions of areas to be selectively demolished. Conditions existing at time of inspection for bidding purposes will be maintained by the Owner as far as practical.

B. Hazardous Materials: Hazardous materials may be present within the limits of work of this project. The Owner is responsible to remove existing hazardous materials from the project area before the start of contract work. If materials suspected of containing hazardous materials are encountered, do not disturb the materials. Immediately notify the Owner.

C. Owner's existing ongoing facility operation is sensitive to vibration, noise, smell, dust, loss of utilities, and quality of utilities, and the presence of certain construction debris. Review procedures for protecting existing adjacent operations with Owner before start of selective demolition.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage or sale of removed items or materials on-site is not permitted.

1.11 SUBMITTALS

A. Provide the following before Substantial Completion:
   1. As-built drawings.
   2. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. Use repair materials identical to existing materials.

B. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually and physically match existing adjacent materials to the fullest extent possible.

C. Use materials whose installed performance equal or surpasses that of existing materials.

2.2 MATERIAL OWNERSHIP

A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. Inventory and record the condition of removed and reinstalled items and removed and salvaged items.

D. When unanticipated mechanical, electrical, or structural elements that conflict with the intended function or design are encountered, investigate and measure the nature and extent of the conflict. Promptly submit a written report to IDC.

E. Survey the conditions of the building to determine whether removing an element might result in structural deficiency or unplanned collapse of a portion of the structure or adjacent structures during selective demolition.

F. Perform surveys as the work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES

A. Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operation.
   1. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to governing authorities.
   2. Provide not less than 72-hours' notice to Owner if shutdown of service is required during changeover.

B. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services serving building to be selectively demolished.
   1. Owner will arrange to shut off indicated utilities when requested by Contractor.
   2. Arrange or shut off indicated utilities with utility companies.
   3. Where utility services are required to be removed, relocated, or abandoned, provide bypass connections to maintain continuity of service to other parts of the building before proceeding with selective demolition.
   4. Cut-off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal the remaining portion of pipe or conduit after bypassing.

3.3 PREPARATION

A. Coordinate the drainage, purging, or otherwise removal, collection, and disposal of chemicals, gasses, explosives, acids, flammables, or other dangerous materials with the Owner before proceeding with selective demolition operations.

B. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

C. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around selective demolition area.
   1. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
   2. Protect existing site improvements, appurtenances, and landscaping to remain.
   3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
   4. Provide temporary weather protection, during interval between demolition and removal of existing construction, on exterior surfaces and new construction to ensure that no water leakage or damage occurs to structure or interior areas.
   5. Protect walls, ceilings, floors, and other existing finish work that are to remain and are exposed during selective demolition operations.
   6. Cover and protect furniture, furnishings, and equipment that have been removed.

D. Erect and maintain weather barrier and dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise.
   1. Insulate partition to provide noise protection to occupied areas.
   2. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.
   3. Protect air-handling equipment.
   4. Weatherstrip openings.

E. Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of building to be selectively demolished. Strengthen or add new supports when required during progress of selective demolition.

3.4 POLLUTION CONTROLS

A. Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt. Comply with governing environment protection regulations. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

B. Remove and transport debris in a manner that prevents spillage on adjacent surfaces and areas. Remove debris from elevated portions of building by chute, hoist, or other devices that convey debris to grade level.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before start of selective demolition.

3.5 SELECTIVE DEMOLITION

A. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete work within limitations of governing regulations and as follows:
   1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition work above each floor or tier before disturbing support members on lower levels.
   2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
   3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
   4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
   5. Maintain adequate ventilation when using cutting torches.
   6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
   7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
   8. Locate selective demolition equipment throughout the structure and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
   9. Dispose of demolished items and materials promptly. On-site storage or sale of removed items is prohibited.
   10. Return elements of construction and surfaces to remain to condition existing before start of selective demolition operations.

B. Existing Fire-Rated Construction:
   1. Schedule and execute selective demolition of fire-rated construction within existing facilities in a manner that minimizes disruption to integrity and continuity of the fire separation.

2. Through-Penetrations in Fire-Rated Construction: Make penetrations that shall be firestopped in the final construction in a manner that is consistent with the UL through penetration or construction gap design. Coordinate penetration size and configuration with firestopping assemblies specified in Section 07840, Firestopping.

C. Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain.

D. Breakup and remove concrete slabs on grade unless otherwise shown to remain.

E. Remove resilient floor coverings and adhesive according to recommendations of the Resilient Floor Covering Institute's (RFCI) Recommended Work Practices for the Removal of Resilient Floor Coverings and Addendum. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.

F. Remove no more existing roofing than can be covered in one day by new roofing.

3.6 PATCHING AND REPAIRS

A. Promptly patch and repair holes and damaged surfaces caused to adjacent construction by selective demolition operations.

B. Where repairs to existing surfaces are required, patch to produce surface suitable for new materials. Completely fill holes and depressions in existing masonry walls to remain with an approved masonry patching materials, applied according to manufacturer's printed recommendations.

C. Fire-Rated Construction: Fill openings made through existing fire-rated construction caused by selective demolition of conduits, ducts, and pipes. Install repair materials to maintain the integrity and continuity of existing fire separations. Repair or replacement firestopping materials shall comply with Section 07840, Firestopping.

D. Restore exposed finishes to patched areas and extend finish restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.

E. Patch and repair floor and wall surfaces in the new space where demolished walls or partitions extend one finished area into another. Provide a flush and even surface of uniform color and appearance.
1. Closely match texture and finish of existing adjacent surface.
2. Patch with durable seams that are as invisible as possible. Comply with specified tolerances.

3. Where patching smooth painted surfaces, extend final paint coat over entire unbroken surface containing the patch after the surface has received primer and second coat.
4. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
5. Inspect and test patched areas to demonstrate integrity of the installation, where feasible.

F. Patch, repair, and rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

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

B. Burning: Do not burn demolished materials on project site.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.8 CLEANING

A. Before completion of selective demolition operation clean work area free of debris, dirt, and dust to a level consistent with project cleaning protocol.

B. Change filters on air-handling equipment serving areas of selected demolition on completion of selective demolition operations.

END OF SECTION

SECTION 05410

COLD-FORMED METAL FRAMING

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. Furnishing and installing cold-formed metal framing, accessories, and fasteners for:
   1. Interior partitions and furred walls.
   2. Cold-formed framing for mechanical screens.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for cold-formed metal framing:
   1. Division 1 sections included in the project specifications.
   2. The Contract.
   3. Section 05500 - Metal Fabrications.
   4. Section 09260 - Gypsum Board Assemblies.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 STANDARDS

A. Work included in this Section shall conform to the following, in addition to the Contract Documents, except specified otherwise in this Section:
   1. AISI Specification for the Design of Cold-Formed Steel Structural Members.
   2. AWS D1.3 Structural Welding Code-Sheet Steel.

1.4 DESIGN REQUIREMENTS

A. Lateral Design and Deflection Requirements:
   1. Wind Load: per Section 01000, General Technical Requirements.
   2. Seismic Load: per Section 01000, General Technical Requirements.
   3. Deflection: L/240.
      a. L/240 live and dead load.

B. System Designs:
   1. Conform with ICC International Building, 2006 Edition and AISI Specification for the Design of Cold-Formed Steel Structural Members.

2. Provide for movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day and night temperature ranges.
3. Accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

1.5 QUALITY ASSURANCE

A. As specified in Section 05500, Metal Fabrications, unless specified otherwise in this Section.

B. Cold-formed metal framing and powder-actuated fasteners shall be ICC approved.

1.6 SUBMITTALS

A. Provide the following 2 weeks prior to delivery of materials to the project site:
1. Product information indicating section profiles, dimensions, section properties, resisting moment capacities, notching or punching, and material grades.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Dietrich Industries, Inc.

B. Dale/Incor.

C. Marino\Ware.

2.2 MATERIALS

A. Components: as specified in Section 05500, Metal Fabrications, unless specified otherwise in this Section.

B. Cold-Formed Metal Framing: ASTM C955 and ASTM A653, Grade 50, for 12-, 14-, and 16-gauge material or Grade 33, for 18- and 20-gauge material, coating designation G60, designation G90 for exterior applications.

C. Self-Drilling, Self-Tapping Screws for Framing Fastening: ANSI B18.6.4 and ASTM C954, No. 8 minimum except as otherwise shown on the Drawings, with hex or pan type heads.

D. Powder Actuated Fasteners - 0.145 inch diameter minimum except as otherwise shown on the Drawings, low-velocity type. Acceptable Manufacturers:
   1. Ramset Fastening Systems.
   2. Hilti Fastening Systems Inc.

E. Acoustical Sealant: per Section 09260, Gypsum Board Assemblies.

2.3 ACCESSORIES

A. Accessories such as slide clips, cold-rolled angles and channels, hole-reinforcement plates, and hat channels shall be provided by the cold-formed framing manufacturer.

2.4 FABRICATION

A. As specified in Section 05500, Metal Fabrications, unless specified otherwise in this Section.

B. Stud Requirements:
   1. Section shall be C type.
   2. Flanges shall have returns.
   3. Webs shall be punched.
   4. Section Properties: as noted on the Drawings.

C. Joist Requirements:
   1. Section shall be C type.
   2. Flanges shall have returns.
   3. Webs shall be punched.
   4. Section Properties: as noted on the Drawings.

D. Track Requirements:
   1. Standard Flange Width: 3/4 inch minimum.
   2. Deep Leg Flange Width: 1-1/4 inches minimum.
   3. Webs shall be unpunched.

E. Accessory material thickness shall be as required for the application except:
   1. Slide Clips: 12 gauge minimum.
   2. Hole-Reinforcement Plates and Cold-Rolled Angles and Channels: 16 gauge minimum.
   3. Hat Channels: 18 gauge minimum.

F. Cut edges shall be true to line and free from projections.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Verify that substrate surfaces and building framing components are ready to receive work.

B. Beginning of installation shall mean acceptance of existing conditions and substrates.

3.2 INSTALLATION

A. As specified in Section 05500, Metal Fabrications, unless specified otherwise in this Section.

B. Install cold-formed metal framing as shown within the allowable tolerances:
1. Plumbness of Studs: 1/8 inch in 10 feet.
2. Levelness of Joists: 1/8 inch in 10 feet.
3. Stud/Joist Spacing: plus or minus 1/8 inch.

C. Connections shall be as specified unless otherwise shown. Connections and splices not specified or shown are subject to prior review of IDC.

D. Cut cold-formed metal framing with a saw. Flame cutting is not permitted.

E. Fabrication not specified or shown is subject to prior review of IDC.

F. Framing Requirements Unless Otherwise Shown:
1. Full-length studs, sills, headers, and joists without splices.
2. Studs shall have their wide dimension perpendicular to the wall.
3. Provide triple studs at all corners and intersections.
4. Provide full-height jamb studs at openings with the number of studs in each jamb equal to 1/2 of the studs interrupted by the opening, except as otherwise shown on the Drawings.
5. Space intermediate studs above and below openings at the same spacing as studs each side of the opening.
6. Erect studs plumb with flanges in same direction.
7. Seat studs squarely in the tracks with stud web and flanges abutting track web.
8. Nest double-joist headers in deep leg track, top and bottom.
9. Track flanges shall overlap studs.
10. Sill ends shall have flanges cut and web bent upwards 90 degrees.
11. Tracks shall be butted and inter-connected at corners and intersections. Miters are not permitted.
12. Splices in tracks shall be made centered between studs and spliced with a stud section full length between wall studs.

13. Block and bridge chase walls and walls without sheathing on both sides to develop full moment capacity of studs except as otherwise shown on the Drawings.
14. Install blocking in every fourth stud space of the same size and gauge as the wall studs.
15. Install flat strap or rolled hat channel bridging continuously along each line of blocking with splices centered over and connected to a single piece of blocking.
16. Locate joists directly over studs.
17. Provide full-length multiple joists at openings interrupting joists with the quantity added at each side equal to 1/2 of the interrupted joists.
18. Provide double joists under partitions parallel to the joist span when the partition length exceeds 1/2 the joist span.
19. Set camber of joists up.
20. Minimum End Bearing Length: 2 inches.
21. Minimum Continuous Bearing Length: 4 inches.
22. Provide web stiffeners at joists, concentrated loads, and supports as required by the manufacturer.
23. Web stiffeners at supports shall be the same size and gauge as the supporting studs.
24. Web stiffeners at concentrated loads shall be the same size and gauge as the joists.
25. Provide web hole-reinforcement plates at oversized holes in joist webs.
26. Provide web hole-reinforcement plates at holes in joist webs, which occur within the joist end connection.
27. Solid block joists at ends unless connected to band tracks.
28. Blocking shall be the same size and gauge as the studs or joists.
29. Provide blocking for installation of finishing materials, fixtures, and trim.
30. Joints shall be true, tight, and properly connected.

G. Connections shall be made by welding or with self-drilling, self-tapping screws. Wire tying or metal locking of framing components is not permitted.

H. Paint all welded connections with zinc-rich paint.

I. Hold members firmly in position until properly fastened.

J. Install screws from the lighter to heavier gauge and without stripping the screw shank in the framing.

K. Install acoustical sealant per Section 09260, Gypsum Board Assemblies at sound-prohibiting walls.

3.3 FIELD QUALITY CONTROL

A. As specified in Section 05500, Metal Fabrications, unless specified otherwise in this Section.

B. Inspect cold-formed metal framing after installation and prior to installation of final cover.

3.4 SCHEDULES

A. Unless shown otherwise, provide as a minimum, type, number, and size of fastener specified for the following connections:
   1. Joist to Top Track:
      a. 4 Inch or Smaller Track: two screws.
      b. 6 Inch or Larger Track: three screws.
   2. Joist to Band or End Joist: Full depth 2-inch by 2-inch clip angle or full depth stud section of same gauge as joist with screws to band or end joist and joist at 2 inches on center.
   3. Bottom Track to Metal Joist, Blocking, or Band Joist: screws at 2 inches from each end and at 16 inches on center.
      a. 4 Inch and Narrower Track: one row of screws.
      b. 6 Inch or Deeper Track: two rows of screws, staggered.
   4. Bottom Track or End Stud to Concrete, Masonry, or Steel: powder-actuated fasteners 2 inches from each end and at 16 inches on center.
      a. 4 Inch and Narrower Track: one row of fasteners.
      b. 6 Inch or deeper track: two rows of fasteners, staggered.
   5. Track Splices: two screws at 5 inches on center each side of splice each flange.
   6. Track to Stud: one screw each flange, except do not fasten directly at deflection heads as shown on the Drawings.
   7. Sill to Jamb Stud: one screw each flange.
      a. 4 Inches or Shallower: two screws at web.
      b. 6 Inches or Deeper: three screws at web.
   8. Cross Bracing to Stud:
      a. 4 Inches and Shallower: two screws.
      b. 6 Inches or Deeper: four screws.
   9. Blocking and Bridging to Stud: two screws.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Miscellaneous metal fabrications and fasteners.
   2. Steel bar grating, accessories, and fasteners.
   3. Safety grating, accessories, and fasteners.
   4. Shop priming.
   5. Hot-dip galvanizing.
   6. Epoxy painting .

1.2 RELATED WORK

A. Use this Section conjunction with the following other specifications and related Contract Documents to establish the total requirements for metal fabrications.
   1. Division 1 sections included in the project specifications.
   2. The Contract.
   3. Section 09915 - Building Painting.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 STANDARDS

A. Work and material included in this Section shall conform to the following in addition to the Contract Documents:
   1. AISC Specification for Structural Steel Buildings.
   2. AISC Code of Standard Practice for Steel Buildings and Bridges.
   3. AWS D1.1 Structural Welding Code-Steel.
   4. AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.

1.4 QUALITY ASSURANCE

A. Wedge-type and expansion-nut concrete anchors, resin/adhesive anchors, and headed concrete anchors shall be ICBO approved.

B. Welding procedures and qualifications and welders' and tackers' qualifications shall be in accordance with AWS D1.1.

C. Welding inspector's qualifications shall be in accordance with AWS D1.1.

D. Safety grating section properties shall be computed in accordance with AISI Specifications for the Design of Cold-Formed Steel Structural Members.

E. Safety grating slip resistance shall be in conformance with FS RR-G-1602B.

F. Testing/inspection agencies shall be in conformance with ASTM E329.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Miscellaneous metal fabrications shall be delivered to the site prime or special painted/coated, except as otherwise specified, and marked with a piece number.

B. Miscellaneous metal fabrications and fasteners at the site shall be stored off the ground and stored/handled in such a manner as to prevent soiling, corrosion, and/or damage.

1.6 SUBMITTALS

A. Provide the following 3 weeks prior to start of fabrication:
   1. Shop and installation drawings showing all piece numbers, grades, profiles, sizes, dimensions, fasteners, welds, holes, hole types, special painting/coatings, paint masking, templating, positions, spacing, welding processes, connections, etc., for the fabrication and installation of miscellaneous metal fabrications.
   2. Product information data sheets showing compliance with these Specifications.
   3. A copy of welders' certifications.
   4. Mill test reports certifying physical and chemical properties for each lot of A325 and A449 anchor bolts to be delivered to the site.
   5. Weld procedure qualifications per AWS D1.1 for welds to be made on painted steel surfaces. Weld procedure qualification shall be for the same paint to be welded through in project work.

B. Provide the following within 48 hours of completion of tests and inspections:
   1. Inspection reports concerning fabrication and installation of miscellaneous metals and fasteners.
   2. Test/inspection reports concerning welding and concrete anchor tightening.
   3. A certificate of conformance for hot-dip galvanized fabrications certifying compliance with these Specifications.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. Steel Shapes, Plates, and Bars: ASTM A572, Grade 50or ASTM A36, as noted on the Drawings.

B. Steel Checkered Safety Plate: ASTM A36 with medium pattern lugs.

C. Aluminum Checkered Safety Plate: FS QQ-A-250/2D Alloy 3003 - H22.

D. Stainless Steel Shapes and Bars: ASTM A276, Type 304.

E. Stainless Steel Plate: ASTM A240, Type 304.

F. Steel Pipe: ASTM A53, Grade B.

G. Steel Shaped Tubing: ASTM A500, Grade B.

H. Standard Hex Head Bolts with Hex Nuts: ASTM A307.

I. High-Strength Hex Head Bolts with Heavy Hex Nuts: ASTM A325 or A490, as noted on the Drawings.

J. Stainless Steel Hex Head Bolts with Hex Nuts: ASTM A193, Class 1, Grade B8.

K. Expansion-Nut Type Concrete Anchors: Taper Bolts by the USE Diamond Inc.

L. Wedge-Type Concrete Anchors: FS FF-S-325, Group II, Type 4, Class 1, Parabolts by Power-Stud by Powers Fasteners, Inc. or Kwik-Bolts by Hilti Fastening Systems Inc., or Wedge-All wedge anchors by Simpson Strong-Tie Company, Inc.

M. Resin/Adhesive Anchors: Epcon by Ramset Fastening Systems, Chem-Stud and Power-Fast by Powers Fasteners, Inc., HIT or HVA by Hilti Fastening Systems Inc., or Epoxy-Tie anchors by Simpson Strong-Tie Company, Inc.

N. Turnbuckle Assemblies: ASTM F1145.

O. Clevises: T&D Hardware Co., Ltd.

P. Standard, Jamb, and Heavy Hex Nuts: ASTM A563.

Q. Sleeve Nuts: type by the Cleveland City Forge Company Division of Park Ohio Structural Hardware.

R. Plain Washers: ANSI B18.22.1, Type A-W.

S. Plain Hardened Washers: ASTM F436.

T. Beveled Washers: IFI B18.23.1.

U. Welding Filler Metal for Carbon Steel: AWS A5.1 or A5.5 E70XX for SMAW welding process, AWS A5.18 ER70S-X for GMAW welding process, AWS A5.17 or A5.23 F7X-EXXX for SAW welding process, and AWS A5.20 E7XT-X for FCAW welding process.

V. Welding Filler Metal for Stainless Steel: AWS A5.4 E316 for stainless-to-stainless applications and E309 for carbon-to-stainless applications.

W. Steel Bar Grating: ANSI A202.1; IKG Borden Weldforged Type WB by the IKG Industries Division of Harsco Corp., Tru-Weld, Type 19W4, by Tru-Weld Grating Inc., Type KW-19-4 by Klemp Corporation, Engra-Grating Type 19W4 by Engineered Grating Inc., or Electroforged Type 1 by Blaw-Knox Equipment Inc; steel, ASTM A569.

X. Steel: ASTM A1011.

Y. Steel Bar Grating Hold-Down Fasteners: by HILTI, Inc.

Z. Safety Grating: Grip Strut by Morton Manufacturing Company.
1. Material: carbon steel.
2. Finish: ASTM A653 G90.

AA. Safety Grating Hold-Down Clips: manufacturer's standard stainless steel.

BB. Standard Prime Paint: per Section 09915, Building Painting.

CC. Epoxy Paint: per Section 09915, Building Painting.

DD. Zinc for Hot-Dip Galvanizing: ASTM B6.

EE. Zinc Compound for Field Repair of Hot-Dip Galvanized Surfaces: MS DOD-P-21035B, Z.R.C. Cold Galvanizing Compound, by Z.R.C. world wide.

2.2 EQUIPMENT

A. Concrete Anchor Drill Bits: ANSI B94.12.

2.3 FABRICATION

A. Miscellaneous metal fabrications shall be fabricated completely in the shop except as otherwise shown on the Drawings.

B. Miscellaneous metal fabrications shall conform accurately to the shape and dimensions as shown on the Drawings within the allowable tolerances as defined in AISC Code of Standard Practice for Steel Buildings and Bridges.

C. Sheared and flame cut edges shall be true to line and free from rough corners and projections.

D. Reentrant cuts/corners shall be filleted to a radius of not less than 1/2 inch.

E. Holes shall be punched, subpunched and reamed, or drilled in accordance with AISC Specifications for Structural Steel Buildings. Holes shall not be made by flame cutting.

F. Holes shall be 1/16 inch larger than the nominal bolt diameter, except holes for cast-in-place anchor bolts and inserts which shall be 3/16 inch larger than the nominal bolt diameter and as otherwise shown on the Drawings.

G. The use of oversized or slotted holes not shown on the Drawings shall be subject to prior review by IDC.

H. Bent plate shall be in accordance with AISC Minimum Radius for Bending.

I. Column and stringer ends bearing upon base and cap plates shall be saw cut to true surfaces and correct bevels.

J. Column and stringer caps and baseplates shall have full contact when assembled.

K. Fabricated Threads: ANSI B1.1 UNC-2A.

L. Perforated Plate: per IPA Perforating Standards and Practices.

M. Welding shall be done in a sequence, which minimizes distortion and shrinkage.

N. Electrodes preheat and welding process shall meet AWS prequalification requirements and the electode manufacturer's written recommendations for specific applications.

O. Headed concrete anchors and deformed bar anchors shall be shop welded in accordance with AWS C5.4 and AWS D1.1.

P. After welding stainless steel, weld splatter, flux, and scale shall be removed.

Q. Fabrication (holes, notches, etc.) not required by nor shown on the Drawings shall be subject to prior review by IDC.

R. Steel Bar Grating Fabrication Requirements:
   1. Bearing bar size and coating shall be as shown on the Drawings.
   2. Bearing Bar Spacing: 1 3/16 inches on center.
   3. Bearing Bar Surface: smooth.
   4. Crossbar Spacing: 4 inches on center.
   5. Crossbars: round, hexagonal, or square twisted.
   6. Crossbars shall be at right angles to bearing bars.
   7. Crossbars shall be pressure welded to bearing bars.
   8. The tops of all bars shall be flush.
   9. Provide edge bands of the same size as the bearing bars.
   10. Provide checkered plate nosings of 1-1/4-inch to 1-1/2-inch width/face at treads and landing traffic edges.
   11. Provide carrier/end plates at treads.
   12. Provide Schedule 40 pipe collar bands at miscellaneous openings that interrupt bearing bars.
   13. Banding/end plates/collar bands/carrier plates shall be attached by welding.
   14. Carrier/end plates shall have one 7/16-inch hole and slot.

S. Miscellaneous welding to steel bar grating shall be in accordance with NAAMM Welding of Steel Bar Grating.

T. Grating Frame Fabrication Requirements: Corners shall be miter cut, bevel groove welded, and welds ground flush at bearing surfaces.

U. Safety Grating Fabrication Requirements:
   1. Plank and walkway size and thickness shall be as shown on the Drawings.
   2. Plank sections shall be channel type.
   3. Walkway sections shall have 5-inch-high integral toeboards.
   4. Walkway toeboards shall have returns.
   5. Opening pattern shall be 3-7/8-inch-long by 1-1/4-inch-wide diamonds with serrated edges.
   6. Provide carrier/end plates at treads.
   7. Carrier/end plates shall have one 7/16-inch hole and slot.
   8. Provide 1/8-inch minimum thick pipe collar bands at miscellaneous openings attached by welding.

2.4 FINISHES

A. Miscellaneous metal fabrications, except stainless steel, surfaces to be epoxy painted, galvanized, or epoxy-coated, surfaces and anchors encased in concrete, surfaces to be grouted against, and surfaces to be welded shall be per Section 09915, Building Painting.

B. Miscellaneous metal fabrications where shown on the Drawings to be epoxy painted shall be painted per Section 09915, Building Painting.

C. Surface preparation for prime painting shall be per Section 09915, Building Painting.

D. Surface preparation for epoxy painting shall be per Section 09915, Building Painting.

E. Surfaces to be welded shall be protected from painting by use of masking. Inadvertent overspray on surfaces to be welded shall be removed by wire brushing.

F. Paint application shall be per Section 09915, Building Painting.

G. Steel bar grating shall be galvanized.

H. Exterior standard bolts, cast-in-place anchor bolts, turnbuckles, clevises, and nuts shall be galvanized.

I. Hot-dip galvanizing of metal fabrications shall be in conformance with ASTM A385 and A123.

J. Hot-dip galvanizing of metal fasteners shall be in conformance with ASTM A385 and ASTM A153.

K. Safeguarding against warping and distortion during hot-dip galvanizing of metal fabrications shall be in conformance with ASTM A384.

L. Exterior standard washers shall be plated.

2.5 SOURCE QUALITY CONTROL

A. Miscellaneous metal fabrications shall be inspected after fabrication.

B. Inspection of welding shall be in accordance with AWS D1.1 with all welds visually inspected as required by the Authority Having Jurisdiction.

C. Acceptance of welding inspection results shall be in accordance AWS D1.1.

D. Inspection of headed concrete anchor and deformed bar anchor welding shall be in accordance with AWS D1.1.

E. Hot-dip galvanizing shall be inspected after galvanizing in accordance with AHDGA Inspection of Products Hot-Dip Galvanized after Fabrication.

F. Miscellaneous metal fabrications blast cleaned for epoxy painting or fusion-bonded epoxy coating shall be inspected after cleaning and prior to primer painting or coating.

G. Acceptance of blast cleaning inspection shall be in accordance with SSPC VIS-1, Pictorial Surface Preparation Standards for Painting Steel Surfaces.

H. A minimum of 10 percent of headed concrete anchors and deformed bar anchors shall be tested in accordance with AWS D1.1.

I. Ultrasonic testing shall be in accordance with AWS D1.1.

J. A minimum of 10 percent of indicated welds shall be tested as indicated on the Drawings.

K. Acceptance of welding test results shall be in accordance with AWS D1.1.

PART 3 -- EXECUTION

3.1 FIELD PREPARATION

A. At the time of connecting, bearing surfaces shall be free from loose or nonadherent rust, loose mill scale, oil, grease, dirt, mud, and any foreign matter, coating, or defect that adversely affects the connection.

B. Surface preparation for welding shall be in accordance AWS D1.1, except loose or nonadherent rust, loose mill scale, and paint shall be removed by wire brushing.

3.2 ERECTION AND INSTALLATION

A. Miscellaneous metal fabrications and fasteners shall be located and installed so as to conform accurately with the Drawings within the allowable tolerances as defined in the AISC Code of Standard Practice for Steel Buildings and Bridges.

B. Connections shall be as shown on the Drawings. Connections and splices not shown on the Drawings shall be subject to prior review by IDC.

C. Anchor bolts shall be placed within the allowable tolerances as defined in the AISC Code of Standard Practice for Steel Buildings and Bridges.

D. Cast-in-place miscellaneous metals and fasteners shall be installed and set by templating prior to concrete placement.

E. Concrete anchors shall be installed and tightened to proper torques using proper initial head clearances at expansion nut-type concrete anchors and with nuts initially flush with the end of the bolt at wedge and sleeve-type concrete anchors in accordance with the manufacturer's written instructions and specifications.

F. Resin/adhesive anchors shall be fully cured prior to use.

G. Connection parts in connections not slip joints shall be properly drawn together and the bolts tightened to the snugtight condition.

H. Bolts in slip-joint connections shall be provided with lock nuts and initially tightened to the snugtight condition, then backed off half turn.

I. Standard bolt heads and nuts at oversized and slotted holes shall be provided with plain washers.

J. High-strength bolt heads and nuts at oversized and slotted holes shall be provided with plain hardened washers.

K. Bolt heads and nuts at sloped surfaces shall be provided with beveled washers.

L. Turnbuckles and clevises shall be provided with jamb nuts.

M. Welding shall be done in a sequence, which minimizes distortion and shrinkage.

N. Holes that must be enlarged to admit bolts shall be reamed. Holes shall not be enlarged by flame cutting.

O. Field correcting by flame cutting shall not be permitted without prior review by IDC.

P. Steel Bar Grating Installation Requirements:
1. Install level and rattlefree.
2. Bearing bars shall bear on supports with 1-inch minimum bearing.
3. Crossbars shall be on the topside.
4. Notching of bearing bars shall not be permitted.
5. Attach to supports, except at trench and sump angles, with two grating clamps per panel per support.

Q. Safety Grating Installation Requirements:
1. Install level and rattlefree.
2. Sections/panels shall bear on supports with 1-1/2-inch minimum bearing.
3. Install with 1/4-inch maximum gap between sections.
4. Attach to supports with two hold-down clips per section/panel per support.

R. Filler and/or shim plates shall be furnished and installed by the Contractor to provide alignment of members where required due to mill and/or fabrication tolerances.

3.3 FIELD QUALITY CONTROL

A. Miscellaneous metal fabrications and fasteners shall be inspected after installation.

B. Cast-in-place anchor bolts and miscellaneous metal fabrications shall be inspected after they have been placed and prior to concrete placement.

C. Inspection of welding shall be in accordance with AWS D1.1 with all welds visually inspected.

D. Acceptance of welding inspection results shall be in accordance with of AWS D1.1.

E. A minimum of 10 percent of slip-joint connections shall be inspected.

F. A minimum of 10 percent of all concrete anchor connections shall be tested using a calibrated torque wrench.

G. Ultrasonic testing shall be in accordance with AWS D1.1.

H. A minimum of 10 percent of indicated welds shall be tested as indicated on the Drawings.

I. Acceptance of welding test results shall be in accordance with of AWS D1.1.

3.4 REPAIR AND CLEANING

A. Abraded and scarred areas and connections on painted surfaces exposed to view shall be repaired with the same kind of paint and with a minimum dry film thickness equal to that previously applied to the steel.

B. Abraded and scarred areas on galvanized surfaces shall be repaired with cold galvanizing compound in accordance with ASTM A780 with a minimum dry film thickness of 8 mils.

C. Wet storage stains on stainless and galvanized steel shall be removed after installation.

D. Abraded and scarred areas on fusion-bonded epoxy-coated surfaces shall be repaired with patching compound in accordance with the manufacturer's written instructions and specifications with a minimum dry film thickness of 10 mils.

END OF SECTION

SECTION 06100

ROUGH CARPENTRY

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. Furnish and install:
   1. Plywood and miscellaneous sheathing.
   2. Accessories and fasteners.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for rough carpentry:
   1. Division 1 sections included in the project specifications.
   2. The Contract.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 QUALITY ASSURANCE

A. Lumber Grading Rules: as approved by the Board of Review of the American Lumber Standards Committee.

B. Inspection Agencies:
   1. Lumber Grading: certified by the Board of Review of the American Lumber Standards Committee.
   2. Pressure Treating: certified by the American Wood Preserves Bureau.

C. Sawn lumber shall be marked with a WWPA/WCLIB grading stamp.

D. Plywood and structural wood panels shall be marked with an APA grade mark.

E. Preservative pressure-treated lumber shall be marked with an AWPB quality control mark.

F. Fire-retardant treated material shall have a Class 1 flame-spread rating of 25 or less in accordance with ASTM E84.

G. Fire-retardant sawn lumber and plywood shall have an Underwriters Laboratories' label affixed to it.

1.4 SUBMITTALS

A. Submit product information showing compliance with these Specifications to the Owner 2 weeks prior to shipment to the site.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. Plywood Sheathing: interior, Exposure 1 plywood with exterior glue graded as shown and in conformance with NBS PS-1 and APA E445.

B. Oriented Strand Board: interior, Exposure 1, structural-use panel with exterior resin graded as shown and in conformance with APA E445.

C. Waferboard: interior, Exposure 1, structural-use panel with exterior resin graded as shown and in conformance with APA E445.

D. Particleboard: ANSI A208.1, Type I, Grade M1, mat-formed type.

E. Fiberboard: ASTM C208 asphalt-impregnated wood fiber sheathing.

F. Building Paper: ASTM D226 nonperforated, asphalt-saturated felt.

G. Hex Head Standard Bolts with Hex Nuts and Lag Bolts: ASTM A307, Grade A.

H. Carriage Bolts with Hex Nuts: ASTM A307, Grade A/ANSI B18.5.

I. Hex Nuts: ASTM A563.

J. Plain Washers: ANSI B27.2, Type A-W.

K. Plate Washers: mild steel type.

L. Malleable Iron Washers: Star Heel Plate Company, Victor.

M. Plywood Sheathing Clips: extruded from ASTM B221 6063-T6 aluminum alloy with varying flange thickness of 0.075 inch at web to 0.035 inch at edges.

N. Sheathing Nails: FS FF-N-105B.

Application	Nail Type
Sheathing	Commons

Application	Nail Type
Siding and soffit	Casing

O. Pneumatically Driven Common Nails and Staples - FS FF-N-105B as Manufactured By:
   1. Senco Fastening Systems Division of Senco Products Inc.
   2. Hilti Fastening Systems Inc.
   3. Air Nail Company Inc.

P. Self-Drilling, Self-Tapping Screws for Fastening Framing Lumber to Steel Framing: Buildex Division of Illinois Tool Works Inc., Header TEKS/4, No. 12 with flat heads.

Q. Self-Drilling, Self-Tapping Screws for Fastening Plywood to Steel Framing: Buildex Division of Illinois Tool Works Inc., Plymetal TEKS/3 No. 10 with wafer heads.

R. Powder-Driven Fasteners - FS FF-395B 11/64-Inch Low-Velocity Type as Manufactured By:
   1. Ramset Fastening Systems.
   2. Hilti Fastening Systems Inc.
   3. Phillips Drill Division of ITT Corporation.

S. Adhesive: APA AFG-01.

T. Preservative for Pressure Treating: AWPA P-5 waterborne salts type.

U. Preservative for Fire-Retardant Treating: interior Type A.

V. Preservative for Field Treating:
   1. Darworth Company, Cuprinol Green 10.
   2. Koppers Company Inc., Wolman Green.
   3. Olympic Stain, Olympic Green.

2.2 FABRICATION

A. Sawn lumber and timber shall be S4S with a maximum moisture content of 19 percent.

2.3 PRESERVATIVE TREATMENT

A. Sawn lumber to be in contact with concrete or masonry or exposed to the weather shall be pressure treated in accordance with AWPA C-2 and AWPB LP-2 having a retention of 0.25 pound per cubic foot.

B. Fire-retardant lumber shall be pressure treated in accordance with AWPA C20. After treatment, lumber shall be dried to a maximum moisture content of 19 percent.

C. Fire-retardant plywood shall be pressure treated in accordance with AWPA C27. After treatment, plywood shall be dried to a maximum moisture content of 15 percent.

2.4 FINISHES

A. Exterior bolts and nuts, plate washers, and malleable iron washers shall be galvanized.

B. Hot-dip galvanizing of metal fasteners shall be in conformance with ASTM A385 and ASTM A153.

C. Exterior standard washers shall be plated.

D. Nails shall be galvanized or coated.

PART 3 -- EXECUTION

3.1 WOOD TREATMENT

A. Field cuts and holes in pressure-treated lumber shall be field treated with preservative in accordance with AWPA M4.

3.2 SHEATHING AND SIDING INSTALLATION

A. Install particleboard with:
1. The face grain perpendicular to supports.
2. Best face up.
3. End joints staggered 32 to 48 inches.
4. End joints offset one joist spacing with that of plywood subfloor end joints.
5. Side joints offset one-half panel with that of plywood subfloor panels.

B. Install fiberboard with:
1. The face grain parallel to framing.

2. Best side out.
3. Unframed panel edges solid blocked.

C. Horizontal sheathing less than 12 inches in width shall have unframed edges solid blocked.

D. Install wall sheathing with:
1. The face grain either perpendicular or parallel to framing.
2. Best face out.
3. Unframed edges solid blocked.

E. Install plywood siding over building paper with:
1. The face grain parallel to framing.
2. Best face out.
3. Unframed edges solid blocked.

F. Plywood, fiberboard, and particleboard joints shall be centered over supports.

G. Plywood and structural-use panel joints shall be open 1/8 inch unless specified otherwise by the manufacturer.

H. Nailing requirements shall be in accordance with the nailing schedule unless otherwise shown.

I. Nails at panel edges shall be spaced 3/8 inch from edges.

3.3 FIELD QUALITY CONTROL

A. Inspect rough carpentry after installation and prior to installation of final cover.

B. Inspect plywood fastening after installation and prior to continuation of final cover.

END OF SECTION

SECTION 06114

WOOD BLOCKING AND CURBING

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Roof curbs, nailers, and cants.
   2. Blocking in wall and roof openings.
   3. Plywood sheathing.
   4. Wood furring and grounds.
   5. Concealed wood blocking for support of laboratory accessories and wall cabinets, handrails, and insulation stops.
   6. Telephone and electrical panel back boards.
   7. Wood treatment.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for wood blocking and curbing.
   1. The Contract.
   2. Division 1 sections included in the project specifications.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 QUALITY ASSURANCE

A. Lumber Standards: Manufacture lumber to comply with PS 20 "American Softwood Lumber Standard" and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.

B. Inspection agencies used to reference lumber grades and species:
   1. West Coast Lumber Inspection Bureau (WCLIB).
   2. Western Wood Products Association (WWPA).

C. Plywood Grading Agency: certified by APA. Plywood panels shall be marked with an APA grade mark.

D. Preservative Treated Wood: AWPA C1 - All Timber Products - Preservative Treatment by Pressure Process.

E. Fire-Retardant Treatment by Pressure: AWPA C20 – Structural Lumber – Fire-Retardant Treatment by Pressure.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. Softwood Lumber: hem/fir species, standard or better grade, 19 percent maximum moisture content.

B. Plywood: APA Rated Sheathing, Grade C-D; Exposure Durability 1; sanded. Provide waterproof glue.

C. Particleboard: Oriented Strand Board; wood shavings set with waterproof resin binder; B-C grade; sanded faces.

2.2 ACCESSORIES

A. Fasteners: hot-dipped zinc-coated steel for exterior, high humidity, and treated wood locations; plain finish elsewhere; size and type to suit condition.

B. Anchors: toggle bolt type for anchorage to hollow masonry. Expansion shield and lag bolt type for anchorage to solid masonry or concrete. Bolts or ballistic fasteners for anchorages to steel. Hot-dip zinc-coated, ASTM A153.

2.3 WOOD TREATMENT

A. Wood Preservative Pressure Treatment:
   1. AWPA Treatment C1, water-borne oxide type, with 0.25 percent chemical retainage for above-ground applications.
   2. Acceptable Products:
      a. “ACQ Preserve”; Chemical Specialties, Inc.
      b. "Wolmanized" wood; Hickson Corporation.
      c. "CCA"; Hoover Treated Wood Products Inc.
      d. "K-33"; Osmose Wood Products.

B. Fire-Retardant Treatment:
   1. Chemically treated and pressure impregnated; capable of providing a maximum flame spread of 25 and smoke developed of 450 when tested in

accordance with ASTM E84 and meeting performance criteria of ASTM D2898.

2. Acceptable Products:
   a. “D-Blaze”; Chemical Specialties, Inc.
   b. "Dricon"; Hickson Corporation.
   c. "Exterior Fire-X"; Hoover Treated Wood Products Inc.

C. Following treatment, redry preservative and fire-retardant treated wood products to the following maximum moisture contents:
   1. Lumber: 19 percent.
   2. Plywood: 15 percent.
   3. Surface dry material 3 inches nominal and greater.

PART 3 -- EXECUTION

3.1 FIELD PREPARATION

A. Verify substrate conditions are ready to receive blocking, curbing, and framing.

B. Coordinate placement of blocking, curbing, and framing items.

3.2 FIELD-APPLIED WOOD TREATMENT

A. Apply treatment in accordance with AWPA M4.

B. Brush-apply two coats of treatment on cut surfaces of treated wood in contact with cementitious materials and roofing and related metal flashings.

C. Allow treatment to dry before erecting members.

3.3 INSTALLATION

A. Discard units of material with defects that might impair quality of work and units that are too small to use in fabricating work with minimum joints or optimum joint arrangement.

B. Cut, fit, and set work to required levels and lines, with members plumb and true.

C. Place horizontal members, crown side up.

D. Securely attach work to substrate by anchoring and fastening as shown and as required by recognized standards.

E. Secure sheathing to framing members with ends over firm bearing and staggered.

F. Install telephone and electrical panel back boards with plywood sheathing material where required. Size back boards 12 inches beyond size of electrical and telephone equipment panels.

G. Use galvanized common wire nails, except as otherwise indicated. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; predrill as required.

3.4 WOOD, NAILERS, BLOCKING, AND SLEEPERS

A. Provide wherever shown and where required for attachment of other work. Form to shapes as shown and cut as required to achieve a substrate of true line and level to which subsequent work can be attached. Coordinate location with other work involved.

B. Attach to substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise indicated.

3.5 ROOF CURBS AND NAILERS

A. Curb roof openings except where prefabricated curbs are provided. Form corners by lapping side members alternatively.

B. Coordinate curb installation work with installation of roofing and flashing.

3.6 SCHEDULE

A. Roof Blocking: softwood lumber, pressure preservative treatment.

B. Telephone and Electrical Panel Boards: 3/4 inch thick, square edges, site brush applied preservative treated.

END OF SECTION

SECTION 06400

ARCHITECTURAL WOODWORK

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Finish carpentry including standing wood trim.
   2. Shop fabricated and finished custom trims.
   3. Shop-fabricated wall, base, and storage cabinet units.
   4. Countertops.
   5. Cabinet hardware.
   6. Preparations for utilities installed in woodwork and countertops.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for architectural woodwork:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 06114 - Wood Blocking and Curbing.
   4. Section 08800 - Glazing.
   5. Section 09915 - Building Painting.
   6. Section 15440 - Plumbing Fixtures.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 QUALITY ASSURANCE

A. Perform work in accordance with Architectural Woodwork Institute (AWI) Architectural Woodwork Quality Standards Illustrated, Custom Grade.

B. Fabricator: company specializing in performing work of this Section with minimum 3 years documented experience.

C. Installer Qualifications: firm specializing in custom casework with 3 years' experience in installation of custom casework similar to that required for this project.

D. Single-Source Responsibility: Provide custom casework for the entire project produced and installed by a single manufacturer.

E. Verify field measurements before start of fabrication.

1.4 DELIVERY, HANDLING, AND STORAGE

A. Do not deliver casework to the jobsite until excessive moisture has been out of the building for at least 10 days.

B. Protect casework and paneling from damage and dampness. Store in weathertight, well-ventilated areas. Do not subject to extreme changes of temperature or humidity.

C. Deliver, store, and handle casework in manner to prevent damage and deterioration. Defer delivery to the job until the installation and storage areas are complete and dry of all wet-type construction. Maintain relative humidity in storage areas not to exceed 60 percent.

1.5 SUBMITTALS

A. Provide the following within 4 weeks of Contract award:
   1. Product data: for cabinet hardware products.
   2. Shop drawings indicating materials, component profiles, fastening methods, assembly methods, joint details, accessory listings, and schedule of finishes.
   3. Samples, plastic laminate: 6 inches by 6 inches in size illustrating plastic laminate color and pattern for each specified type.
   4. Samples, wood products: 8 inches by 8 inches in size illustrating wood grain and specified finish for each specified wood product.
   5. One sample unit of each type and finish of exposed hardware.
   6. IDC shall review samples before start of fabrication.

1.6 OPERATION AND MAINTENANCE DATA

A. Include recommended cleaning and stain removal methods, cleaning materials, and polishes and waxes.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Laminate:
   1. Formica Corporation.
   2. Lamin-Art, Inc.
   3. Nevamar.
   4. Wilsonart International, Inc.

a. PLAM-1, Basis of Design: Wilsonart Graphite Grafix (515-58) - Matte Finish.
b. PLAM-2: Basis of Design: Wilsonart Northern Oak (7152-58) - Matte Finish.

B. Solid Surface Material:
1. Dupont Corporation; Corian.
2. Formica Corporation; Surell.
3. Wilsonart International, Inc.; Gibralter.
a. Basis of Design: Formica Black Matrix.

C. Cabinet Hardware:
1. Accuride International, Inc.
2. Grass America, Inc.
3. Hafele America Co.
4. HEWI, Inc.
5. Julius Blum, Inc.
6. Knape & Vogt Manufacturing Co.
7. Schlage Lock Company.
8. SOSS Invisible Hinge Division.
9. Stanley Hardware.

2.2 MATERIALS

A. Hardwood Lumber: PS20. AWI Grade II, Custom; maximum moisture content of 6-8 percent; and the following:
1. Species of Wood: Oak.
2. Cut or Slicing of Wood: Rift or plain.
3. Matching of Individual Leaves to Each Other: book matching.

B. Hardwood Plywood: AWI Grade A with lumber core; type of glue recommended for application; and the following:
1. Species of Veneer: Red Oak.
2. Cut or Slicing of Veneer: Rift or plain.
3. Matching of Individual Leaves to Each Other: book matching.
4. Matching Across Panel Face: running matching.
5. Matching or Relationship of Panels to Each Other: sequence matched uniform size sets matching.

C. All lumber and panel components shall meet appropriate AWI grading rules and moisture content standards

D. Wood Particleboard: ANSI A208.1 Type 1; composed of wood chips or sawdust, medium density, made with water-resistant adhesive; sanded faces.

E. Hardboard: AHA A135.4; pressed wood fiber with resin binder, tempered grade, 1/8 inch thick, smooth one sides.

F. Sheet Metal Components: stainless steel, Type 304 with #4 satin finish; 1/8-inch thick.

G. Formaldehyde-Free Binder Panels: MDF manufactured in accordance with ANSI A208.2, product Class MD.

H. Moisture Resistant Panels: countertops containing sinks shall be made from MDF with exterior glue, per ANSI A208.2 or particle board, Grade M-2, exterior glue, per ANSI A208.1.

I. Semi-exposed and Concealed Components: shall comply with AWI standards and may consist of medium-density particle board per ANSI A208.1; tempered hardboard per ANSI/AHBA Standard A135A; or lumber as described above.

J. Solid Surface Material: synthetic marble of polymer resins, with integral color, stain resistant to domestic chemicals and cleaners.

2.3 ACCESSORIES

A. Fasteners: Of size and type to suit application; stainless steel epoxy coated finish in concealed and exposed locations.

B. Lumber for Shimming, Blocking, edge strips and cants: Softwood lumber of fir-hemlock species.

C. Veneer Edge Band: Standard wood veneer edge band matching face veneer.

D. Solid Wood Edge Band: Minimum 1/4-inch thick solid hardwood edge band of species to match face veneer.

E. Glass: 1/8-inch, clear tempered.

F. Fasteners:
1. Size and type to suit application.
2. Concealed Joint Fasteners: threaded steel.
3. Bolts, Nuts, Washers, Lags, Pins, and Screws: of size and type to suit application.
4. Finishes: U.S. 32D finish in concealed locations and U.S. 32D finish in exposed locations.

G. Grommets: metal material for cut-outs.

H. Wood Filler: Oil base, tinted to match surface finish color.

I. Wood Treatment:
1. Fire Retardant (FR-S Type): Chemically treated and pressure impregnated; capable of providing maximum flame spread/smoke development rating of 25 / 450 in accordance with ASTM E84.
2. Wood Preservative (Surface Application): clear, synthetic varnish type.
3. Shop brush apply treatment to wood materials requiring fire rating and preservatives to concealed wood blocking and casework.
4. Provide identification on fire retardant treated material.
5. Deliver fire retardant treated materials cut to required sizes. Minimize field cutting.
6. Redry wood after pressure treatment to maximum 12 percent moisture content.

2.4 HARDWARE

A. Supply hardware as listed below for project casework that requires custom fabrication:
1. Shelf Support: bent plate style with pin for drilled hole mount stainless steel by Stanley or K&V.
2. Drawer and Door Pulls: brushed stainless steel, by Cipco.
3. Catches: self-aligning, magnetic, bright aluminum finish, by K&V or Stanley.
4. Drawer Slides: K & V Model 8000 undermount.
5. Hinges: concealed type stainless steel by Stanley.
6. Cabinet and Door Locks: Grade 1 per ANSI/BHMA A156.11, key removable in locked position only in finish to match pulls.

2.5 FABRICATION

A. Cabinet Door and Drawer Front Construction: 3/4-inch thick; flush style.

B. Shop assemble casework for delivery to site in units easily handled and to permit passage through building openings.

C. Fit shelves, doors, and exposed edges with matching veneer edging. Use full-length pieces only.

D. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

E. Mechanically fasten backsplashes to countertops with steel brackets at 16 inches on center.

F. Provide cutouts for plumbing fixtures specified in Section 15440, Plumbing Fixtures, inserts, appliances, outlet boxes, and other fixtures and fittings. Verify locations of cutouts from onsite dimensions. Seal contact surfaces of cut edges.

2.6 FINISHES

A. Sand work smooth and set exposed nails and screws.

B. Apply wood filler in exposed nail and screw indentations.

C. On items to receive transparent finishes, use wood filler matching surrounding surfaces and of types recommended for applied finishes.

D. Stain, seal, and varnish exposed to view surfaces.

E. Seal internal surfaces and semi-concealed surfaces.

F. Prime paint surfaces in contact with cementitious materials.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify adequacy of backing and support framing specified in Section 06114, Wood Blocking and Curbing.

B. Verify mechanical, electrical, and building items affecting work of this Section are placed and ready to receive this work.

3.2 INSTALLATION

A. Architectural Woodwork, General:
1. Install work in accordance with AWI Custom Quality Standard.
2. Set and secure materials and components in place, plumb and level.
3. Carefully scribe architectural woodwork that is against other building materials, leaving gaps of 1/32-inch maximum. Do not use additional overlay trim to conceal larger gaps.
4. Countersink anchorage devices at exposed locations used to wall mount components and conceal with solid plugs of species to match surrounding wood. Finish flush with surrounding surfaces.
5. Install components with nails and adhesive by gun application.

B. Casework:

1. Comply with AWI Quality Standards Section 400.
2. Set and secure casework in place rigid, plumb, and level.
3. Use purpose designed fixture attachments at concealed locations for wall-mounted components.
4. Use threaded steel concealed joint fasteners to align and secure adjoining cabinet units.
5. Secure cabinet and counter bases to floor using appropriate angles and anchorages.
6. Site glaze glass materials using interior dry method specified in Section 08800, Glazing.

C. Countertops:
1. Comply with AWI Quality Standards Section 400.
2. Use threaded steel concealed joint fasteners to align and secure adjoining countertops.

D. Paneling:
1. Comply with AWI Quality Standards Section 500.
2. Coordinate installation of blocking behind paneling.
3. Install prefinished paneling with beveled wood rails.

E. Install hardware in accordance with manufacturer's instructions.

F. Site Applied Wood Treatment:

G. Preparation For Site Finishing:
1. Site Finishing: Refer to Section 09915, Building Painting.
2. Before installation, prime paint surfaces of items or assemblies that will be installed in contact with cementitious materials.

3.3 ERECTION TOLERANCES

A. Maximum Variation from Indicated Position: 1/16 inch.

B. Maximum Offset from Alignment with Abutting Materials: 1/32 inch.

3.4 ADJUSTING AND CLEANING

A. Adjust doors, drawers, hardware, fixtures, and other moving or operating parts to function smoothly and correctly.

B. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION

SECTION 07212

BOARD INSULATION

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Adhesive bed, sheet, and vapor retarder.
   2. Board insulation at exterior wall behind clean room wall assemblies.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for board insulation:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 13051 - Cleanroom Wall Assemblies.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 SYSTEM DESCRIPTION

A. Materials of this Section shall provide a continuous thermal, and vapor retarder at building enclosure elements.

1.4 COORDINATION

A. Coordinate work of this Section with Section 13051, Cleanroom Wall Assemblies.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not install adhesives when temperature or weather conditions are detrimental to successful installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's recommendations for storage and handling insulation. Store plastic foam insulation in dry, wrapped condition, protected from direct sunlight exposure until ready for installation.

1.7 SUBMITTALS

A. Provide the following within 3 weeks of Contract award:
   1. Product data
   2. Manufacturer's Installation Instructions: provide special environmental conditions required for installation, installation techniques, and fastening methods.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Extruded Polystyrene Insulation Type EPI-1:
   1. DiversiFoam Products.
   2. Dow Chemical Company.
   3. Tenneco Foam Products.
   4. UC Industries/Owens Corning.

2.2 MATERIALS

A. Insulation Type EPI-1: extruded cellular polystyrene; mean thermal resistance "R" per inch of 5.0; minimum compressive strength of 30 psi; water absorption by volume in accordance with ASTM D2842 0.3 percent; tongue and groove edges; board size of 48-inches by 120-inches by1.1/2-inch thick.

2.3 ADHESIVE MATERIALS

A. Adhesive Bed: as recommended by insulation manufacturer for type of insulation used.

2.4 ACCESSORIES

A. Tape: polyester self-adhering type; mesh reinforced; 2 inches wide.

PART 3 -- EXECUTION

3.1 FIELD PREPARATION

A. Verify substrate and adjacent materials and insulation boards are dry and ready to receive insulation and adhesive.

B. Verify substrate surface is flat, free of honeycomb, fins, irregularities, and other materials that can impede adhesive bond.

C. Verify insulation boards are unbroken, and free of damage.

3.2 INSTALLATION - EXTERIOR WALLS

A. Adhere a 48-inch-wide strip of polyethylene sheet over vertical joint with double beads of adhesive each side of joint. Tape seal joints between sheets. Extend sheet full height of joint.

B. Apply adhesive in continuous beads per board length as recommended by insulation manufacturer. Daub adhesive tight to protrusions.

C. Install boards on wall surface perimeter, vertically. Place membrane surface of insulation against adhesive.

D. Place boards in a method to maximize contact bedding. Butt edges and ends tight to adjacent board and to protrusions. Cut insulation with a saw, knife, or other sharp tool to fit tightly around all obstructions.

E. Place 6-inch-wide polyethylene sheet at perimeter of wall openings from adhesive vapor and air barrier bed to window frame. Tape seal in place to ensure continuity of vapor and air barrier.

F. Verify the intended location of vapor barrier to ensure that condensation does not occur within insulation system.

G. Tape insulation board joints.

H. Use care to avoid damage and soiling face of insulation units that will be exposed to view.

END OF SECTION

SECTION 07213

BATT AND BLANKET INSULATION

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Batt insulation in ceiling construction.
   2. Insulation for filling perimeter window and crevices in exterior wall and roof assembly.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for batt and blanket insulation:
   1. The Contract.
   2. Division 1 sections included in the project specifications.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 SYSTEM DESCRIPTION

A. Materials of this Section: provide a thermal with integral vapor-resistant membrane at building enclosure elements.

B. Materials of this Section: provide an acoustic attenuation barrier at interior ceiling assemblies.

1.4 SUBMITTALS

A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Glass Fiber Insulation: Not permitted.

B. Mineral Fiber Insulation:
   1. Thermafiber, Inc.

2.2 MATERIALS

A. Insulation: ASTM C665; preformed mineral fiber batt, Type III, Class A, 25/50, or Class B, with covering on one side. R-Value: 19.

B. Nails or Staples: steel wire; galvanized, type and size to suit application.

C. Insulation Fasteners: corrosion-resistant steel impale spindle and clip on corrosion-resistant flat metal base, self adhering backing, length to suit insulation thickness, capable of securely and rigidly fastening insulation in place, as recommended by manufacturer.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify adjacent materials are clean, dry, and ready to receive installation.

B. Verify mechanical and electrical services within walls have been installed and tested.

3.2 INSTALLATION

A. Install batt insulation in accordance with manufacturer's instructions.

B. Install batt insulation, in exterior walls, roof, and ceiling spaces without gaps or voids.

C. Trim insulation neatly to fit spaces. Use batts free of damage.

D. Fit insulation tight in spaces and tight to exterior side of mechanical and electrical services within the plane of insulation to ensure a continuous seal. Leave no gaps or voids.

E. Install insulation with factory-applied membrane facing warm side of building spaces. Lap ends and side flanges of membrane over ceiling system members. Tape seal tears or cuts in membrane.

F. Verify intended location of vapor retarder to ensure that condensation does not occur within insulation system.

G. Use care to avoid damage and soiling face of insulation that will be exposed to view.

3.3 SCHEDULE

A. Install insulation where indicated on Drawings.

3.4 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	NO. OF WEEKS	AS INDICATED
07213-001	Product data: product characteristics, performance criteria, limitations on installation.		2	
07213-002	Manufacturer's Certification: written certification that insulation materials meet or exceed project design criteria.		2	

END OF SECTION

SECTION 07620

SHEET METAL FLASHING AND TRIM

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Roof flashings.
   2. Roof joint cover flashings.
   3. Counterflashings at roof-mounted mechanical equipment and vent stacks.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for sheet metal flashing and trim:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 06114 - Wood Blocking and Curbing.
   4. Section 07710 - Manufactured Roof Specialties.
   5. Section 07900 - Joint Sealers.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 SYSTEM DESCRIPTION

A. Work of this Section is to physically protect membrane roofing from damage that would permit water leakage to building interior.

1.4 WARRANTY

A. Fluoropolymer (Kynar) coating factory-finish items; furnish manufacturer's written 20-year performance guarantee, including, but not limited to, the following:
   1. Color Fastness: less than 5 NBS units of color change as measured by an IDL color eye, Model D.
   2. Chalk Resistance: no chalking in excess of ASTM D659, No. 8 rating.
   3. No peeling, blistering, flaking, chipping, cracking, or checking.

B. Warranty shall be in effect from date of final acceptance of the project.

1.5 QUALITY ASSURANCE

A. Sheet Metal Flashings: conform to criteria of SMACNA "Architectural Sheet Metal Manual".

B. Applicator: company specializing in sheet metal flashing work with 3 years' minimum experience.

C. Preconstruction Conference: convene minimum 1 week before start of work of this Section.

D. Field measure site conditions prior to fabricating work.

1.6 STORAGE AND HANDLING

A. Stack preformed and prefinished material to prevent twisting, bending, or abrasion and to provide ventilation.

B. Prevent contact with materials during storage which may cause discoloration, staining, or damage.

1.7 SUBMITTALS

A. Provide the following within 2 weeks of award of Contract:
   1. Shop Drawings: Describe material profile, jointing pattern, jointing details, fastening methods, and installation details.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. Galvanized Steel: ASTM A924, Grade A, or ASTM A653, G90 zinc coating; 24-gauge (0.02-inch) core steel.

B. Prefinished Galvanized Steel Sheet: ASTM A924, Grade A, or ASTM A653, G90 zinc coating; 24-gauge (0.02-inch) core steel, shop prefinished with fluoropolymer coating; color as selected from manufacturer's standard color range.

C. Aluminum Sheet: ASTM B209, alloy and temper as required for application and finish; 0.032 inch thick; mill finish.

D. Prefinished Aluminum Sheet: ASTM B209, alloy and temper as required for application and finish; 0.032 inch thick; mill finish; shop precoated with fluoropolymer coating; color as selected from manufacturer's standard color range.

E. Terne-Coated Stainless Steel: 0.015-inch ASTM A666, Type 304 core material with 0.092-pound-per-square-foot Terne alloy coating on both sides of core metal.

F. Zinc Sheet: Titanaloy A, Microzinc 70, zinc alloy, 0.027 inch thickness.

2.2 ACCESSORIES

A. Fastener: stainless steel. Finish pf exposed fasteners shall match finish of flashing metal.

B. Underlayment: ASTM D226; No. 30 asphalt-saturated roofing felt.

C. Metal Primer: iron oxide linseed oil.

D. Protective Backing: bituminous.

E. Slip Sheet: rosin-sized building paper.

F. Sealant: type specified in Section 07900, Joint Sealers for required material and exposure conditions.

G. Bedding Compound: butyl type recommended by manufacturer.

H. Plastic Cement: ASTM D4586, Type I.

I. Reglets: surface mounted 24-gauge galvanized steel, manufactured by Fry Reglet, standard zinc finish.

J. Sealer Tape: polyisobutylene sealer tape specifically manufactured for setting flanges or bituminous roofing.

K. Isolation Tape: butyl or polyisobutylene, internally reinforced, or 20-mil-thick minimum polyester.

2.3 FABRICATION

A. Form sections true to shape indicated on the Drawings, accurate in size, square, and free from distortion or defects.

B. Fabricate cleats and starter strips of same material as sheet, minimum 3 inches wide, interlockable with sheet.

C. Form pieces in longest practical lengths unless otherwise indicated.

D. Hem exposed edges on underside 1/2 inch; miter and seam corners.

E. Form material with cover plate seam. At moving joints, use sealed lapped, bayonet-type, or interlocking hooked seams.

F. Fabricate corners from one piece with minimum 18-inch-long legs; seam for rigidity, seal with sealant.

G. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.

H. Fabricate flashings to allow toe to extend 2 inches over roofing gravel. Return and brake edges.

I. Seal metal joints.

2.4 FINISH

A. Backpaint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mils.

B. Primer Coat: Finish concealed side of metal sheets with primer compatible with finish system, as recommended by finish system manufacturer.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, cant strips and reglets in place.

B. Verify nailing strips and blocking specified in Section 06114, Wood Blocking and Curbing are located.

C. Verify membrane termination and base flashings are in place, sealed, and secure.

3.2 FIELD PREPARATION

A. Install starter and edge strips and cleats before starting installation.

B. Install surface mounted reglets true to lines and levels. Seal top of reglet with sealant per reglet manufacturer recommendation.

3.3 INSTALLATION

A. Comply with recommendations from SMACNA.

B. Separate dissimilar metals from each other where electrolysis might occur.

C. Isolate metal from wood and concrete with two coats backing paint or isolation tape.

D. Reglets: Install reglets in accordance with manufacturer's written instructions.

E. Flashings:
1. Install flashing and sheet metal to straight, true lines with exposed faces aligned in proper plane without bulges or waves.
2. Secure flashings in place using concealed fasteners wherever possible in exposed work. Use exposed fasteners only in locations with prior review by IDC.
3. Seam and seal joints.
4. Apply plastic cement compound between metal flashings and felt flashings.
5. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

F. Seal metal joints watertight.

G. Coping shall have joints at 10-foot maximum spacing and 2-1/2 feet from corners unless otherwise indicated. Install butt joints with 3/16-inch space centered over 8-inch-long backing plate with matching profile and coping set in 1/4-inch-wide sealant.

H. Set flanges of roof accessories specified in Section 07710, Manufactured Roof Specialties on continuous sealer tape or in plastic roof cement on top of envelope ply of roofing. Nail flanges through sealer tape and at 3-inch maximum spacing. Touch up asphalt paint on flanges.

I. Size and locate joints, fastenings, reinforcements, and supports as required to preclude distortion or displacement due to thermal expansion and contraction.

J. Provide continuous hold-down clips at counterflashing and gravel stops.

K. Prefabricated Systems: Install prefabricated metal systems in accordance with manufacturer's written instructions.

3.4 ADJUSTING AND CLEANING

A. Exposed surfaces of flashing and sheet metal work shall be free of dents, scratches, abrasions, or other visible defects and shall be clean and ready for painting where applicable.

END OF SECTION

SECTION 07710

MANUFACTURED ROOF SPECIALTIES

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Gravel stops and vents.
   2. Multiple pipe curb assembly.
   3. Pipe penetration seal.
   4. Prefabricated roof curb.
   5. Equipment support curb.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for prefabricated roof specialties:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 07620 - Sheet Metal Flashing and Trim.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 SUBMITTALS

A. Provide the following within 2 weeks of Contract award:
   1. Product Data: shape of components, materials and finishes, anchor types, and locations.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Copings and Gravel Stops:
   1. Architectural Products Company.
   2. W. P. Hickman Company.
   3. MM Systems.

B. Multiple Pipe Curb Assembly:
   1. Pate.
   2. Thy-Curb.

C. Pipe Penetration Seal: Pate.

D. Prefabricated Roof Curb:
   1. Pate.
   2. Thy-Curb.

E. Equipment Support Curb:
   1. Pate.
   2. Thy-Curb.

2.2 COMPONENTS

A. Gravel Stops: extruded aluminum, 12 gauge (0.080 inch thick), shaped to match existing, including special supports for nominal spacing of 16 inches on center, including cover plates to conceal and seal joints and attachment flanges.

B. Multiple Pipe Curb Assembly: 18-gauge minimum galvanized steel with continuous welded corner seams, factory-installed wood nailer, and insulated with 1-1/2-inch-thick rigid fiberglass board insulation; counterflashing cap shall be acrylic-clad ABS thermoplastic with graduated-step neoprene boots, adjustable steel clamps, and cap fastening screws. Style and size as indicated on the Drawings.

C. Pipe Penetration Seal: spun aluminum base with minimum 5-inch roof surface flange, stepped neoprene boot secured to base and pipe with adjustable stainless steel clamps furnished. Sizes as required by project conditions.

D. Prefabricated Roof Curb: 18-gauge minimum galvanized steel, continuous mitered and welded corner seams, integral baseplate, factory-installed wood nailer, insulated with 1-1/2-inch-thick rigid fiberglass board insulation. Style and size as indicated on the Drawings.

E. Equipment Support Curb: prefabricated 18-gauge galvanized steel, continuous and welded corner seams, integral baseplate, factory-installed wood nailer, 2 inches by 4 inches minimum, and 22222-gauge galvanized steel counterflashing. Length of profile and size required as indicated on the Drawings.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify that deck, curbs, roof membrane, base flashing, and other items affecting work of this Section are in place and positioned correctly.

B. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

A. Install components in accordance with manufacturer's instructions.

B. Coordinate roofing membrane and base flashings and related sheet metal flashings specified in Section 07620, Sheet Metal Flashing and Trim, with installation of components of this Section.

C. Coordinate installation of sealants and roofing cement with work of this Section to ensure watertightness.

D. Coordinate work in this Section with sheet metal flashings specified in Section 07620, Sheet Metal Flashing and Trim.

E. Coordinate installation of flashing flanges into reglets.

F. Use type and number of fasteners as required to withstand design loads specified in Section 01000, General Technical Requirements.

END OF SECTION

SECTION 07900

JOINT SEALERS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Sealants for exterior joints.
   2. General-purpose interior joints.

B. Section does not include integrated system sealants for:
   1. Roofing.
   2. Wet glazed glazing.
   3. Chemical-resistant coatings.
   4. Gypsum board acoustic sealants.
   5. Firestopping sealants.
   6. Cleanroom sealants.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for joint sealers:
   1. The Contract.
   2. Division 1 sections included in the project specifications.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 WARRANTY

A. Warranty: Include coverage of installed sealants and accessories which fail to achieve airtight and watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

1.4 QUALITY ASSURANCE

A. Manufacturer: company specializing in manufacturing the products specified in this Section with minimum 5 years' documented experience.

B. Applicator: company specializing in applying the work of this Section with minimum 3 years' documented experience and approved by sealant manufacturer.

C. Conform to Sealant, Waterproofing, and Restoration Institute recommendations, ASTM C1193, and joint sealer manufacturers' recommendations.

D. Sealant material shall carry SWRI validation seal for compliance with ASTM C920.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not install solvent-curing sealants without proper ventilation.

B. Comply with temperature and humidity recommendations by the sealant manufacturer during and after installation.

1.6 SUBMITTALS

A. Provide the following within 2 weeks of Contract award:
   1. Product data indicating sealant chemical characteristics, performance criteria, limitations, and color availability.
   2. SWRI certificate of validation, as well as actual test results, on SWRI Priority Performance Profile Format.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Dow Corning Corporation.

B. GE Silicones.

C. Pecora Corporation.

D. Sika Corporation.

E. Sonneborn.

F. Tremco.

2.2 SEALANTS

A. Type S-1, Latex Sealant:
   1. ASTM C834, single component; color, as selected by IDC from manufacturer's standard colors.
   2. Acceptable Products:
      a. AC-20 plus Silicone; Pecora Corporation.
      b. Sonolac; Sonneborn Building Products.

c. Tremflex 834; Tremco.

B. Type S-2, Acrylic Terpolymer:
1. FS TT-S-00230C; CGSB 19-GP-5; nonsag, single component; color, as selected by IDC from manufacturer's standard colors.
2. Acceptable Product: Mono 555, Tremco.

C. Type S-3, Butyl Sealant:
1. FS TT-S-001657, Type 1 gun grade above 40 degrees F, single component, solvent release, nonskinning, nonsagging, color, black.
2. Acceptable Products:
a. BC-158; Pecora Corporation.
b. Tremco Butyl Sealant, Tremco.

D. Type S-4, Polysulfide Sealant:
1. Single component; moisture-curing, nonstaining, nonbleeding; ASTM C920, Type M, Grade NS, Class 25; FS-TT-S-00230C, Type II-nonsag, Class A, 50 percent maximum total joint movement (plus or minus 25 percent joint movement); color, as selected by IDC from manufacturer's standard colors.
2. Acceptable Product: GC-9 Synthacalk; Pecora Corporation.

E. Type S-6, Polyurethane Sealant:
1. Single component; moisture-curing, nonstaining, ASTM C920, Type S, Class 25; FS TT-S-00230C, Type I, self-leveling, and II, nonsag, Class A; color as selected by IDC from manufacturer's standard colors.
2. Acceptable products for self-leveling, Grade P, Uses T, M:
a. Sikaflex 1a: Sika Corporation.
b. Urexpan NR-201: Pecora Corporation.
c. Sonolastic SL1: Sonneborn.
d. Tremflex SL: Tremco.
3. Acceptable products for nonsag, Grade NS, Uses NT, M, A:
a. Dymonic; Tremco.
b. Dynatrol 1; Pecora Corporation.
c. Sonolastic NP1; Sonneborn.

F. Type S-9, Silicone Sealant:
1. Single component, chemical curing, nonsagging, nonstaining, fungus resistant, nonbleeding; ASTM C920, Type S, Grade NS, Class 25; FS TT-S-001543, Class A, NSF Standard F-51; (FDA 21 CFR 175.105, Adhesives).
2. Acceptable Products:
a. No. 786; Dow Corning Corporation.
b. Sanitary SCS1700 Sealant; GE Silicones.

G. Type S-10, Cleanroom Sealant:
   1. Acceptable Products: Sikaflex 1A; Sika Corporation.

H. Tape Sealant: closed-cell PVC foam in black color, coated on both sides with a modified acrylic pressure-sensitive adhesive, in size indicated in details, and as recommended by manufacturer for particular application.

2.3 ACCESSORIES

A. Primer: nonstaining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: noncorrosive and nonstaining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Joint Backing: nonoffgassing, extruded, of size and composition as recommended by the manufacturer for the selected sealant formulation.

D. Bond Breaker: pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify that substrates are ready to receive work and field measurements are as shown on Drawings and recommended by the manufacturer.

B. Beginning of installation means installer accepts existing substrate.

3.2 FIELD PREPARATION

A. Clean and/or prime joints in accordance with manufacturer's instructions.

B. Remove loose materials and foreign matter, which might impair adhesion of sealant.

C. Verify that joint backing and release tapes are compatible with sealant.

D. Protect elements surrounding the work of this Section from damage or disfiguration.

3.3 INSTALLATION

A. Install joint sealers in accordance with ASTM C804 for solvent release and C790 for elastomeric sealants.

B. Install sealant in accordance with manufacturer's instructions.

C. Measure joint dimensions and size materials to achieve required width/depth ratios.

D. Install joint backing to achieve a neck dimension no greater than half the joint width.

E. Install bond breaker where joint backing is not used.

F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

G. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

H. Tool joints flush.

I. Use only one manufacturer's product in each joint.

J. Use self-leveling sealants for horizontal joints; maximum slope 1 percent; nonsag for steeper sloped joints, vertical and overhead joints.

3.4 CLEANING AND REPAIRING

A. Clean sealant from adjacent surfaces per manufacturer’s recommendations.

B. Repair or replace defaced or disfigured finishes caused by work of this Section.

3.5 PROTECTION OF FINISHED WORK

A. Protect sealants until cured.

3.6 SCHEDULE

LOCATION	TYPE	COLOR
A. Exterior building wall joints	S3	
B. Sheet metal flashing lap joints	S8	As selected by IDC
C. Concrete floor slab joints	S6 or S7 self leveling	As selected by IDC
D. Cleanroom joints	S10	As selected by IDC
F. Threshold sealant bed	S3 or S8	As selected by

LOCATION	TYPE	COLOR
		IDC
G. Interior joints at doors, windows, louvers, and other opening perimeters	S1or S2	As selected by IDC
H. Plumbing fixture joints and countertop joints	S9	As selected by IDC

END OF SECTION

SECTION 08110

STEEL DOORS AND FRAMES

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Standard-fabricated steel frames.
   2. Acoustic rated frames.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for steel doors and frames:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Door Schedule as shown on the Drawings
   4. Section 08710 - Door Hardware.
   5. Section 09915 - Building Painting.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DESIGN CRITERIA

A. Acoustic Rating for Door and Frame Assembly: ASTM E413; minimum STC 32 as tested in accordance with ASTM E90.

1.4 WARRANTY

A. Provide manufacturer's 5-year warranty in writing with Owner named as beneficiary. Warranty shall provide for correction or, at the option of the Owner, removal and replacement of steel doors and frames found defective during stated warranty period after the Date of Substantial Completion.

1.5 QUALIFICATIONS

A. Fabricator: company specializing in performing the work of this Section with minimum 5 years documented experience.

B. Installer: company specializing in performing work of this Section with minimum 5 years documented experience and approved by the door manufacturer.

1.6 COORDINATION

A. Coordinate work in this Section with door hardware sizes, types, and installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect frames with resilient packaging, sealed with heat-shrunk plastic.

B. Break seal on site to permit ventilation.

1.8 SUBMITTALS

A. Provide the following within 2 weeks of Contract award.
   1. Product Data: general construction, connections, anchor types, location of cutouts for hardware, and hardware reinforcement.
   2. Shop Drawings:
      a. Indicate frame configurations, dimensions, anchor spacing, anchor types, and location of cutouts for hardware and reinforcement, as shown on the Drawings.
   3. Door and Frame Schedule: including doors, and frames, noted with the same reference numbers used on the Drawings.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Amweld Building Products Corp.

B. Curries Company, part of Essex Industries, subsidiary of Assa Abloy, Inc.

C. Ceco Door Products, a United Dominion Company.

D. Deansteel Manufacturing Co.

E. Habersham Metal Products.

F. Republic Steel.

G. Steelcraft/Ingersol Rand Company.

2.2 GENERAL

A. Standard Frame Product Descriptions:
   1. Interior Frames:

a. Level 2 nominal 16-gauge/0.053-inch-thick material, base metal thickness.

2.3 MATERIALS

A. Frame Material: ASTM A366, cold-rolled steel.

B. Frame Reinforcement: ASTM A653 sheet steel with 1.25-ounce-per-square-foot galvanized coating.

C. Hardware Reinforcement: ANSI A250.6.

D. Primer: rust-inhibiting type compatible with finish coating specified in Section 09915, Building Painting.

2.4 FABRICATION

A. Fabricate frames and assemble as a shop-welded unit with mitered corners. Grind welds smooth and apply filler; sand smooth.

B. Size units to allow for installation clearances, shim spacing at perimeter of installed assembly, and deflection of lintel.

C. Provide flush, hairline, joints and connections. Match components for continuity of line and design.

D. Fabricate frames with hardware reinforcement plates welded in place. Locate reinforcement in accordance with hardware location templates provided for door hardware specified in Section 08710, Door Hardware.

E. Prepare frame for silencers. Install three single silencers for single doors on strike side.

F. Unless otherwise detailed, fabricate frames with 2-inch face profile.

2.5 ACCESSORIES

A. Jamb Anchors: manufacturer's standard as appropriate for indicated substrate.

B. Silencers: resilient rubber.

C. Shim Space Insulation: acoustical sealant with closed cell backer rod.

D. Gaskets: Continuous resilient rubber.

2.6 FINISHES

A. Interior Door and Frame Assemblies Subject to Normal, Dry Environments: manufacturer's standard rust-inhibitive primer compatible with finish paint coats.

B. Finish: field painted as scheduled and specified in Section 09915, Building Painting.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify that wall opening sizes and tolerances are acceptable. Verify that preparation work required before execution of work specified in this Section has been completed and is acceptable.

B. Notify IDC in writing describing conditions that are not acceptable for execution of work specified in this Section. Recommend remedial work as necessary. Do not proceed with work of this Section until unacceptable conditions are corrected.

3.2 INSTALLATION

A. Install frames in accordance with manufacturer's instructions and ANSI A250.8.

B. Install type S-1 sealant around perimeter of frame assemblies to maintain continuity of thermal barrier.

C. Coordinate with wall construction for anchor placement.

D. Coordinate installation of hardware.

3.3 TOLERANCES

A. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.4 ADJUSTING AND CLEANING

A. Adjust door assemblies and door hardware for smooth and balanced door movement.

B. Remove temporary protection and clean assemblies just before acceptance review of work.

3.5 SCHEDULE

A. Door and frame sizes, materials, and door hardware groups are shown on the Drawings in the Door Schedule.

END OF SECTION

SECTION 08210

WOOD DOORS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Wood doors.
   2. Metal frames for door vision lights.
   3. Factory preparation (premachining) for door hardware.
   4. Factory finish for doors.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for wood doors.
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 06400 - Architectural Woodwork.
   4. Section 08110 - Steel Doors and Frames.
   5. Section 08710 - Door Hardware.
   6. Section 08800 - Glazing.
   7. Door Schedule located on the Drawings.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 WARRANTY

A. Door Manufacturer's Warranty: Submit written agreement in door manufacturer's standard form signed by manufacturer, installer, and Contractor, agreeing to repair or replace defective doors which have warped (bow, cup, or twist) or which show telegraphing of core construction in face veneers or do not conform to tolerance limitations of NWWDA.

1.4 QUALITY ASSURANCE

A. Manufacturer: Obtain doors from a single manufacturer to ensure uniformity in quality of appearance and construction, unless otherwise indicated.

B. Standards: Conform to requirements of the following standards except where more stringent requirements are shown or specified.
   1. ANSI/NWWDA I.S.1, Industry Standard for Wood Flush Doors, published by National Wood Window and Door Association (NWWDA).
      a. Quality Marking: Mark each wood door with wood flush door certification hallmark certifying compliance with applicable requirements of ANSI NWWDA I.S.1 series.
      b. Factory mark exterior doors with NWWDA Type I glue bond mark.
      c. Where doors are to receive transparent finish, omit factory marking and provide certification of compliance.
      d. For manufacturers not participating in NWWDA hallmark program, a certification of compliance may be substituted for marking of individual doors.
   2. Architectural Woodwork Quality Standards published by the Architectural Woodwork Institute (AWI):
      a. Section 1300, Flush Solid and Hollow Core Doors.
      b. Section 1400, Stile and Rail Doors.

1.5 DELIVERY, STORAGE, AND PROTECTION

A. Protect doors with resilient packing sealed with heat-shrunk plastic. Break seal on site to permit ventilation.

1.6 SUBMITTALS

A. Provide the following within 2 weeks of award of Contract:
   1. Product data.
   2. Shop Drawings: Indicate door elevations, stile and rail reinforcement, internal blocking for hardware attachment, and cutouts for glazing and louvers.
   3. Samples: full thickness, illustrating face veneer and typical exposed-edge construction.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Stile and Rail Doors:
   1. Vt Industries
   2. Eggers Industries.
   3. The Maiman Company.
   4. Karona Inc.
   5. Sun-Dor-Co.

2.2 DOOR TYPES

A. Stile and Rail Interior Doors: 1-3/4 inches thick; stiles and rails as shown on the Drawings.

2.3 DOOR CONSTRUCTION

A. Stile and Rail Doors: AWI Section 1400, custom grade construction.

2.4 EDGE CONSTRUCTION AND BLOCKING

A. Vertical Edges:
   1. Provide exposed edges of hardwood, same species as face veneers.
   2. Fire-Rated Composite Core Doors: Provide manufacturer's standard laminated edge construction for improved screw-holding capability and split resistance as compared to edges composed of a single layer of treated lumber

B. Blocking: Coordinate size and location of top and bottom rails and lock blocks with specified door hardware.

2.5 DOOR FACING

A. Wood Veneer Facing:
   1. Hardwood veneer cross band or manufacturer's standard two- or three-ply veneer face panel.
   2. Facing Quality: AWI custom grade.
   3. Interior Door Face Veneer: Red Oak species, rift cut, with book-matched grain for transparent finish.

B. Hardboard Face Panel: ANSI A135.6, Type S25 hardboard, untempered for interior doors; 1/8 inch thick.

2.6 ADHESIVES

A. Interior Doors: NWWDA, Type II.

B. Metal Vision Light Frames:
   1. Provide vision light frames from a single manufacturer of same or similar profile.
   2. Manufacturer's standard frame of 18-gauge cold-rolled steel for single glazing, profile, mitered and welded corners, factory primed, countersunk thru-bolts with one head blank; sizes as indicated.
   3. Glazing: as specified in Section 08800, Glazing.

C. Frames:
   1. Steel door frames for wood doors are specified in Section 08110, Steel Doors and Frames.

2.7 FABRICATION

A. Comply with applicable requirements of referenced standards for kind(s) of doors required.

B. Door sizes and types are shown on the Drawings in the Door Schedule.

C. Openings:
   1. Cut and trim openings through doors as shown.
   2. Vision Light Openings: factory cut openings; furnish metal frames loose with doors.

2.8 FINISHING

A. Factory finish doors in accordance with AWI Quality Standard Section 1500 to the following finish designations; color as selected:
   1. Transparent Finish TR-6: Catalyzed polyurethane, quality, satin sheen.

B. Seal door top and bottom edge(s) with clear sealer to match door facing.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Condition doors to average prevailing humidity in installation area prior to hanging.

B. Hardware: For installation, see Section 08710, Door Hardware.

C. Install wood doors to comply with manufacturer's instructions and as indicated.

D. Install fire-rated doors in corresponding fire-rated frames in accordance with requirements of NFPA 80.

E. Machine doors for hardware requiring cutting of doors.
   1. Comply with final hardware schedules and door frame shop drawings and with hardware templates and other essential information required to ensure proper fit of doors and hardware.
   2. Take accurate field measurements of hardware mortises in metal frames to verify dimensions and alignment before proceeding with machining in factory.

F. Fit to frames and machine for hardware to whatever extent not previously worked at factory as required for fit and uniform clearance at each edge.
   1. Trim door width by cutting equally on both jamb edges to a maximum of 3/16 inch. Trim fire door width from lock edge only.
   2. Trim door height by cutting equally on top and bottom edges to a maximum of 3/4 inch. Trim fire door height at bottom edge only.
   3. Pilot drill screw and bolt holes. Use threaded through bolts for half surface hinges.
   4. Conform to AWI requirements for fit tolerances.

G. Coordinate installation of glass and glazing.

H. Install door louvers where not factory installed.

3.2 INSTALLATION TOLERANCES

A. Maximum Diagonal Distortion: 1/16 inch measured with straight edge corner to corner.

3.3 ADJUSTING AND CLEANING

A. Adjust for smooth and balanced door movement.

END OF SECTION

SECTION 08462

AUTOMATIC SLIDING ENTRANCE DOORS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Complete custom automatic sliding aluminum entrance door assemblies internally wired for door operator, detection device, and all associated hardware for single-point electrical connection.
   2. Glass and glazing for door vision panels and sidelights.
   3. Access controls.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for automatic sliding entrance doors:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Door Schedule as shown on the Drawings
   4. Section 08800 - Glazing.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 QUALITY ASSURANCE

A. The nature of the completed facility demands special attention to maintaining an overall cleanliness in the project area. Utilize methods of installation which minimize the generation of contaminants.

B. ANSI A156.10 Standard: Provide automatic doors complying with applicable requirements of power-operated pedestrian door standard.

C. Installer: company approved by manufacturer and capable of providing postconstruction maintenance and warranty services.

1.4 SUBMITTALS

A. Provide the following with the Bid:
   1. Automatic Doors: manufacturer's specifications, recommendations, and standard details for automatic doors, including fabrication, finishing, hardware, accessories, and other components of the work. Include rough-in diagrams, wiring diagrams, and parts lists.
   2. Door Operators: manufacturer's specifications, rough-in diagrams, wiring diagrams, certified performance reports, installation instructions, and parts lists.
   3. Lubricants: type, properties, and sample, if any.

B. Provide the following within 2 weeks of award of Contract:
   1. Complete shop drawings and erection diagrams. Shop drawings shall give pertinent information of proposed construction method, including connection details, dimensions for proper fitting and connection with other work, and other conditions as may be required to complete installation.
   2. Maintenance manuals describing the materials, devices, and procedures to follow in cleaning and maintenance of automatic doors. Include manufacturer's brochures describing the actual materials and components used in the work, including metal alloys, finishes, sealants, gaskets, and other major components.
   3. Recommend list of replacement parts based on historical failure rates.

1.5 WARRANTY

A. Provide 5-year manufacturer's warranty covering operator and workmanship of door units.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Clean Applications:
   1. Besam Inc.
   2. Horton Automatics.
   3. Stanley Access Technologies.

B. Manufacturers listed above are classified as sole source. No substitution will be considered.

2.2 MATERIALS AND COMPONENTS

A. Basic aluminum extrusions shall be of 6063-T5 aluminum not less than 0.125 inch thick, and major parts of door extrusions shall be not less than 0.125 inch thick.

B. Provide concealed guides to stabilize bottom of door.

C. Glazing Splines, Seals, and Gasketing: manufacturer's standard materials.

D. Concealed fastening devices, reinforcements, and other internal components shall be of aluminum alloy, stainless steel, or finished with corrosion-resistant plating.

E. Screws shall be stainless steel. Screws that cannot be concealed shall be stainless steel with factory finish; color to match the aluminum finish color.

2.3 AUTOMATIC SLIDING DOOR UNITS AND OPERATORS

A. Door Units:
1. Single Slide: single sidelight with single active slide panel. Provide emergency breakaway on ~~both~~ active ~~and sidelight~~ panel~~s~~ only. Active panel placement shall be as indicated on the Drawings.
2. Door units shall include operator, header and track, jambs, sliding door, threshold, and sidelight, if required.
3. Track must be replaceable without having to remove the operator.
4. Provide beveled glass stops.
5. Sliding door units shall swing out 90 degrees from any position of slide movement~~, and sidelight leaves shall swing out 90 degrees relative to their pivot points~~.

B. Finish, Exposed Aluminum Surfaces: satin clear anodized aluminum finish.

C. Operator:
1. Electromechanical operator shall be header mounted and concealed with a securely attached removable cover. It shall have a time delay adjustable from 1 to 30 seconds. The opening speed, closing speed, back check, and latch check shall be fully and independently adjustable.
2. Braking or checking shall be an integral function of the operator for deceleration of the moving panel.
3. For protection in case of electrical power failure, operator shall include automatic pressure relief to prevent closing on pedestrians, and there shall be no springs or mechanisms to prevent free manual operation of the door. A power on and off switch shall be located on the inside of the header and shall serve a second function as hold open for door. The operator shall reverse

when maximum force of 15 pounds is exerted to prevent the door from closing. The reverser shall be field adjustable to meet project conditions.

D. Electrical: The electrical contractor shall furnish and install wiring to operator. Provide 120-Vac, 60-cycle, 15-amp service to each operator (header) on a separate circuit breaker routed into header.

E. Glass and Glazing: Provide as specified in Section 08800, Glazing.

F. Door-Holding Beam:
1. Factory installed in the door package to provide safety by causing a door-open signal if the path of the sliding panel is interrupted by an object.
2. Door-holding beam (DHB) shall consist of a separate transmitter and receiver. Fail-safe design shall cause a door-open signal in the event of a component failure in the DHB.

G. Interlock Control Module:
1. Solid-state control unit shall provide interlock operation of two automatic door operators, permitting only one door to be open at any given time. When both doors are closed, an actuating signal from either operator will cause the control module to send an open command to the corresponding operator. Actuating signal for the other operator is ignored until the open door returns to a fully closed position.
2. Control module shall be placed in the header of the door operators adjacent to the existing corridor.

H. Actuating Controls and Switches:
1. Provide photoelectric LED light source and transmitter recessed in sidelight interlock rail at 24-inch height and 48-inch height from finish floor.
2. Provide fail-secure carriage lockout on electromechanical operator for installations requiring key fob access.

2.4 FABRICATION

A. Prefabrication: Except as otherwise indicated, provide each complete unit of frame, doors, sidelights, transom panels, hardware, and accessory items as a packaged entrance unit. To the greatest extent possible, complete the fabrication, assembly, finishing, application of hardware, and other work before shipment to the project site. Disassemble only to the extent necessary for shipment and installation.

B. Complete the cutting, fitting, forming, drilling, and grinding of metal work prior to cleaning and finishing. Remove arrises from cut edges and ease edges and corners to a radius of approximately 1/64 inch.

C. Door panel construction shall be by means of tongue-and-groove key-fitted gussets with tempered bolts to ensure against racking failure.

D. Conceal fasteners wherever possible except as otherwise shown.

E. Reinforce the work as necessary for performance requirements and for support to the structure. Separate dissimilar metals with preformed separators which will prevent corrosion. Provide secure attachment and support at mechanical joints with hairline fit of contacting members.

F. Provide specified gasketing around door perimeter.

G. Factory assemble operator components in the header, adjusted, and tested. Minimize field wiring or operator adjustments other than connection to jobsite power.

H. Seal wire entrances of drive motor and other housing penetrations.

I. Door track and antiriser guide shall be an integral part of the structural member.

J. The cover shall have a continuous self-locking hinge which allows it to open approximately flush with the top of the header.

K. Fabrication and assembly methods, unless otherwise specified, shall be at the discretion of the manufacturer.

L. Plastic wrap completed automatic sliding/swing door assembly, door operator, and associated hardware.

M. Paint concealed contact surfaces of dissimilar materials with a heavy coating of isolation paint or provide other separations per manufacturer's recommendations.

PART 3 -- EXECUTION

3.1 CONDITION OF SURFACES

A. Examine adjoining construction and the conditions under which the work is to be installed, and do not proceed with the work until unsatisfactory conditions detrimental to the proper and timely completion of the work have been corrected.

3.2 INSTALLATION

A. Do not proceed with installation until reviewed shop drawings have been received.

B. Install door and operating equipment complete with necessary hardware in accordance with final shop drawings, manufacturer's instructions, and as specified in this Section.

C. Set door items in their correct locations as shown in the details. The installation shall be straight, level, square, plumb, and at proper elevations and in alignment with other work.

D. Securely anchor units to surrounding structure to withstand the normal loads imposed by the operation of the doors.

E. Seal joints. Framing members shall be screwed in place using backing, anchor plugs, or straps as required. Where moldings are joined, they shall be accurately cut and fitted to result in a tightly closed joint. No unfinished aluminum shall be visible.

3.3 ADJUSTING AND CLEANING

A. Clean aluminum surfaces promptly with approved solutions.

B. After repeated operation of completed installation equivalent to 3 days' use by normal traffic (100 to 300 cycles), readjust door operators and controls for optimum operating condition and safety. Lubricate operating equipment and clean exposed surfaces.

C. Advise general contractor of protective treatment and other precautions required through the remainder of the construction period to ensure that automatic entrances will be without damage or deterioration at the time of acceptance.

3.4 PROTECTION

A. Protect and maintain the automatic doors throughout the construction period so they will be without any indication of damage at the time of Substantial Completion.

3.5 SCHEDULE

A. Refer to the Door Schedule on the Drawings, for size, type, number, and location of automatic sliding doors.

B. Active panel designations and emergency breakout swing directions are indicated on the Drawings.

END OF SECTION

SECTION 08710

DOOR HARDWARE

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install hardware for wood doors, including, but not necessarily limited to:
   1. Hinges.
   2. Lock cylinders and keys.
   3. Lock and latch sets.
   4. Closers.
   5. Kickplates.
   6. Door gaskets.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for door hardware:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 07900 - Joint Sealers
   4. Door Schedule as shown on the Drawings.
   5. Section 08110 - Steel Doors and Frames.
   6. Section 08210 - Wood Doors.
   7. Hardware schedule attached to end of this Section.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 WARRANTY

A. Provide a 1-year warranty for hardware items, except provide manufacturer's standard 10-year warranty for surface and concealed overhead closers.

1.4 REGULATORY REQUIREMENTS

A. Exit door hardware shall conform to the applicable sections of Chapter 5 of NFPA 101.

1.5 QUALITY ASSURANCE

A. Single-Source Responsibility: Obtain each type of hardware (latch and lock sets, hinges, closers, etc.) from a single manufacturer.

B. Supplier Qualifications: an architectural door hardware supplier with warehousing facilities in the project's vicinity and that has at least 5 years of documented experience supplying door hardware similar in quantity, type, and quality to that indicated for this project. The supplier shall employ an experienced architectural hardware consultant (AHC) who is available to Owner, IDC, and Contractor at reasonable times during the course of the work for consultation.

1.6 COORDINATION

A. Coordinate work of this Section with other directly affected sections involving manufacturer of any internal reinforcement for door hardware.

B. Coordination and Templates: Work with hardware supplier as required to coordinate hardware with other work in respect to both fabrication and installation. The hardware supplier shall furnish templates and deliver hardware to proper locations.

C. Coordinate installation of door hardware with installation of life safety and security hardware specified in Section 13851, Fire Alarm and Smoke Detection System, and Section 13700, Security/Access Control System.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Package hardware items individually; label and identify package with door opening code to match hardware schedule.

B. Deliver keys to Owner.

C. Protect hardware from theft by cataloging and storing in secure area.

1.8 SUBMITTALS

A. Provide the following within 3 weeks of Contract award:
   1. Product data, including manufacturer's technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
   2. Final hardware schedule coordinated with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware. Indicate locations and mounting heights of each type of hardware.

1.9 MAINTENANCE MATERIALS

A. Provide special wrenches and tools applicable to each different or special hardware component.

B. Provide maintenance tools and accessories supplied by hardware component manufacturer.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Butts and Hinges:
1. Hager Hinge Company.
2. Lawrence Brothers Inc.
3. McKinney Products Company.
4. Stanley Hardware, division of Stanley Works.

B. Cylinders and Locks:
1. Best Lock Corporation.
2. Corbin & Russwin Architectural Hardware, division of Black & Decker Corporation.
3. Sargent Manufacturing Company.
4. Schlage Lock, division of Ingersoll-Rand Door Hardware Group.
5. Yale Security Inc.

C. Overhead Closers:
1. Corbin & Russwin Architectural Hardware, division of Black & Decker Corporation.
2. Dorma Door Controls International.
3. LCN, division of Ingersoll-Rand Door Hardware Group.
4. Norton Door Controls, division of Yale Security Inc.
5. Rixson-Firemark, division of Yale Security Inc.

D. Kick Plates:
1. Builders Brass Works Corporation.
2. H. B. Ives, a Harrow Company.
3. Quality Hardware Manufacturing Company Inc., division of Newman Tonks Inc.
4. Tice Manufacturing.
5. Trimco.

E. Door Gasketing:

1. National Guard Products Inc.
2. Pemko Manufacturing Company Inc.
3. Reese Enterprises Inc.
4. Sealeze Corporation.
5. Zero International Inc.

2.2 LOCK CYLINDERS AND KEYING

A. Schedule a meeting between hardware supplier and Owner to finalize keying requirements. Document final instructions in writing and submit to IDC.

B. Cylinders:
1. Review the keying system with the Owner and provide the type required (master, grandmaster, or great grandmaster), either new or integrated with Owner's existing system.
2. Equip locks with cylinders for interchangeable-core pin tumbler inserts. Furnish only temporary inserts for the construction period and remove these when directed.

C. Keys:
1. Comply with Owner's instructions for masterkeying and, except as otherwise indicated, provide individual change key for each lock that is not designated to be keyed alike with a group of related locks.
2. Permanently inscribe each key with number of lock that identifies cylinder manufacturer's key symbol and notation "do not duplicate".
3. Key Material: nickel silver.
4. Supply two keys for each lock.

2.3 HARDWARE - GENERAL

A. Scheduled Hardware: Requirements for design, grade, function, finish, size, and quantity of each type of door hardware are indicated in the hardware group schedule at the end of this Section. Provide either the product designated or a comparable product of one of the other acceptable manufacturers that complies with requirements.

B. Base Metals: Produce hardware units of manufacturer's basic metal and forming methods and using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified.

C. Fasteners:
1. Provide hardware generally prepared for machine screw installation. Do not use self-tapping sheet metal screws, except as specifically indicated.

2. Furnish Phillips flat-head screws, except as otherwise indicated. Finish exposed screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible.
   a. For steel frames specified in Section 08110, Steel Doors and Frames, install machine screws into drilled and tapped holes.
   b. For wood doors specified in Section 08210, Wood Doors, install wood screws.
   c. Finish screw heads to match surface of hinges.
3. Provide concealed fasteners for hardware units that are exposed when door is closed, except to the extent no standard units of type specified are available with concealed fasteners.
4. Do not use through-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.

2.4 HARDWARE

A. Hinges:
   1. Minimum Number per Door Leaf Based on Height of Door:
      a. Up to 5 Feet: one pair.
      b. To 7 Feet 7 Inches: one and a half pairs.
      c. To 9 Feet: two pairs.
      d. To 12 Feet 6 Inches: two and a half pairs.
   2. Minimum Height Based on Width of Doors:
      a. Up to 3 Feet: 4 1/2 inches.
      b. To 4 Feet: 5 inches.
   3. Width of Hinges: minimum that will clear trim and permit 180 degree swing.
   4. Hinge Pins:
      a. Out-Swing Exterior Doors: nonremovable pins.
      b. Out-Swing Corridor Doors with Locks: nonremovable pins.
      c. Interior Doors: nonrising pins.
      d. Tips: flat button and matching plug, finished to match leaves, except where hospital tip (HT) indicated.

B. Lock and Latch Types:
   1. Levers and Roses: LL Lever and Rose.
   2. Locks: Furnish interchangeable, removable core cylinders with a minimum of six pins.
   3. Strikes:

a. Provide manufacturer's standard wrought box strike for each latch or lock bolt with curved lip extended to protect frame, finished to match hardware set, unless otherwise indicated.

4. Backset: 2 3/4 inches.

C. Closers:

1. Design: Comply with ANSI A156.4.
2. Size: Size closers in accordance with manufacturer's instructions.
3. Mounting: Mount closers on push or interior side of doors.
4. Where parallel arms are indicated for closers, provide closer unit one size larger than recommended for use with standard arms.

D. Door Trim Units:

1. Design: solid metal, not plated; bevel four edges; square corners.
2. Size: height as scheduled by full-width door leaf less 2 inches at single leaf and 1 inch at pairs by 0.05 inch thick.
3. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine screws or self-tapping screws.
4. Fabricate protection plates not more than 1 1/2 inches less than door width on hinge side and not more than 1/2 inch less than door width on pull side by height indicated.
   a. Metal Plates: stainless steel, 0.05 inch (U.S., 18 gauge).

E. Seals:

1. Weatherstripping at Jambs and Heads: bumper-type resilient insert and metal retainer strips, surface applied, and of following metal, finish, and resilient bumper material:
   a. Resilient Bumper: flexible, hollow EPDM bulb or loop insert.

2.5 HARDWARE FINISHES

A. The designations used in the hardware group schedule to indicate hardware finishes are those listed in ANSI/BHMA A156.18, Materials and Finishes.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify that doors and frames are ready to receive work and dimensions are as indicated on shop drawings.

B. Verify that power supply is available to power-operated devices.

C. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

A. Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by IDC.
   1. DHI standard Recommended Locations for Builders' Hardware for Standard Steel Doors and Frames.
   2. NWWDA industry Standard I.S.1.7, Hardware Locations for Wood Flush Doors.
   3. NFPA 80, Standard for Fire Doors and Windows.
   4. Conform to ANSI A117.1 for positioning requirements for the handicapped.

B. Where cutting and fitting is required to install hardware onto or into surfaces that will be finished later, coordinate removal, storage, and reinstallation with finishing work. Do not install surface-mounted items until finishes have been completed.

C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

D. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

E. Weatherstripping and Seals: Comply with manufacturer's instructions. Clean and dry door frames directly before adhering adhesive-backed door seals.

F. Use the templates provided by hardware item manufacturer.

3.3 ADJUSTING AND CLEANING

A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.

B. Where door hardware is installed more than 1 month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items. Clean operating items for proper hardware and door function and finish. Adjust door control devices to compensate for final operation of heating and ventilating systems.

3.4 SCHEDULE

A. Provide hardware groups listed on hardware group schedule attached to end of this Section for doors as indicated in the Door Schedule as shown on the Drawings.

Hardware Set 1
Door: C-1

3	Hinges	TA2714 4 1/2 X 4 ½	26D	MC
1	Lockset	10G05 LL	26D	SA
1	Closer	1431 O/P9	EN	SA
1	Kickplate	KP50 8” X 2” L.D.W.	US32D	MC
1	Convex Stop	WS04	US26D	MC
1	Gasketing	MCKS88D		MC
1	Auto Door Bottom	MCK434APKL	MC	

Doors: A-1, B-1, D-1
By Door Manufacturer.

END OF SECTION

SECTION 08800

GLAZING

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Glass glazing for metal frames, doors, and windows.
   2. Glass and polycarbonate glazing for cabinet liners and doors.
   3. Glass polycarbonate glazing materials and installation requirements are included in this Section for other sections referencing this Section.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total glazing requirements for the project:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 07900 - Joint Sealers.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 STANDARDS

A. Work included in this Section shall conform to the following, except specified otherwise within this Section:
   1. ANSI Z97.1 - Safety Glazing Materials Used in Buildings Safety.
   2. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
   3. ASTM C1193 - Standard Guide for Use of Joint Sealants.
   4. ASTM E576 - Standard Test Method for Frost Point of Sealed Insulating Glass Units in the Vertical Position.
   5. ASTM E774 - Standard Specification for Sealed Insulating Glass Units.
   6. GANA - FGMA Sealant Manual.
   7. GANA - Glazing Manual.
   8. GANA - Laminated Glass Design Guide.
   9. NFPA 80 - Standard for Fire Doors, Fire Windows.
   10. UL - Building Materials Directory.

1.4 DESIGN CRITERIA

A. Provide glass and glazing materials for continuity of building enclosure vapor retarder and air barrier:
   1. In conjunction with materials described in Section 07900, Joint Sealers.
   2. To utilize inner pane of multiple pane sealed units for continuity of air barrier and vapor retarder seal.
   3. To maintain continuous air barrier and vapor retarder throughout glazed assembly from glass pane to heel bead of glazing sealant.

B. Size glass to withstand dead loads and positive and negative live loads acting normal to plane of glass as measured in accordance with ASTM E330 and for wind loads specified in Section 01000, General Technical Requirements.

C. Limit glass deflection to 1/200 or flexure limit of glass with full recovery of glazing materials, whichever is less.

D. Sealed Insulating Glass Units: comply with ASTM E774.

1.5 WARRANTY

A. Furnish 5-year warranty to include coverage for sealed glass units from seal failure, interpane dusting or misting, and replacement of same.

1.6 QUALITY ASSURANCE

A. Glazing shall conform to Consumer Product Safety Commission, CFR Title 16, Part 1201, Safety Standards for Architectural Glazing Materials.

B. Preconstruction Conference: Convene minimum 1 week before starting work of this Section.

C. Perform work in accordance with GANA Glazing Manual and GANA Sealant Manual for glazing installation methods.

D. Installer: Company specializing in performing work of this Section with minimum 3 years documented experience.

E. Inspection guidelines are as follows:
   1. Pinholes larger than 1/32-inch diameter are not allowed.
   2. The normal viewing area shall be considered the entire piece of glass.
   3. Clusters or close spacing (three or more) of smaller pinholes are not be allowed.
   4. Scratches are not allowed.

1.7 SUBMITTALS

A. Product Data:
   1. Glass and Polycarbonate: Provide structural, physical and environmental characteristics, size limitations, special handling, or installation requirements.
   2. Glazing Sealants, Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors where exposed.

B. Certificates: Certify products meet or exceed specified requirements.

C. Manufacturer's Certificate: Certify sealed insulated glass, meets or exceeds specified requirements.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not install glazing when ambient temperature is less than 50 degrees F.

B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Flat Glass Manufacturers:
   1. Guardian Industries.
   2. PPG Industries Inc.
   3. Pilkington/Libbey-Owens-Ford, Inc.
   4. Viracon.

B. Glass Fabricators:
   1. AFGD, Inc.
   2. Arch Aluminum & Glass LC.
   3. Cardinal LG.
   4. Guardian Industries.
   5. Interpane Glass Company.
   6. Viracon.

C. Polycarbonate Glazing Manufacturers:
   1. Cyro Industries.
   2. GE Structured Products.

3. Rohm and Hass Company.
4. SC Technologies, Inc.
5. Sekisui Chemical Company, Ltd.

D. Glazing Sealant, Gasket and, Tapes Manufacturers:
1. Dow Corning.
2. General Electric Silicones.
3. Pecora Corporation.
4. Tremco.

2.2 COMPONENTS

A. Flat Glass: 1/8 inch unless other thickness is required to meet specified design criteria.
1. Type G-1, Clear Float Glass: ASTM C1036, Type 1 transparent flat, Class 1 clear, Quality q3 glazing select.
2. Type G-2, Low E Clear Float Glass: Clear float glass Type G-1, with low emissivity coating on Number 1 surface.
a. Solar Light Transmittance: 40 percent.
b. Shading Coefficient: 60.

B. Safety Glass: Conform to ANSI Z97.1, thickness 1/8 or 1/4 inch unless otherwise indicated.
1. Type G-3, Clear Tempered Glass: ASTM C1048, Kind FT Fully tempered, Condition A, uncoated, Type 1 transparent flat, Class 1 clear, Quality q3 glazing select.

C. Fire Resistive Glass: Glazing materials to by types approved for use with specified materials in fire-rated applications as indicated on Drawings. Minimum 1/4 inch (6mm) thick unless otherwise indicated.
1. Type G-4, Fire-Resistive Glazing:

D. Insulated Glass Units: Total unit thickness 3/4 inch.
1. Type G-5, Double Pane Insulated Glass Units: ASTM E774 Class A and ASTM E773; with silicone sealant edge seal; purge interpane space with dry hermetic air.
a. Outer Pane: Glazing Type G-1.
b. Inner Pane: Glazing Type G-2.
2. Insulated Glass Unit Edge Seal Material: match existing glazing throughout other laboratories in the building.

E. Plastic Glazing:
1. Type G-6, Polycarbonate Sheet: plastic compound, clear; ultraviolet stabilized; silicone abrasion resistant coating, for scratch resistance.
a. Acceptable Product: MarGuard; manufactured by GE.
b. Thickness: 3/16 inch.

2.3 ACCESSORIES

A. Elastomeric Glazing Sealants: Materials compatible with adjacent materials including glass, insulating glass seals, and glazing channels.
1. Silicone Glazing Sealant: ASTM C920, Type S, Grade NS, class and use suitable for glazing application indicated; single component; solvent curing; capable of water immersion without loss of properties; nonbleeding, nonstaining, cured Shore A hardness of 15 to 25.
a. Color: As selected.

B. Glazing Splines and Gaskets: ASTM C864 Option II, flame propagation test is not required, resilient neoprene extruded shape to suit glazing channel retaining slot.
1. Color: Black.

C. Preformed Glazing Tape: Size to suit application. Tapes shall comply with applicable section of AAMA 800 for specified type of tape.
1. Preformed butyl compound; 10 to 15 Shore A durometer hardness; coiled on release paper; black color.
a. Butyl Corner Sealant: ASTM C920 single component nonskinning butyl compatible with glazing tape; color to match tape.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify openings for glazing are correctly sized and within acceptable tolerance.

B. Verify surfaces of glazing channels or recesses are clean, free of obstructions impeding moisture movement, weeps are clear, and ready to receive glazing.

3.2 FIELD PREPARATION

A. Clean contact surfaces with solvent and wipe dry.

B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

C. Prime surfaces scheduled to receive sealant.

3.3 INSTALLATION

A. Perform installation in accordance with GANA Glazing Manual.
   1. Glazing Sealants: Comply with ASTM C1193.
   2. Fire Rated Openings: Comply with NFPA 80.
   3. Permit sealant to cure then remove foam backer rod. Apply sealant to opposite side, tool smooth to concave profile.
   4. Remove masking tape.

B. Interior Dry Method (Tape and Tape) Installation:
   1. Cut glazing tape to length and set against permanent stops, projecting 1/16 inch above sight line.
   2. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.
   3. Rest glazing on setting blocks and push against tape for full contact at perimeter of pane or unit.
   4. Place glazing tape on free perimeter of glazing in same manner described above.
   5. Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
   6. Knife trim protruding tape.

C. Interior Wet/Dry Method (Tape and Sealant) Installation:
   1. Cut glazing tape to length and install against permanent stops, projecting 1/16 inch above sight line.
   2. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.
   3. Rest glazing on setting blocks and push against tape to ensure full contact at perimeter of pane or unit.
   4. Install removable stops, spacer shims inserted between glazing and applied stops at 24-inch intervals, 1/4 inch below sight line.
   5. Fill gaps between pane and applied stop with elastomeric glazing sealant to depth equal to bite on glazing, to uniform and level line.
   6. Trim protruding tape edge.

3.4 CLEANING

A. Remove glazing materials from finish surfaces.

B. Remove labels after work is complete.

C. Clean glass and adjacent surfaces.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

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

3.6 SCHEDULE

A. Exterior Windows: Type G-1 and G-2 as scheduled on the Drawings, exterior wet/dry method with silicone glazing sealant on exterior.

B. Interior Non-fire Rated Wood Doors: Type G-3, interior wet method with silicone glazing sealant.

C. Interior Fire Rated Metal Doors and Windows: Type G-4 fire rated glazing system.

D. Interior Borrowed Lites: Type G-3.

E. Replacement Windows: Type G-5.

F. Interior Liner of Custom Casework as shown on the Drawings: Type G-6.

END OF SECTION

SECTION 09260

GYPSUM BOARD ASSEMBLIES

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Metal stud wall framing.
   2. Metal furring channels.
   3. Metal channel ceiling framing.
   4. Acoustic insulation.
   5. Gypsum board.
   6. Taped and sanded joint treatment.
   7. Skim coat wall treatment.
   8. Metal or plastic edge treatment accessories and joints.
   9. Metal fasteners.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for gypsum board assemblies:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 05410 - Cold-Formed Metal Framing.
   4. Section 07840 - Firestopping.
   5. Section 09510 - Acoustical Ceilings.
   6. Room Finish Schedule as shown on the Drawings.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 SYSTEM DESCRIPTION

A. This Section describes interior and exterior gypsum board assemblies, including installation with steel supporting members and finishing materials and accessories.

1.4 DESIGN CRITERIA

A. Select steel studs in accordance with the manufacturer's standard load tables and following design pressures and deflections:

1. At gypsum board partitions: L/240 at 5 pound per square foot.
2. At gypsum board ceilings: L/240 at actual dead load.
3. At exterior metal stud walls: as specified in Section 05410, Cold-Formed Metal Framing.

B. Seismic Provisions: exterior and interior walls, shaft walls, and partitions and anchorage for suspended ceilings and soffits shall be, in addition, designed and constructed to resist effects of seismic forces in accordance with local seismic zone requirements.

1.5 REGULATORY REQUIREMENTS

A. Fire Resistive Ratings: For gypsum board assemblies in conjunction with Section 05410, Cold Formed Metal Framing and this Section indicated to have fire resistance rated assemblies, provide materials and construction identical to those tested for fire resistive properties in accordance with ASTM E119, ASTM E84, and ASTM E814 by an independent testing and inspecting agency acceptable to authorities having jurisdiction. Provide assemblies having ratings as indicated in GA 600, Fire Resistance Design Manual.

1.6 QUALITY ASSURANCE

A. Perform work in accordance with ASTM C840, ASTM C1280, GA-214, GA-216and GA 600.

B. Installer Qualifications: Provide installation by a company specializing in work similar to that required on this project and with not less than 5-years documented experience.

1.7 COORDINATION

A. Coordinate work in this Section with mechanical, electrical, plumbing, telecommunications, controls, and fire protection work before framing or enclosing partitions.

B. Firestopping:
1. Firestopping of joints through or between fire-resistance-rated walls, floors, and roofs, or firestopping of penetrations through fire-resistance-rated walls, floors, and roofs shall be in accordance with Section 07840, Firestopping. Sleeving, coring, or cutting of fire-resistance-rated construction shall be as described in the approved UL-listed firestop assembly.
2. Sleeving, cutting, or coring not within the parameters of the approved firestopping assembly shall be corrected at no cost to the Owner or firestopping manufacturer.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Maintain a minimum ambient temperature of 40 degrees F during installation of gypsum board.

B. Do not apply finishing compounds until all components have been maintained a minimum of 50 degrees F for at least 48 hours.

C. Provide adequate and continuous ventilation during the application and curing of finishing compounds to comply with ASTM C840.

D. Protect materials from drying too rapidly during hot and dry weather. Eliminate excess moisture on gypsum board.

1.9 SUBMITTALS

A. Provide the following within 2 weeks of Contract award:
   1. Product data on metal framing, gypsum board, joint tape, and joint compound.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Gypsum Board:
   1. Georgia-Pacific Corporation.
   2. Gold Bond Building Products, Division of National Gypsum.
   3. United States Gypsum Corporation.

B. Metal Framing:
   1. Dale/Incor.
   2. Dietrich Industries, Inc.
   3. Knorr Steel Systems International Inc.
   4. Unimast Incorporated.

2.2 MATERIALS

A. Framing Materials:
   1. Studs and Runners: ASTM C645; sheet steel, C shape; size and base metal thickness designed for specified structural performance characteristics and the following:
      a. Sheet Steel: ASTM A446, Grade A.
      b. Finish: Hot-dip galvanizing, ASTM A653, G60.

c. Steel Thickness: as required to meet design criteria but not less than 0.018 inch (25 gauge).
d. Stud Depth: as indicated in the wall types on the Drawings.
e. Steel studs shall comply with the following requirements:

Size	Min. thick of uncoated base metal	Minimum effective properties		Spacing	Max. unsupported height.
		$S_x(in^3)$	$I_x(in^4)$		
6" by 20 gauge	0.0346"	0.512	1.744	16"	24'-0"
4" by 16 gauge	0.0566"	0.490	1.060	12"	24'-0"
4" by 20 gauge	0.0346"	0.299	0.674	16"	18'-0"
4" by 25 gauge	0.0188"	0.085	0.240	16"	14'-0"
2-1/2" by 20 gauge	0.0346"	0.162	0.231	16"	15'-0"
2-1/2" by 25 gauge	0.0188"	0.052	0.079	16"	11'-0"

f. Maximum unsupported height is based on having gypsum board attached to both sides of stud for entire length of stud.

B. Gypsum Board Materials:
1. Standard Gypsum Board: ASTM C36; 5/8 inch thick, maximum available size in place; ends square cut, square edges.
2. Fire Rated Gypsum Board: ASTM C36; fire resistive type, UL rated; 5/8 inch thick, maximum available size in place; ends square cut, square edges.
3. Moisture-Resistant Gypsum Board: ASTM C630; 5/8 inch thick, maximum available size in place; ends square cut, square edges.
4. Gypsum Sheathing Board: ASTM C79; moisture-resistant type; 5/8 inch thick, maximum available size in place; ends square cut, square edges; water-repellent glass mat faces.

2.3 ACCESSORIES

A. Acoustical Insulation: ASTM C665, Type I, unfaced; preformed mineral wool, friction-fit type, 3 inch thick.

B. Acoustical Sealant: nonhardening, nonskinning, for use in conjunction with gypsum board; manufactured by Tremco or U.S. Gypsum.

C. Corner Beads: metal.

D. Edge Trim: ASTM C840; Type L bead.

E. Joint Materials: ASTM C475; reinforcing tape, joint compound, adhesive, water, and fasteners.

F. Adhesives: as recommended by gypsum board manufacturer for intended use.

G. Fasteners: gypsum board screws, ASTM C1002.

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

2.4 FINISHES

A. Prime or seal gypsum board surfaces to be painted or textured with specific primer or sealer recommended by paint or texture manufacture for application over gypsum board.

B. Provide gypsum board level of finish as defined by GA 214 and as scheduled at end of this Section.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify that site conditions are ready to receive work and opening dimensions are as indicated on the drawings.

B. Notify IDC in writing describing conditions that are not acceptable for execution of work specified in this Section. Recommend remedial work as necessary. Do not proceed with work of this Section until unacceptable conditions are corrected.

3.2 FIELD PREPARATION

A. Rooms with Access Flooring: Prepare and finish gypsum board surfaces with primer coat and first coat of paint before installation of access flooring pedestals and flooring. Vacuum clean and hand wipe gypsum dust from pedestals and horizontal support members.

3.3 INSTALLATION

A. Metal Stud:
   1. Install studding in accordance with GA 201 and GA 216.
   2. Metal Stud Spacing: 16 inches on center.

3. Partition Heights: as indicated on the wall types on the Drawings.
4. Door Opening Framing: At a minimum install double studs at door frame and window jambs and jambs of other penetrations.
5. Blocking: Install blocking for support of plumbing fixtures wall cabinets, laboratory accessories, and hardware.
6. Coordinate installation of bucks, anchors, blocking, and electrical and mechanical work placed in or behind partition framing.

B. Wall Furring:
1. Space freestanding metal stud framing maximum 16 inches on center, not more than 4 inches from abutting walls.
2. Install thermal insulation directly attached to concrete masonry walls in accordance with manufacturer's instructions.

C. Ceiling Framing:
1. Install in accordance with GA 201 and GA 216.
2. Coordinate location of hangers with other work.
3. Install ceiling framing independent of walls, columns, and above-ceiling work.
4. Reinforce openings in ceiling suspension system which interrupt main carrying channels or furring channels with lateral channel bracing. Extend bracing minimum 24 inches past each end of openings.
5. Laterally brace entire suspension system as specified in Section 09510, Acoustical Ceilings.

D. Gypsum Board:
1. Install gypsum board in accordance with GA 216 and GA 600.
2. Erect single layer standard gypsum board in most economical direction with ends and edges occurring over firm bearing.
3. Erect exterior gypsum sheathing in accordance with ASTM C1280, horizontally, with edges butted tight and ends occurring over firm bearing.
4. Use screws when fastening gypsum board to metal furring or framing.
5. Treat cut edges and holes in moisture-resistant gypsum board and exterior gypsum ceiling board with sealant.
6. Place corner beads at external corners as indicated. Use longest practical length. Place edge trim where gypsum board abuts dissimilar materials.

3.4 JOINT TREATMENT

A. Tape, fill, and sand exposed joints, edges and corners, and fastener heads to produce smooth surface ready to receive finishes per GA 216.

B. Control Joints: Install one-piece control joints at required locations indicated on the Drawings. Do not remove tape until finishing operations are complete.

C. Feather coats onto adjoining surfaces so that camber is maximum 1/32 inch.

D. Level of Finish: Provide the following gypsum board finishes based on GA 214, as scheduled at the end of the Section.

1. Level 2: all joints and interior angles shall have tape embedded in joint compound and wiped with a joint knife leaving a thin coating of joint compound over all joints and interior angles. Fastener heads and accessories shall be covered with a coat of joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable. Joint compound applied over the body of the tape at the time of tape embedment shall be considered a separate coat of joint compound and shall satisfy the conditions of this level.
2. Level 3: all joints and interior angles shall have tape embedded in joint compound and one additional coat of joint compound over all joints and interior angles. Fastener heads and accessories shall be covered with two separate coats of joint compound. All joint compound shall be smooth and free of tool marks and ridges.
3. Level 4: all joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound over all flat joints and one separate coat of joint compound applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. All joint compound shall be smooth and free of tool marks and ridges.

3.5 TOLERANCES

A. Tolerances of 1/8 inch in 10 feet are readily visible in certain conditions. Take care to verify if this is acceptable.

B. Maximum Variation from True Flatness: 1/8 inch in 10 feet in any direction.

3.6 FIRE-RATED GYPSUM BOARD PARTITION IDENTIFICATION

A. Identify fire-rated gypsum board partitions above the ceiling by stenciling the fire rating of the partition using 4-inch-high black letters located at 10 feet on center along the full length of the partition and 2 to 3 feet above the line of suspended ceiling.

3.7 SCHEDULE

A. Level 2 Gypsum Board Finish: Provide where wall base or other architectural finish is to be adhered to the wall surface.

B. Level 3 Gypsum Board Finish: Provide in plenum areas above ceiling and areas not normally open to public view.

C. Level 4 Gypsum Board Finish: Provide where flat sheen paints, light textures, or wall covering are applied as the final wall finish.

END OF SECTION

SECTION 09510

ACOUSTICAL CEILINGS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Suspended metal grid ceiling assembly.
   2. Acoustical tile.
   3. Non-fire-rated assembly.
   4. Acoustic insulation over acoustic units.
   5. Perimeter trim.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for suspended acoustical ceilings.
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 07213 - Batt Insulation.
   4. Section 07900 - Joint Sealers.
   5. Section 09915 - Building Painting.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 STANDARDS

A. Work included in this Section shall conform to the following, except specified otherwise within this Section:
   1. ASTM C636, Standard Practice for Installation of Metal Ceiling Suspension System for Acoustical Tile and Lay-in Panels.
   2. ASTM E580, Standard Practice for Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in areas requiring seismic restraint.

1.4 DESIGN CRITERIA

A. Suspension System: design acoustic ceiling assembly including integral mechanical and electrical components with maximum deflection of 1/360.

B. Design ceiling assembly to comply with seismic design criteria specified in Section 01000, General Technical Requirements.

1.5 REGULATORY REQUIREMENTS

A. Work included in this Section shall conform to the following, except specified otherwise within this Section:
   1. UL Fire Resistance Directory.
   2. WH Certification Listings.

1.6 QUALITY ASSURANCE

A. Manufacturer: company specializing in manufacture of ceiling suspension system with 3 years' minimum experience.

B. Installer: company with 3 years' minimum documented experience.

C. Provide seismic design of suspended ceiling under direct supervision of professional engineer experienced in design of this work and licensed in the jurisdiction where the project is located.

1.7 COORDINATION

A. Do not install acoustical ceilings until the building is enclosed, sufficient heat is provided, dust-generating activities have terminated, and overhead work is completed, tested, and accepted.

B. Schedule installation of acoustic units after interior wet work is dry.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Maintain uniform temperature of minimum 60 degrees F and humidity of 20 to 40 percent prior to, during, and after installation.

1.9 SUBMITTALS

A. Provide the following within 3 weeks of award of Contract:
   1. Product Data: for metal grid system components and acoustic units; include manufacturer’s installation instructions.
   2. Shop Drawings: Indicate grid layout and related dimensioning, junctions with other work or ceiling finishes, interrelation of mechanical and electrical, and other items related to system.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Suspension System:
1. Armstrong World Industries.
2. Chicago Metallic.
3. USG Interiors.

B. Acoustic Units:
1. Armstrong World Industries.
2. Celotex Building Products.
3. USG Interiors.

2.2 MATERIALS

A. Metal Suspension System:
1. Nonfire-Rated Grid: ASTM C635, intermediate duty, exposed T; components die cut and interlocking.
2. Grid Materials: commercial-quality cold-rolled steel with galvanized coating.
3. Grid Finish: white.
4. Support Channels and Hangers: galvanized steel; size and type to suit application and to comply with specified ceiling system flatness criteria. Use to rigidly secure acoustic ceiling system including integral mechanical and electrical components.
5. Grid Accessories: splices and edge moldings, profile as detailed required for suspended grid system.
6. Hanger Wire: minimum 12-gauge, galvanized, soft-annealed, mild steel wire.
7. Wire Ties: 18-gauge, galvanized, annealed steel wire.

B. Acoustic Units:
1. Type SAC-1 acoustic panels conforming to the following:
a. Size: 48 by 48 inches.
b. Thickness: 3/4 inch.
c. Composition: wet-formed mineral.
d. Density: 1.05 pounds per square foot.
e. Light Reflectance: 0.90.
f. NRC Range: 0.70.
g. CAC Range: 35.
h. ASTM E1264 Classification: Type IV, Form 2, Pattern E.
i. Edge: square.
j. Surface Color: white.
k. Surface Finish: nondirectional acoustically transparent.

l. Basis of design: Armstrong Optima Open Plan.

2. Type SAC-2, acoustical panels conforming to the following:
   a. Size: 48 by 48 inches and cut to dimensions where shown on the Drawings.
   b. Thickness: 5/8 inch.
   c. Composition: wet-formed mineral.
   d. Density: 1.05 pounds per square foot for field units and 1.15 pounds per square foot for border units.
   e. Light Reflectance: 0.80.
   f. NRC Range: N/A.
   g. CAC Range: 40.
   h. ASTM E1264 Classification: Type IV, Form 2, Pattern E.
   i. Edge: Square.
   j. Surface Color: white.
   k. Surface Finish: Vinyl-faced membrane.
   l. Basis of design: Armstrong Clean Room VL unperforated.

2.3 ACCESSORIES

A. Acoustic Batt Insulation: as specified in Section 07213, Batt Insulation.

B. Perimeter Trim: Axiom Classic – Channel sized per scheduled ceiling transition.

C. Gasket for Perimeter Moldings: closed-cell rubber sponge tape.

D. Acoustic Sealant for Perimeter Moldings: specified in Section 07900, Joint Sealers.

E. Touch-Up Paint: type and color to match acoustic and grid units.

2.4 FINISHES

A. Shop or Factory Finishing:
   1. Furnish manufacturer's standard baked enamel finish; color: white.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify that preparation work required before execution of work specified in this Section has been completed and is acceptable.

B. Verify that layout of hangers will not interfere with other work.

3.2 INSTALLATION

A. Install suspension system in accordance with ASTM C636, manufacturer's instructions, and as supplemented in this Section.

B. Install system in accordance with ASTM E580.

C. Install system capable of supporting imposed loads to a deflection of 1/360 maximum.

D. Install after major above ceiling work is complete. Coordinate the location of hangers with other work.

E. Supply hangers or inserts for installation to existing concrete structure.

F. Hang system independent of walls, columns, ducts, pipes, and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

G. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

H. Locate system on room axis according to reflected plan.

I. Space hanger wires a maximum of 4 feet on center each direction. Do not splay direct hanger wires more than 8 inches in a 4-foot vertical drop without providing a counter splay wire at same location.
   1. Provide 12-gauge supplemental support within 3 inches of each corner of fixture.
   2. Support fixtures or other equipment weighing more than 20 pounds but less than 56 pounds with two 12-gauge wires from the housing to the structure above or to other hanger wires. These wires may be slack. Independently support fixtures or other equipment weighing in excess of 56 pounds with 12-gauge wire at each corner to the structure above. Support pendant hung fixtures with minimum of one 9-gauge wire.

J. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability. Support fixture loads by supplementary hangers located within 6 inches of each corner or support components independently.

K. Support mechanical fixtures independent of the grid.

L. Provide stainless steel independent support kits for surface-mounted lights.

M. Do not eccentrically load system or produce rotation of runners.

N. Install edge molding at intersection of ceiling and vertical surfaces using longest practical lengths. Miter corners. Provide edge moldings at junctions with other interruptions. Where round obstructions occur, provide preformed closers to match edge molding.

O. Fit acoustic units in place, free from damaged edges or other defects detrimental to appearance and function.

P. Fit border neatly against abutting surfaces.

Q. Install acoustic units level, in uniform plane, and free from twist, warp, and dents.

3.3 TOLERANCES

A. Variation from Flat and Level Surface: 1/8 inch in 10 feet.

B. Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees maximum.

END OF SECTION

SECTION 09650

RESILIENT FLOORING

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Resilient sheet flooring.
   2. Resilient base.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for resilient flooring:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Room Finish Schedule as shown on the Drawings.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DESIGN CRITERIA

A. Conform to applicable code for fire-performance ratings as follows:
   1. Flooring:
      a. Critical Radiant Flux (CRF): Minimum watt per square centimeter, per NFPA 253.
      b. Smoke Developed: Maximum 450 per ASTM E662.
   2. Wall Base:
      a. Flame Spread: Maximum, per ASTM E84.
      b. Smoke Developed: Maximum 450 per ASTM E84.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Store materials for 3 days before installation within area of installation to achieve temperature stability. During and after installation maintain conditions above 55 degrees F.

B. Maintain temperature in storage area between 55 degrees F and 90 degrees F.

C. Maintain ambient temperature required by adhesive manufacturer 3 days prior to, during, and 24 hours after installation of materials.

1.5 SUBMITTALS

A. Provide the following within 3 weeks of Contract award:
   1. Product Data: on specified products describing physical and performance characteristics.

B. Provide the following before Substantial Completion: extra materials.

1.6 EXTRA MATERIALS

A. Provide 45 square feet for each 500 square feet of flooring from same production run and 5% lineal feet of base of each material specified.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Sheet Flooring:
   1. Armstrong World Industries, Inc.
   2. Johnsonite, Division of Duramax, Inc.
   3. Freudenberg Building Systems, Inc./Nora Rubber Flooring Division.
   4. Forbo Industries, Inc.
   5. Mannington Commercial.
   6. Mipolam.
   7. VPI Floor Products Division.

B. Base Materials:
   1. Armstrong World Industries, Inc.
   2. Azrock Commercial Flooring.
   3. Johnsonite, Division of Duramax, Inc.
   4. Marley Floors-Flexco.
   5. Roppe Corp.

2.2 MATERIALS

A. Resilient Sheet Flooring:
   1. Vinyl Sheet with Acoustical Backing: FS L-F-475, Type II, Grade A; ASTM F1303, Type II, Grade 1, Class B, color and pattern through total thickness:
      a. Total Thickness: 0.080 inch nominal.

b. Sheet Width: 72 inches minimum.
c. Static Load Limit: 250 psi minimum.
d. Basis of Design Product: Johnsonite Granit Acoustiflor.
e. Integral continuous base with trim strip at all wall surfaces and casework toe-kick areas.

B. Base Materials:
1. Base - ASTM F1861:
a. Material: rubber.
b. Size: 3-1/8 inches high (3 inch face) for resilient flooring and 4-1/2 inches high (4-1/4 inch face) for carpet tile.
c. Thickness: 0.125 inch thick.
d. Length: roll.
e. Type: top set coved.
2. Base Accessories: premolded internal corners, and external corners of same material, size, and color as base.
3. Basis of Design Product: Johnsonite, Tightlock® Wall Base.

C. Edge Strips / Adaptors
1. Sized to fit thickness transition between carpet tile and resilient flooring.
~~2.~~a. Basis of Design Product: Johnsonite, CTA-XX-X.
2. Subfloor leveler at automatic clean room doors to be provided full width of operable leaf, mitered to provide smooth transition from all angles.
a. Basis of Design Product: Johnsonite LS-40E

2.3 ACCESSORIES

A. Subfloor Filler: type recommended by flooring material manufacturer.

B. Primers and Adhesives: waterproof; types recommended by flooring manufacturer.

C. Sheet Flooring Welding Rod: solid vinyl bead produced by manufacturer of vinyl flooring for heat welding seams, in color as scheduled.

D. Sealer and Wax: types recommended by flooring manufacturer.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify that surfaces are smooth and flat with maximum variation of 1/8 inch in 10 feet and are ready to receive work.

B. Verify concrete floors are dry to a maximum moisture content as recommended by flooring manufacturer and exhibit negative alkalinity, carbonization, or dusting. Test concrete floor for moisture content using ASTM F1869 test method.

C. Verify floor and lower wall surfaces are free of substances capable of impairing adhesion of new adhesive and finish materials.

3.2 FIELD PREPARATION

A. Remove subfloor ridges and bumps. Fill low spots, cracks, joints, holes, and other defects with subfloor filler.

B. Remove from flooring substrate existing paint, oils, waxes, and sealers (and curing compounds not compatible with the adhesives employed).

C. Apply, trowel, and float filler to leave a smooth, flat, hard surface; sand and smooth to level any uneven areas.

D. Prohibit traffic from area until filler is cured.

E. Vacuum clean substrate.

F. Apply primer as required to prevent bleed-through or interference with adhesion by substances that cannot be removed.

3.3 INSTALLATION

A. General:

1. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.
2. Where floor finishes are different on opposite sides of door, terminate flooring under centerline of door.
3. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
4. Install flooring in recessed floor access covers. Maintain floor pattern.
5. At movable partitions, install flooring under partitions without interruption of floor pattern.
6. ~~Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.~~
7. ~~7.~~6. Spread only enough adhesive to permit installation of materials before initial set.
8. ~~8.~~7. Set flooring in place; press with heavy roller to attain full adhesion.

B. Sheet Flooring:

1. Install in accordance with manufacturer's instructions.
2. Lay flooring with joints and seams in accordance with seaming plan in the pattern as shown on the Drawings. Lay out seams to avoid widths less than 1/3 of roll width; match patterns carefully at seams.
3. Verify color consistency from roll to roll of sheet goods.
4. Do not ~~D~~double cut sheet; provide heat-welded seams.

C. Heat-Welded Seams:
1. Install sheet material the same as conventional installation procedure.
2. Seams shall be worked in one direction at a time. Cut V-groove in installed bead at seam intersection and complete procedure in opposite direction.
3. Do not rout into foam acoustical backing material.
~~3.~~4. Allow bead to cool and trim the excess bead with a spatula knife using trim plate on the first trim. For the second trim or flush trim, use the spatula knife only.

3.4 PROTECTION

A. Prohibit traffic on floor finish for 48 hours after installation.

3.5 CLEANING

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

B. Clean, seal, and wax floor and base surfaces in accordance with manufacturer's instructions.

3.6 SCHEDULE

A. Locations of specified resilient flooring type and color pattern are as shown on the Drawings:
1. RF-1, Sheet Flooring: Granit, 779-Morning Surf.
2. RF-2, Sheet Flooring: Granit, 776-Wind Swept.
3. RF-3, Sheet Flooring: Granit, 772-Sea Stone.
4. RF-4, Sheet Flooring: Granit, 773-Carmel Sundae.
5. RF-5, Sheet Flooring: Granit, 379-Full Sail.
~~6. RB-1, Base: to match manufacturer Johnsonite; color 76-Cinnamon.~~
~~7.~~6. RB-2, Base: to match manufacturer Johnsonite; color 30-Ink.
~~8. RB-3, Base: to match manufacturer Johnsonite; color 59-Heather Green.~~

END OF SECTION

SECTION 09682

CARPET TILE

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Carpet tile.
   2. Accessories.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for carpet tile:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 09650 - Resilient Flooring.
   4. Room Finish Schedule as shown on the Drawings.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 WARRANTY

A. Manufacturer shall furnish to the Owner his standard wear warranty for 10 years.

1.4 REGULATORY REQUIREMENTS

A. Conform to applicable standard for carpet flammability requirements:
   1. AATC 134 - Electrostatic Propensity of Carpet.
   2. ASTM E648 - Class I Rating; Critical Radiant Flux Using Radiant Heat Energy Source.
   3. DOG FF1-70 - Pass Rating; Methanamine Pill Test.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: company specializing in carpet tile with 3 years' minimum documented experience.

B. Installer Qualifications: company with 3 years' minimum documented experience and approved by manufacturer.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Store materials for 3 days prior to installation in area of installation to achieve temperature stability.

B. Maintain minimum 70 degree F ambient temperature 3 days prior to, during, and 24 hours after installation of materials.

C. Chemical Emissions/Indoor Air Quality: Carpets and adhesives shall be in compliance with the Carpet and Rug Institute (CRI) indoor air quality carpet testing program. The program label and registration number serve as evidence of compliance.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in manufacturer's original packaging, clearly identified as to type and location.

1.8 SUBMITTALS

A. Provide the following within 3 weeks of Contract award:
   1. Product data on specified products describing physical and performance characteristics, sizes, patterns, colors available, and method of installation.
   2. Provide maintenance and cleaning instructions.
   3. Provide MSDS sheets for adhesives to be used.
   4. Three full-tile samples illustrating color, pattern, and backing for each carpet material specified. Sample shall be of same quality as carpet to be installed.

1.9 EXTRA MATERIALS

A. Furnish additional carpeting materials from same production run as materials installed for future maintenance at the rate of 25 square feet for each 500 square feet of each color (5 percent).

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Milliken.

B. Interface.

C. Networx by Shaw.

2.2 MATERIALS

A. Carpet Tile: materials.
   1. CPT-1, Carpet Tile Conforming to the Following Criteria:
      a. Carpet and Rug Institute (CRI) Indoor Air Quality: product basis of design, Type InterfaceFLOR Commercial - Paintbox.
      b. Flammability (Radiant Panel): Class I.
      c. Yarn System: Antron® Lumena solution dyed nylon.
      d. Color System: Solution Dyed.
      e. Lifetime Antimicrobial: Intersept®.
      f. Soil/Stain Protection: Protekt® with DuraTech®.
      g. Yarn Weight: 24 ounces.
      h. Pile Thickness: 0.132 inch (3.4mm).
      i. Pile Density: 6,545.
      j. Color:
         1) 3530 Baltic.
         2) 3597 Sandbar.
      k. Tile Installation: Quarter-turn.

2.3 ACCESSORIES

A. Subfloor Filler: white premix latex; type recommended by carpet manufacturer.

B. Primers and Adhesives: waterproof; of types recommended by carpet manufacturer. Adhesivesshall be in compliance with the Carpet and Rug Institute indoor air quality carpet testing program.

C. Edge Strips: resilient type, matte finish, color as selected by IDC from resilient flooring manufacturer listed in Section 09650, Resilient Flooring.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify that substrate surfaces are smooth and flat with maximum variation of 1/8 inch in 10 feet; and are ready to receive work.

B. Verify moisture content with 4-foot by 4-foot polyethylene sheet, fully taped at perimeter to substrate for 48 hours. No condensation may occur in this time.

C. Verify that pH level is 9 or less when substrate is wetted with potable water and tested with pHydrion paper.

D. Beginning of installation means acceptance of existing substrate and site conditions.

3.2 FIELD PREPARATION

A. Remove subfloor ridges and bumps. Fill low spots, cracks, joints, holes, and other defects with subfloor filler.

B. Apply, trowel, and float filler to leave smooth, flat, hard surface.

C. Prohibit traffic until filler is cured.

D. Remove dirt, oil, grease, or other foreign matter from surfaces to receive floor covering.

E. Prime surfaces if recommended by floor covering manufacturer.

3.3 INSTALLATION

A. Apply carpet and adhesive in accordance with manufacturer's instructions.

B. Determine the center of the room utilizing standard tile-laying methods. Offset the center chalk line if necessary to ensure that perimeter modules will be half size or larger. The resulting chalk lines shall form quadrants that meet at right angles (use the 6-8-10 method as a check to ensure lines at 90 degree angles).

C. Apply a full spread of the releasable modular adhesive recommended by the manufacturer. After adhesive becomes tacky, lay modules firmly and accurately along anchor lines. Install remaining modules in the quadrant using the stair-step method.

D. A tight installation without compression is mandatory for good performance of the module installation. As a periodic check throughout the installation, monitor the cumulative space gained; compression gain or loss not to exceed 1/4 inch over ten modules.

E. As each module is installed, ensure that the installation remains square and conforms to the chalk lines by checking the joints for excessive play.

F. In larger areas, establish a control grid consisting of an adhered row of carpet tiles at approximately 15-foot intervals in each direction to prevent shifting of the modules.

G. Anchor carpet tile modules at the perimeter of the installation with adhesive. Install cove base after carpet tile installation is complete.

H. Cut carpet modules from back side to fit against walls, columns, and other fixed obstructions, or to activate underfloor utilities. Glue cut modules with release adhesive. Cut and fit carpet tile around interruptions.

I. Do not cut carpet modules under 6 inches in a doorway; cut back into next full tile.

J. Fully adhere accent band pieces with manufacturer's recommended adhesive.

K. Install edge strip where edge of carpet tile is exposed or abuts a dissimilar material unless otherwise noted.

L. Install modules with full-spread adhesive in areas subjected to wheeled traffic, as well as on ramps, inclines, stairs, and doorways.

3.4 CLEANING

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

B. Clean and vacuum carpet surfaces.

3.5 PROTECTION

A. To avoid dislodging modules, do not walk on or move furniture onto carpet until the area is completely anchored on all sides. Lay sheets of plywood or hardboard over the carpet surface when transporting heavy furniture on carts or dollies.

3.6 SCHEDULE

A. Refer to the Room Finish Schedule as shown on the Drawings, and the Drawings for locations of carpet tile and tile installation pattern.

END OF SECTION

SECTION 09915

BUILDING PAINTING

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Surface preparation.
   2. Paint materials.
   3. Exterior and interior building painting applications.
   4. Miscellaneous paint application schedule at end of this Section.
   5. Paint color schedule at end of this Section.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total building painting requirements:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Door Schedule as shown on the Drawings.
   4. Room Finish Schedule as shown on the Drawings.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DEFINITIONS

A. Conform to ASTM D16 for interpretation of terms used in this Section.

B. Abbreviations:
   1. MDFT: minimum dry film thickness.
   2. MDFTPC: minimum dry film thickness per coat.
   3. mil: thousandths of an inch.
   4. SP: surface preparation.

1.4 REGULATORY REQUIREMENTS

A. Conform to applicable code for flame/fuel/smoke rating requirements for finishes.

B. Green Seal Chemical Component Limitations:
   1. VOCs:

a. VOC concentrations of the product shall not exceed those listed below as determined by U.S. Environmental Protection Agency (EPA) Reference Test Method 24 (Determination of Volatile Matter Content, Water Content, Density Volume Solids, and Weight Solids of Surface Coatings), Code of Federal Regulations Title 40, Part 60, Appendix A.
b. The calculation of VOC shall exclude water and tinting color added at the point of sale.

2. Interior Coatings:
   a. Non-flat: 150 (VOC weight in grams/liter of product minus water).
   b. Flat: 50 (VOC weight in grams/liter of product minus water).
3. Exterior Coatings:
   a. Non-flat: 200 (VOC weight in grams/liter of product minus water).
   b. Flat: 100 (VOC weight in grams/liter of product minus water).
4. Aromatic Compounds: The product shall contain no more than 1.0 percent by weight the sum total of aromatic compounds.
5. Chemical Component Restrictions: The manufacturer shall demonstrate that the following chemical compounds are not used as ingredients in the manufacture of the product.
   a. Halomethanes: methylene chloride.
   b. Chlorinated ethanes: 1,1,1-trichloroethane.
   c. Aromatic solvents: bezene, toluene (methylbenzene), ethylbenzene.
   d. Chloronated ethylenes: vinyl chloride.
   e. Polynuclear aromatics: naphthalene.
   f. Chlorobenzenes: 1,2-dichlorobenzene.
   g. Phthalate esters: di (2-ethylhexyl) phthalate, butyl benzyl phthalate, di-n-butyl phthalate, di-n-octyl phthalate, diethyl phthalate, dimethyl phthalate.
   h. Miscellaneous semi-volatile organics: isophorone.
   i. Metals and their compounds: antimony, cadmium, hexavalent chromium, lead, mercury.
   j. Preservatives (antifouling agents): Formaldehyde.
   k. Ketones: methyl ethyl ketone, methyl isobutyl ketone.
   l. Miscellaneous volatile organics: acrolein, acrylonitrile.

1.5 QUALITY ASSURANCE

A. Product Manufacturer: company specializing in manufacturing quality paint and finish products specified in this Section with minimum 3 years' experience.

B. Applicator: company specializing in commercial painting and finishing with 3 years' documented experience applying material similar to that specified, has worked on projects of similar size to this project, and is approved by product manufacturer.

C. Paint products for each general purpose shall be of same manufacturer.

D. Use only thinners recommended by paint manufacturer, and only within recommended quantity limits.

E. Do not use products of different manufacturers over one another, except as specifically approved by the paint manufacturer.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by paint product manufacturer.

B. Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures as follows for 24 hours before, during, and 48 hours after application of finishes:
   1. Minimum Application Temperatures for Water-Based Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.
   2. Minimum Application Temperatures for Varnish and Solvent-Based Paints: 65 degrees F for interior or exterior, unless required otherwise by manufacturer's instructions.

C. Do not apply exterior coatings during rain or snow when relative humidity is outside recommended humidity ranges or when moisture content of substrate surfaces exceeds that required by paint product manufacturer.

D. Do not apply exterior coatings when surfaces are in direct sunlight where surface temperature of substrate exceeds manufacturer's recommendation.

E. Illumination: do not perform work under less than 30-foot candles measured mid-height at substrate surface.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver each container with labeling intact which identifies manufacturer, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation, and instructions for mixing and reducing.

B. Store paint materials at minimum ambient temperature of 50 degrees F and a maximum of 90 degrees F in well-ventilated area, unless required otherwise by manufacturer's specifications.

C. Provide storage facilities outside of buildings being constructed. Limit quantities in buildings to daily use.

D. Take precautionary measures to prevent fire hazards and spontaneous combustion.

1.8 SUBMITTALS

A. Provide the following within 3 weeks of Contract award:
   1. Product data on protective coatings and architectural paint products.
   2. Material safety data sheets for each paint product.
   3. Samples for Review: painted samples, 8-1/2 by 11 inches in size of each proposed finish material, illustrating range of color and textures available for each scheduled surface finish and color.
   4. Color matching to existing field finishes: painted samples, 8-1/2 by 11 inches in size of each color to match existing conditions where noted on the Drawings.

1.9 MAINTENANCE DATA

A. Include cleaning methods and cleaning solutions recommended in maintaining the painted surfaces.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Architectural Coatings:
   1. Benjamin Moore & Co.
   2. ICI Paints.
   3. Kelley Moore.
   4. Martin Senour.
   5. Pittsburgh Paint Company.
   6. Porter Paints.
   7. Sherwin Williams.

2.2 PAINT MATERIALS

A. Following are generic descriptions of the paint systems for this project. Products furnished for the project from the listed manufacturers shall comply with the generic descriptions at a minimum. Use low-odor (low-VOC) formulations.

B. Primers:

1. Acrylic Masonry Primer: single-component water-based acrylic; minimum volume solids, 27 percent; suitable for priming cured brick, concrete, concrete masonry, and plaster.
2. Acrylic Primer Sealer: single component polyvinyl acetate (PVA) primer, minimum solids 23 percent; suitable for use on properly prepared new or previously painted gypsum board, cured plaster and masonry, and wood surfaces.
3. Acrylic Direct to Metal Primer: single-component, 100 percent acrylic resin, minimum volume solids 38 percent; suitable for aluminum, ferrous metal, and galvanized steel.
4. Alkyd Primer: single-component alkyd resin; minimum volume solids, 55 percent; suitable as primer under alkyd or latex finish coats.
5. Recoatable Epoxy Primer: two-component epoxy polyamide primer; minimum volume solids, 72 percent; fast drying, with maximum 6-month recoat window.
6. Universal Alkyd Primer: single-component modified alkyd resin, 52 percent minimum volume solids, 52 percent; suitable for ferrous and aluminum substrates and as a barrier coat over existing alkyd systems; can be top coated with epoxy, alkyd, or urethane products.

C. Block Filler: single-component acrylic primer; minimum volume solids 43 percent; designed to fill porous surfaces of cured interior or exterior concrete and masonry surfaces.

D. Finish Paint Materials:
1. Acrylic Latex (Eggshell): single-component, 100 percent acrylic resin; minimum volume solids 32 percent; eggshell sheen.
2. Acrylic/Latex (Semi-gloss): single-component, 100 percent acrylic resin; minimum volume solids 30 percent; semi-gloss sheen.
3. .
4. Alkyd Enamel: single-component; medium-long oil; minimum volume solids 45 percent; semi-gloss sheen.

E. Accessory Materials: linseed oil, shellac, turpentine, paint thinners, and other materials not specifically indicated but required to achieve the finishes specified, of commercial quality per manufacturer's recommendations.

2.3 COLORS

A. Colors are indicated at the end of this Section.

B. Formulate colors with colorants free of lead and lead compounds.

C. Proprietary identification of colors is for establishment of desired colors only.

PART 3 -- EXECUTION

3.1 INSPECTION

A. The Contractor shall leave surfaces intended to be painted in such a condition that only minor cleaning, sanding, and filling are required prior to surface preparation and painting.

B. Verify that surfaces and substrate conditions are ready to receive work as instructed by the product manufacturer.

C. Examine substrate surfaces scheduled to be painted before commencement of painting work. Report any condition that may potentially affect proper application.

D. Beginning of paint application means acceptance of existing surfaces and substrate.

3.2 FIELD PREPARATION

A. Paint Mixing:
1. Prepare multiple-component coatings using all contents of each component container as packaged by the paint manufacturer; no partial batches permitted.
2. Do not use mixed multiple-component coatings beyond their pot life; provide small quantity kits for touchup painting and for painting other small areas.
3. Mix only the components specified and furnished by the paint manufacturer.
4. Do not intermix additional components for reasons of color or otherwise, even with the same generic type of coating.
5. Seal paint materials when not in use.
6. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that the required number of coats has been applied.

3.3 PREPARATION OF SURFACES

A. Surface Preparation – General:
1. Conform to applicable ASTM, NACE, or SSPC specifications indicated in this Section.
2. Comply with the applicable federal, state, and local air pollution control regulations for cleaning and disposal of cleaning residue.
3. Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings before preparing surfaces for painting.
4. Correct defects and clean surfaces capable of affecting work of this Section.
5. Remove or repair existing coatings that exhibit surface defects.

6. Coat with shellac or other approved sealer those marks or stains that may bleed through paint finishes.
7. Impervious Surfaces: Remove mildew by scrubbing with solution of water, tri-sodium phosphate, and bleach. Rinse with clean water and allow surface to dry.

B. Surface Preparation - Metal:
   1. Conform to the current versions of the following Steel Structures Painting Council (SSPC) surface preparation specifications or National Association of Corrosion Engineers (NACE):
      a. Solvent Cleaning: SSPC SP 1.
      b. Hand Tool Cleaning: SSPC SP 2.
      c. Power Tool Cleaning: SSPC SP 3.
      d. Pickling: SSPC SP 8.
   2. Solvent Cleaning:
      a. Comply with SP 1.
      b. Remove foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by the use of solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods which involve a solvent or cleaning action.
   3. Tool Cleaning:
      a. Comply with SP 2, where surfaces can not be cleaned by power tool cleaning, SP 3.
      b. Smooth sharp edges and grind smooth burrs, jagged edges, and surface defects.
   4. Aluminum - Surface Preparation: remove surface contamination by steam or high-pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following cleaning.
   5. Galvanized Metal - Surface Preparation: remove surface contamination and oils and wash with solvent, SSPC SP-1. If necessary use SSPC SP-7 to remove remaining stabilizer coating. Apply primer immediately following cleaning.
   6. Stainless Steel - Surface Preparation: remove conversion coating with 15 percent phosphoric acid wash and water rinse.

C. Concrete - Surface Preparation:
   1. Begin surface preparation minimum 30 days after concrete placement.
   2. Initial Cleaning: remove grease, oil, dirt, salts, chemicals, loose materials, or other foreign matter by one of the cleaning methods described in ASTM D4258 or as recommended by coating manufacturer for applicable paint.
   3. Acid Etching: is not allowed.

4. Blast clean concrete surfaces to remove loose concrete, laitance, and to provide adequate surface profile for paint adhesion. Mechanically abrade concrete surfaces in accordance with ASTM D4259. Use abrading method recommended by paint manufacturer for proposed product.
5. After abrading concrete, clean surfaces in accordance with ASTM D4258.
6. Testing Concrete Surface:
    a. Test pH level of concrete in accordance with ASTM D4262 and submit test results to IDC. Acid-alkali pH balance of concrete surface shall be within range of 6.8 to 8 unless otherwise required by coating manufacturer.
    b. Test moisture content of concrete substrate in accordance with ASTM D4263, plastic sheet method. If concrete surface fails test do additional tests in accordance with ASTM F1869, anhydrous calcium test and submit test results to IDC. Review test results with IDC and coating manufacturer to determine appropriate action before applying coatings.

D. Plastic - Surface Preparation:
1. Hand-sand plastic surfaces to be painted with medium-grit sandpaper to provide tooth for the painting system.
2. Large areas may be power sanded or brushoff blasted, provided sufficient controls are employed to roughen surface without removing excess material.

E. Masonry - Surface Preparation:
1. Complete and cure masonry construction minimum 14 days before surface preparation work is started.
2. Remove oil, grease, dirt, salts, chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other cleaning method in accordance with ASTM D4261.
3. Avoid damage to masonry mortar joints and adjacent surfaces.
4. Apply paint only to dry and clean surfaces, unless otherwise required by coating manufacturer.
5. Prepare masonry surfaces with uniform texture and free of surface imperfections that may impair the intended finished appearance.

F. Wood - Surface Preparation:
1. Before start of surface preparation, replace or repair damaged wood surfaces in a manner acceptable to IDC.
2. Knots:
    a. Solvent clean (mineral spirits) and coat with shellac or other knot sealer all knots and other resinous areas.
    b. Remove pitch by scraping and wipe clean with solvent or turpentine.
3. Ease sharp edges by sanding prior to priming.

4. Filler:
    a. After priming, fill cracks, holes, and other surface irregularities flush with adjacent surfaces; sand smooth.
    b. Fill with wood putty approved by paint manufacturer; for natural finishes, match putty color with color of opaque finished wood.
5. Apply paint to clean and dry surfaces.

G. Gypsum Board:
1. Apply paint to surfaces which are dry, free of dust, dirt, powdery residue, grease, oil, or any other contaminants.
2. Reinforce and carefully conceal joints between panels and comply with following criteria:
    a. Fastener heads covered.
    b. Sand joint compound with fine grit sandpaper to produce a smooth, flat surface.
3. Water-Resistant Gypsum Board: Use only solvent-type primers.

H. Preparation of Existing Coated Surfaces:
1. Detergent wash and freshwater rinse existing coated or primed surfaces to be repainted or final coated.
2. Clean to substrate loose, abraded, or damaged coatings by hand or power tool.
3. Feather surrounding intact coating.
4. Coat with shellac or other approved sealer those marks or stains that may bleed through paint finishes.
5. Impervious Surfaces: Remove mildew by scrubbing with solution of water, tri-sodium phosphate, and bleach. Rinse with clean water and allow surface to dry.
6. Apply one spot coat of the specified primer to bare areas overlapping the prepared existing coating.
7. Apply one full finish coat of the specified primer or finish coat(s) overall.

3.4 PROTECTION

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery and rated assemblies, and other surfaces not intended to receive paint.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Store solvent- and thinner-contaminated rags and similar refuse in UL-rated containers; remove daily accumulations from the site at the end of each day's work.

E. Remove empty paint containers from site at the end of each day's work.

3.5 APPLICATION

A. Apply products in accordance with manufacturer's specifications and as specified in this Section.

B. Apply paint to dry surfaces, unless otherwise required by coating manufacturer.

C. Apply each coat to uniform finish, free of runs, sags, lap marks, air bubbles, and pinholes.

D. Sand lightly between coats to achieve required finish.

E. Allow applied paint coat to dry before next coat is applied, unless otherwise indicated in manufacturer’s instructions.

F. Fusion-bonded coating application may be electrostatic, fluidized bed, or flocking.

G. Paint units to be bolted together and to structures prior to assembly or installation.

H. Shop-Primed Surfaces:
   1. Damaged Surfaces:
      a. Hand or power sand areas of chipped, peeled, or abraded coatings, feathering the edges.
      b. Spot prime the areas with the specified primer.
   2. Prior to application of finish coats, clean shop-primed surfaces of all dirt, oil, and grease.
   3. Provide mist coat (1 mil dry film thickness) of the specified primer.
   4. After welding, prepare and prime welding hold-back areas as required for specified paint system.

I. Manufacturer-Applied Paint Systems:
   1. Repair abraded areas on factory-finished items in strict accordance with equipment manufacturer's directions.
   2. Carefully blend repaired areas into the original finish.

J. Finishing Existing Coated Surfaces:
   1. This Specification assumes that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with specified paints.
   2. Check compatibility by applying finish paint to a small area.

3. If lifting or other problems occur, request disposition from IDC and coating manufacturer.

3.6 FILM THICKNESS

A. Coverage is listed as total MDFT in mils.

B. Per-coat determinations are listed as MDFTPC.

C. Number of Coats:
1. The number of coats is the minimum required, regardless of the coating thickness.
2. Additional coats may be required to obtain the minimum required paint thickness, depending on method of application, differences in manufacturer's products, and atmospheric conditions.
3. Do not exceed coating manufacturer's recommendations regarding maximum film build per coat.

3.7 POROUS SURFACES

A. Porous surfaces such as concrete, masonry, etc., may have the prime coat thinned to provide maximum penetration and adhesion; type and amount of thinning determined by the paint manufacturer and dependent upon the surface density and type of coating.

B. Prepare porous surfaces specified to receive a water base coating, damp but free of running water, just prior to application of the coating.

3.8 DAMAGED COATING

A. Damaged Coatings, Pinholes, and Holidays: edges feathered and repaired in accordance with the recommendations of the paint manufacturer as reviewed by IDC.

B. Repair of Fusion-Bonded Coatings:
1. As recommended by the original applicator.
2. Provide liquid repair kits for this purpose as recommended by the coating manufacturer.

C. Apply finish coats, including touchup and damage repair coats, in a manner which will present a uniform texture and color-matched appearance.

3.9 UNSATISFACTORY APPLICATION

A. Clean and top coat surfaces with improper finish color or insufficient film thickness.

B. Secure specific surface-preparation information from the coating manufacturer and IDC.

C. Repair defects in the coating system per written recommendations of the coating manufacturer.

3.10 FINISHING DUCTING AND ELECTRICAL EQUIPMENT

A. Paint exposed conduit and electrical equipment occurring in finished areas.

B. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.

C. Replace electrical plates, hardware, light fixture trim, and fittings removed prior to finishing.

3.11 CLEANING

A. As work proceeds, promptly remove paint where spilled, splashed, or spattered.

B. During progress of work, maintain premises free of unnecessary accumulation of tools, equipment, surplus materials, and debris.

C. Collect cotton waste, cloths, and material which may constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.12 ARCHITECTURAL PAINT SYSTEMS

A. Refer to Door Schedule and Finish Schedule on the Drawings for locations of the following paint systems. The system numbers listed are general and may not be used in the project.

B. P-51 Steel Exterior Acrylic - Semi-Gloss:
   1. Surface Preparation: hand tool cleaning, SSPC SP-2.
   2. Primer: universal alkyd primer, one coat, 3.0 MDFT or direct-to-metal acrylic primer, 2.5 MDFT.
   3. Finish Coats: acrylic latex, semi-gloss, 1.3 MDFTPC.

C. P-52 Steel Interior Acrylic - Semi-Gloss:
   1. Surface Preparation: hand tool cleaning, SSPC SP-2.
   2. Primer: direct-to-metal acrylic primer, one coat, 2.5 MDFT.

3. Finish Coats: acrylic latex, semi-gloss, two coats, 1.3 MDFTPC.

D. P-53 Steel Interior Alkyd - Semi-Gloss:
1. Surface Preparation: hand tool cleaning, SSPC SP-2.
2. Primer: universal alkyd primer, one coat, 3.0 MDFT.
3. Finish Coats: alkyd enamel, semi-gloss, two coats, 2.3 MDFTPC.

E. P-54 Steel Structure/Galvanized Metal Deck, Dryfall - Alkyd:
1. Surface Preparation: solvent cleaning, SSPC SP-1.
2. Primer: direct-to-metal wash primer, one coat, 1.0 MDFT.
3. Finish Coats: alkyd dryfall, eggshell, one to two coats, 2.0 MDFTPC.

F. P-55 Steel Structure/Galvanized Metal Deck, Dryfall - Latex:
1. Surface Preparation: solvent cleaning, SSPC SP-1.
2. Primer/Finish Coats: water-based acrylic dryfall, eggshell, two coats, 4.0 MDFTPC.

G. P-56 Galvanized Steel - Interior - Acrylic:
1. Surface Preparation: solvent cleaning, SSPS SP-1 or brushoff-blast cleaning, SP-7 if required to promote adhesion.
2. Primer: direct-to-metal acrylic primer, one coat, 2.5 MDFT.
3. Finish Coats: acrylic latex, semi-gloss, two coats, 1.6 MDFTPC.

H. P-57 Concrete Exterior/Interior Acrylic - Flat:
1. Surface Preparation: concrete.
2. Primer: acrylic masonry primer, one coat 3.6 MDFT.
3. Finish Coats: acrylic latex flat, two coats, 1.5 MDFTPC.

I. P-58 Concrete Exterior/Interior Acrylic - Semi-Gloss:
1. Surface Preparation: concrete.
2. Primer: acrylic masonry primer, one coat 3.6 MDFT.
3. Finish Coats: acrylic latex semi-gloss, two coats, 1.3 MDFTPC.

J. P-59 Concrete Unit Masonry Exterior/Interior Acrylic - Flat:
1. Surface Preparation: masonry.
2. Primer: block filler, one coat, 8.0 MDFT.
3. Finish Coats: acrylic masonry coating, two coats, 1.3 MDFTPC.

K. P-60 Concrete Unit Masonry Exterior/Interior Acrylic - Semi-Gloss:
1. Surface Preparation: masonry.
2. Primer: block filler, one coat, 8.0 MDFT.
3. Finish Coat: acrylic masonry coating, two coats, 1.3 MDFTPC.

L. P-61 Concrete or Concrete Unit Masonry Exterior/Interior - Opaque Stain:

1. Surface Preparation: concrete or masonry as applicable.
2. Primer: none.
3. Finish Coats: acrylic stain, two coats to achieve full penetration and coverage.

M. P-62 Concrete or Concrete Unit Masonry Exterior - Elastomeric Coating:
1. Surface Preparation: concrete or masonry as applicable.
2. Primer: masonry block filler, if necessary to fill surface voids.
3. Finish Coats: single-component elastomeric acrylic coating, two coats, 5.0 MDFTPC.

N. P-63 Gypsum Board Interior Acrylic - Flat:
1. Surface Preparation: gypsum board.
2. Primer: latex primer, one coat, 1.6 MDFT.
3. Finish Coats: acrylic latex, flat, two coats, 1.4 MDFTPC.

O. P-64 Gypsum Board Interior Acrylic Latex - Eggshell:
1. Surface Preparation: gypsum board.
2. Primer: latex primer, one coat, 1.6 MDFT.
3. Finish Coat: acrylic latex, eggshell, two coats, 1.6 MDFTPC.

P. P-65 Gypsum Board Interior Acrylic Latex - Semi-Gloss:
1. Surface Preparation: gypsum board.
2. Primer: latex primer, one coat, 1.6 MDFT.
3. Finish Coats: acrylic latex, semi-gloss, two coats, 1.3 MDFTPC.

Q. P-66 Gypsum Board Interior Acrylic Latex - Gloss:
1. Surface Preparation: gypsum board.
2. Primer: latex primer, one coat, 1.6 MDFT.
3. Finish Coats: acrylic latex, gloss, two coats, 1.3 MDFTPC.

R. P-67 Gypsum Board Water-Based Epoxy:
1. Surface Preparation: gypsum board.
2. Primer: latex primer, one coat, 1.0 - 1.4 MDFT.
3. Finish Coats: water-based catalyzed epoxy, two coats, 2.5 - 3.0 MDFTPC.

S. P-68 Gypsum Board Interior – Textured Coating:
1. Surface Preparation: gypsum board.
2. Primer: gypsum board primer/sealer, one coat per manufacturer's recommended coverage.
3. Intermediate Coat: polychromatic, terpolymer coating, one coat per manufacturer's recommended coverage.
4. Finish Coat: optional, clear epoxy semi-gloss coating.

T. P-69 Wood Stained - Exterior:

1. Surface Preparation: wood.
2. Primer: none.
3. Finish Coats: acrylic polyurethane semi-transparent stain, two coats for full coverage and penetration.

U. P-70 Wood Stained and Varnished - Exterior/Interior:
1. Surface Preparation: wood.
2. Stain: oil-based semi-transparent stain.
3. Intermediate Coat: sanding sealer, one coat, 1.0 MDFT.
4. Finish Coat: oil varnish, satin, two coats, 1.7 MDFTPC.

V. P-71 Wood Transparent Finish - Interior:
1. Surface Preparation: wood.
2. Primer: none.
3. Finish Coats: water-based polyurethane, satin, three coats, 1.3 MDFTPC.

W. P-72 Wood Opaque Finish Exterior Acrylic - Semi-Gloss:
1. Surface Preparation: wood.
2. Primer: exterior alkyd wood primer, one coat, 2.3 MDFT.
3. Finish Coats: exterior acrylic latex, semi-gloss, two coats, 1.3 MDFTPC.

X. P-73 Wood Opaque Finish, Semi-Gloss Interior - Alkyd:
1. Surface Preparation: wood.
2. Primer: alkyd wood primer, one coat, 1.6 MDFT.
3. Finish Coats: alkyd enamel, semi-gloss, two coats, 1.3 MDFTPC.

Y. P-74 Wood Opaque Finish, Semi-Gloss Interior - Acrylic:
1. Surface Preparation: wood.
2. Primer: latex wood primer, one coat, 1.6 MDFT.
3. Finish Coats: latex, semi-gloss, two coats, 1.3 MDFTPC.

3.13 COLOR SCHEDULE

A. C-1: ~~ICI, Emily's Expression - #45YY 83/094.~~ Match to Plascore – Shell White

B. C-2: ~~ICI, Camelcoat - #20YY 43/200.~~ Match to Plascore – Too Beige

C. C-3: ~~ICI, Hillside View - #70GG 39/088.~~ Match to Plascore – Too Beige

D. C-4: ~~ICI, Autumn Blush - #80YR.~~

E. C-5: ~~ICC, America's Cup - #10BB 11/126.~~ Match to Plascore – C2088 Blue

END OF SECTION

SECTION 09920

PAINTING - EQUIPMENT AND PIPING

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Surface preparation; prime and finish paint for mechanical equipment, vessels, and piping.
   2. Safety color coding of equipment and piping.
   3. Repair and touchup of damaged factory-applied coatings on mechanical and electrical equipment.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for painting of the referenced equipment, vessels, and piping:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 09915 - Building Painting.
   4. Color schedule included at the end of this Section.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DEFINITIONS

A. SSPC - Steel Structures Painting Council Specifications:
   1. SP-1: solvent cleaning.
   2. SP-2: hand tool cleaning.
   3. SP-3: power tool cleaning.
   4. SP-5: white metal blast cleaning.
   5. SP-6: commercial blast cleaning.
   6. SP-7: brushoff blast cleaning.
   7. SP-8: pickling.
   8. SP-10: near-white blast cleaning.

B. Shop Finish: Prime, paint, or prime and paint finishes applied prior to delivering equipment to project site.

C. Field Finish: Finish applied at project site may be applied before or after equipment installation.

D. Conform to ASTM D16 for interpretation of terms used in this Section.

E. Abbreviations:
1. MDFT: minimum dry film thickness.
2. MDFTPC: minimum dry film thickness per coat.
3. Mil: thousandths of an inch.
4. PSDS: paint system data sheet.
5. SP: surface preparation.

1.4 SURFACES NOT REQUIRING PAINTING

A. The following materials, items, or surfaces do not require shop or field surface preparation and coating unless otherwise specified on the equipment drawings or by Section 09915, Building Painting:
1. Plated surfaces.
2. Insulation jacketing.
3. Interior surfaces of tanks, fans, heaters, and stacks.
4. Nonferrous surfaces.
5. Nonmetallic surfaces.
6. Polished surfaces or machinery.
7. Uninsulated stainless steel surfaces.

1.5 EQUIPMENT SAFETY COLOR CODING

A. Except where local jurisdiction requirements are more restrictive, comply with the latest published federal and state requirements for safety color coding for marking physical hazards and dangerous material identification.

B. Color Marking of Physical Hazards: Comply with ANSI Z35.1, Safety Color Code for Marking Physical Hazards.

C. Safety Yellow:
1. Identify physical hazards using solid yellow, yellow and black stripes, or yellow and black checkers; use the combination that will attract the most attention.

D. Safety Orange:
1. Using safety orange, identify dangerous parts of machines or energized equipment which may crush, cut, shock, or otherwise injure.
2. Provide safety orange safety color coding on the following:
a. Inside movable guards.

b. Safety starting buttons.
c. Exposed parts (edges only) of pulleys, gears, rollers, cutting devices, power jaws, etc.

E. Safety Red - Identify the following fire protection equipment using safety red:
1. Fire suppression hose connections.
2. Fire hydrants.
3. All other wet- and dry-type fire suppression equipment.

1.6 PIPING SAFETY COLOR CODING

A. Provide safety color coding for all above-ground piping and valves, excepting electrical conduit.

B. Safety Color Coding - Provide coding colors as follows:
1. Safety Red: fire suppression sprinkler and CO_2 piping.
2. Safety Yellow: pipes containing acids, solvents, harmful gases, nonpotable city water, or other hazardous materials.
3. Safety Blue: potable water services.
4. Safety Green: safe materials; gases or liquids used to neutralize or antidotes to dangerous materials.

1.7 WARRANTY

A. Coating manufacturer and installer jointly and severally warrant to the Owner the work of this Section against defective workmanship and materials for a period of 1 year commencing on the date of final acceptance of the work.

1.8 REGULATORY REQUIREMENTS

A. Conform with safety requirements as outlined on manufacturer's material safety data sheets (MSDSs) for each product specified herewith.

B. Protect personnel from harmful toxic fumes associated with specified, as indicated on product MSDS and as required by OSHA.

C. Dispose of paint-related wastes in conformance with EPA or equivalent local environmental protection agency requirements.

1.9 QUALIFICATION

A. Product Manufacturer: company specializing in manufacturing industrial prime and finish products with 5 years' experience.

B. Applicator: company specializing in industrial coating applications with 3 years' documented industrial experience and acceptable to product manufacturer.

1.10 COORDINATION

A. Coordinate the work of this Section with Section 09915, Building Painting.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Provide continuous ventilation and heating facilities to maintain interior surface and ambient temperatures above 50 degrees F for 24 hours before, during, and 48 hours after application of finishes unless otherwise specified by coating manufacturer.

B. Do not apply exterior coatings during rain, snow, or when relative humidity is above 50 percent unless otherwise specified by coating manufacturer.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Deliver each container unopened with labeling which identifies manufacturer, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation, and instructions for mixing and reducing.

B. Store paint materials at minimum ambient temperature of 50 degrees F and a maximum of 90 degrees F in well-ventilated area unless required by manufacturer's specifications.

C. Provide storage facilities outside of buildings; limit quantities in buildings which are part of the work to daily use.

D. Take precautionary measures to prevent fire hazards and spontaneous combustion.

1.13 SUBMITTALS

A. Provide the following in addition to the standard requirements:
1. Submit manufacturer's data and specifications for each product specified herewith; highlight portions of product literature which show conformance with this Section.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Benjamin Moore & Co.

B. Carboline.

C. ICI Paints.

D. International Protective Coatings.

E. Pittsburgh Paint Company.

F. Sherwin Williams.

G. Tnemec.

2.2 PAINT MATERIALS

A. Provide primers and finish coatings which conform to the performance requirements and generic description specified herewith and are compatible as a system as indicated in Article 3.7, Equipment and Piping Painting Schedule.

B. Steel Primers:
   1. Inorganic Zinc Rich Primer (Type P-1):
      a. Minimum Surface Preparation: SSPC-SP10.
      b. Flash Point: 70 degrees F (TOC).
      c. MDFTPC: 2.5 mils.
      d. Number of Coats: one.
      e. Minimum Zinc in Dried Film: 10 grams per square foot.
      f. Service Temperature Limit: 600 degrees F.
   2. Universal Primer (Type P-2):
      a. Minimum Surface Preparation: SSPC-SP2 or 3.
      b. Flash Point: 85 degrees F (TOC).
      c. MDFTPC: 3 mils.
      d. Number of Coats: one.
      e. Service Temperature Limit: 150 degrees F.
   3. Modified Inorganic Zinc Rich Primer (Type P-3):
      a. Minimum Surface Preparation: SSPC-SP3.
      b. Flash Point: 3 mils.
      c. Number of Coats: one.
      d. Service Temperature Limit: 350 degrees F.

C. Steel Finishes:
   1. Polyurethane Paint (Type F-1):
      a. Flash Point: 70 degrees F (SETA).
      b. MDFTPC: 5 mils.
      c. Number of Coats: one.
      d. Service Temperature Limit: 200 degrees F.

2. Silicone Acrylic-Based Paint (Type F-2):
   a. Flash Point: 80 degrees F (SETA).
   b. MDFTPC: 2 mils.
   c. Number of Coats: one.
   d. Service Temperature Limit: 400 degrees F.
3. Silicone Aluminum Paint (Type F-3):
   a. Minimum Surface Preparation: SSPC-SP10.
   b. Flash Point: 85 degrees F (TOC).
   c. MDFTPC: 1 mil.
   d. Number of Coats: two.
   e. Service Temperature Limit: 1,000 degrees F.
4. Silicone Paint (Type F-4):
   a. Minimum Surface Preparation: 45 degrees F (PM).
   b. MDFTPC: 1 mil.
   c. Number of Coats: one.
   d. Service Temperature Limit: 800 degrees F.
5. Coal-Tar Epoxy Coating (Type F-5):
   a. Minimum Surface Preparation: SSPC-SP10.
   b. Flash Point: 96 degrees F (TOC).
   c. MDFTPC: 8 mils.
   d. Number of Coats: two.
   e. Service Temperature Limit: 300 degrees F.
6. Alkyd Enamel Paint (Type F-6):
   a. Minimum Surface Preparation: Primer P-1.
   b. Minimum Solids by Volume: 45 percent.
   c. MDFTPC: 4 mils.
   d. Number of Coats: two.
   e. Service Temperature Limit: 150 degrees F.

D. Factory Tint Coatings: No field tinting allowed.

E. Formulate color with colorants free of lead and lead compounds.

F. Accessory Materials: linseed oil, shellac, turpentine, paint thinners, and other materials not specifically indicated but required to achieve the finishes specified, industrial quality, and in accordance with coating manufacturer's recommendations.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify that surfaces and substrate conditions are ready to receive work as specified by the product manufacturer.

B. Examine surfaces scheduled to be coated prior to commencement of work; report any condition that may potentially affect proper application.

C. Verify that all sharp edges are round or chamfered; burrs, jagged edges, and surface defects are ground smooth.

D. Inspect welds and adjacent areas and verify that there are:
   1. No undercutting or reverse ridges on the weld bead.
   2. No weld spatter on or adjacent to the weld or any other area to be painted.
   3. No sharp peaks or ridges along the weld bead.
   4. All embedded pieces of electrode or wire are ground flush with the adjacent surface of the weld bead.

E. Verify that environmental conditions are in accordance with manufacturer's specifications.

F. Beginning of installation means acceptance by applicator of existing surfaces and substrate.

3.2 PREPARATION OF METAL SURFACES

A. Prepare surfaces conforming to SSPC specifications as applicable for coating scheduled and in accordance with coating manufacturer's specification; in the event of conflict between specifications, the more restrictive shall prevail.

B. Preblast Cleaning Requirements:
   1. Remove all oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
   2. Preblast clean using steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
   3. Clean small isolated areas as above or solvent clean with suitable solvents and clean cloths.
   4. Prior to abrasive blast cleaning, protect all equipment and adjacent surfaces which may be damaged by blast, dust, or particulate matter; protected items include, but are not limited to, rotating shafts, bearings, valves, machined moving parts, motors, and prefinished equipment.

C. Blast Cleaning Requirements:

1. Abrasives for blast cleaning are clean and dry and conform to SSPC specification requirements.
2. Compressed air is free from oil and moisture.
3. Comply with applicable federal, state, and local air pollution control regulations for blast cleaning.
4. Alternatives to standard abrasive blast cleaning methods subject to review by IDC and approval by coating manufacturer.

D. Postblast Cleaning Requirements:
1. Clean surfaces free of dust and residual particles by dry (no oil or water vapor) air blast cleaning or other method prior to painting; vacuum clean in enclosed areas and other areas where dust settling is a problem; wipe with tack cloth.
2. Paint surfaces the same day they are abrasive blast cleaned; reblast rusted surfaces prior to painting.

3.3 PROTECTION

A. Remove, mask, or otherwise protect hardware, lighting fixtures, cover plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates, prefinished items, and other surfaces not scheduled to be painted by this Section.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Store solvent and thinner, contaminated rags, and similar refuse in UL-rated containers; remove daily accumulations and empty paint containers from the site at the end of each day's work.

3.4 APPLICATION

A. Apply products in accordance with manufacturer's specifications and as specified herein.

B. Shop-Primed Surfaces:
1. Damaged Surfaces:
   a. Hand or power sand areas of chipped, peeled, or abraded coatings feathering the edges.
   b. Spot prime the areas with the specified primer.
2. Prior to application of finish coats, clean shop-primed surfaces of all dirt, oil, and grease.
3. After welding, prepare and prime welding hold-back areas as required for specified finish.
4. Shop prime all ferrous metal material prior to delivery to project site.

C. Number of Coats:
   1. The number of coats are the minimum required irrespective of the coating thickness.
   2. Additional coats may be required to obtain the minimum required paint thickness, depending on method of application, differences in manufacturer's products, and atmospheric conditions.
   3. Do not exceed coating manufacturer's recommendations regarding maximum film build per coat.

D. Apply paint with brush, roller, or spray equipment as directed by manufacturer's specifications; equip spray equipment with traps or separators to remove oil and condensate from air supply.

3.5 DAMAGED COATINGS

A. Damaged Coatings, Pinholes, and Holidays: Feather edges and repair in accordance with coating manufacturer's directions as reviewed by IDC.

B. Apply all finish coats, including touchup and damage repair coats in a manner which will present a uniform, color-matched appearance.

C. Factory-Finished Equipment:
   1. Touch up damaged, factory-finished equipment utilizing prime and finish materials identical to the factory-applied materials.
   2. Items which may require touchup include, but are not limited to, the following:
      a. Control equipment.
      b. Electrical equipment.
      c. Motors, drivers, pumps, and compressors of packaged mechanical equipment.
      d. Fabricator's prepainted stock items not identified in the painting schedule.

D. Touch up damaged portions of inorganic zinc-rich primed surfaces with Type P-3 primer prior to applying finish coating.

3.6 CLEANING

A. As work proceeds, promptly remove paint where spilled, splashed, or spattered.

B. During progress of work, maintain premises free of unnecessary accumulation of tools, equipment, surplus materials, and debris.

C. Collect cotton waste, cloths, and material which may constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.7 EQUIPMENT AND PIPING PAINTING SCHEDULE

A. General: Temperatures noted in item B below are maximum allowable operating temperatures and not material design temperatures.

B. Vessels and Exchangers:
   1. Insulated Carbon Steel Surfaces:
      a. 70 Degrees F and Below:
         1) Primer: P-1.
         2) Finish: none.
         3) Color: manufacturer's standard.
      b. 71 Degrees F and Above:
         1) Primer: none.
         2) Finish: none.
         3) Color: manufacturer's standard.
   2. Stainless Steel Surfaces Prior to Insulation - 800 degrees F and Below:
      a. Primer: none.
      b. Finish: F-4.
      c. Color: black.
   3. Skirts, Cradles, and Supports Which Do Not Require Fireproofing:
      a. Exterior Locations:
         1) Primer: P-2.
         2) Finish: F-1.
         3) Color: to be selected by IDC.
      b. Interior Locations:
         1) Primer: P-2.
         2) Finish: F-1.
         3) Color: to be selected by IDC.
   4. Skirts, Cradles, and Supports Which Require Fireproofing: rust-inhibiting primer approved by fireproofing manufacturer.

C. Piping and Fittings:
   1. Stainless Steel Surfaces Prior to Insulation - 800 Degrees F and Below:
      a. Primer: none.
      b. Finish: F-4.
      c. Color: black.
   2. Fire Water Piping - All Above-Grade Locations:
      a. Primer: P-1.
      b. Finish: F-1.
      c. Color: safety red.

D. Fire Equipment - Hydrants, Hose Reel Boxes, Hose Reels, Etc. (Over Manufacturer's Finish):

1. Primer: P-2.
2. Finish: F-1.
3. Color: safety red.

END OF SECTION

SECTION 10100

VISUAL DISPLAY BOARDS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Porcelain enamel markerboards (whiteboards).
   2. Tackboards.
   3. Trim, marker rail, and accessories.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for visual-display boards:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 06114 - Wood Blocking and Curbing.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 WARRANTY

A. Provide minimum 5-year warranty.

B. Warranty: Include coverage of markerboard surface from discoloration due to cleaning, crazing or cracking, staining, and warping.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Conform to applicable code for flame/fuel/smoke rating for vinyl and woven fabric-covered tackboards in accordance with FS CCC-W-408 and ASTM E84 flame tunnel test Class A rating.

B. Conform to uniformity of gloss or reflectance for markerboard surface that gloss variation does not exceed three units when measured on a 45 degree gloss meter in accordance with the Porcelain Enamel Institute Bulletin T-18 gloss test of porcelain enamels, ASTM C346.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials indoors in ventilated areas with constant minimum temperatures of 60 degrees F and maximum relative humidity of 55 percent.

1.6 SUBMITTALS

A. Provide the following within 2 weeks of Contract award:
   1. Product Data: on markerboards, tackboards, trim, and accessories.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Alliance America.

B. Carolina Chalkboard.

C. Clairidge Products and Equipment Inc.

D. Greensteel, Inc.

E. Marsh Industries, Inc.

2.2 MATERIALS

A. Steel Sheet: ASTM A424, Type I, commercial quality.

B. Aluminum Sheet: ASTM B209, 6063 alloy, T52 temper.

C. Aluminum Extrusions: ASTM B221, 6063-T5 alloy, anodized satin finish.

D. Cork: fine-grain natural cork, homogeneous composition.

E. Frame and Markerrail: Aluminum extrusions, 6061 alloy, T5 temper.

F. Tackboard Covering: FS CCC-W-408; Type III, heavy, Class 2, mildew resistant; color selected from manufacturer's standard color range.

2.3 ACCESSORIES

A. Adhesives: type recommended by manufacturer.

B. Map Supports: formed aluminum roller brackets, sliding type to fit map rail.

C. Protective Cover: sheet polyethylene, 8 mils thick.

D. Cleaning Instruction Plate: Provide instructions for markerboard cleaning on metal plate attached to perimeter frame near marker rail.

2.4 FABRICATION MARKERBOARDS (WHITEBOARDS)

A. Verify field dimensions before fabrication.

B. Outer Face Sheet: steel, 28-gauge thick.

C. Core: particleboard; 3/8 inch thick.

D. Backing Surface: steel, 28-gauge thick.

2.5 FABRICATION - TACKBOARDS

A. Outer Facing: cork, 1/4 inch thick.

B. Backing Surface: steel, 28-gauge thick.

2.6 FRAME AND TRIM

A. Frame: extruded aluminum; concealed fasteners; map rail with cork insert over whiteboard[and tackboard surfaces.

B. Marker Rail: extruded aluminum; one piece, full length of markerboard; closed-end closures; concealed fasteners.

2.7 FINISHES

A. Porcelain Enamel: glass-fibered enamel, baked to vitreous surfaces; Porcelain Enamel Institute, Type A; white color.

B. Tackboard Surface: natural light brown cork.

C. Aluminum Frame and Accessories: mill finish natural aluminum.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify that surfaces and internal wall blocking specified in Section 06114, Wood Blocking and Curbing are ready to receive work and opening dimensions are as instructed by the manufacturer.

B. Verify flat-wall surface for frameless adhesive applied type installation.

3.2 INSTALLATION

A. Install markerboards and tackboards in accordance with manufacturer's instructions.

B. Establish bottom of perimeter frame as shown on the Drawings above finished floor.

C. Secure units level and plumb.

3.3 CLEANING

A. Clean markerboard surfaces in accordance with manufacturer's instructions.

B. Cover markerboard surfaces with protective cover, taped to frame for duration of construction.

C. Remove protective cover at Date of Substantial Completion.

END OF SECTION

SECTION 10522

FIRE EXTINGUISHERS, CABINETS, AND ACCESSORIES

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Fire extinguishers.
   2. Accessories.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for fire extinguishers, cabinets and accessories:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 06114 - Wood Blocking and Curbing.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 STANDARDS

A. Work included in this Section shall conform to the following, except specified otherwise within this Section:
   1. ADAAG - Americans with Disabilities Act Accessibility Guidelines.
   2. FM - Factory Mutual System Materials Approval Guide.
   3. NFPA 10 - Standard for Portable Fire Extinguishers.
   4. UL - Fire Protection Equipment Directory.

1.4 QUALITY ASSURANCE

A. Conform to NFPA 10 requirements for extinguishers.

B. Provide fire extinguishers, cabinets, and accessories from a single manufacturer unless otherwise indicated in schedule.

C. Fire Extinguishers: classified and labeled by Underwriters Laboratories Inc. for purpose specified and indicated.

D. Conform to ASTM E119 and ASTM E814 for fire wall performance where required.

E. Conform to ADAAG for cabinet installation and mounting height requirements.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not install extinguishers when ambient temperature is capable of freezing extinguisher ingredients.

1.6 SUBMITTALS

A. Provide the following within 4 weeks of Contract award:
1. Product Data: provide manufacturer's printed information for extinguisher, cabinet, and accessories, color and finish, and anchorage devices for specified models.

1.7 OPERATION AND MAINTENANCE DATA

A. Include test, refill or recharge schedules, procedures, and recertification requirements.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Portable Fire Extinguishers:
1. Amerex.
2. Ansul Incorporated.
3. General Fire Extinguisher Corp.
4. Potter-Roemer.
5. Walter Kidde Fire Extinguishers.

2.2 EXTINGUISHERS

~~A. Water Type:~~

~~B.~~A. Multipurpose Dry Chemical Type:
1. Comply with UL 299; stainless steel tank with pressure gauge; size and classification as scheduled.

B. Carbon Dioxide Type:
1. Comply with UL 154; stainless steel tank with pressure gauge; size and classification as scheduled.

2.3 ACCESSORIES

A. Fire Extinguisher Brackets: where no cabinet is provided, heavy-duty brackets with clip-together strap for wall-mounted hand extinguishers.

2.4 FINISHES

A. Fire Extinguisher: red enamel.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify wood backing specified in Section 06114, Wood Blocking and Curbing is installed in correct locations.

B. Verify servicing, charging, and tagging of all items.

C. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

A. Install extinguishers plumb and level on wall surfaces as shown on the Drawings.

3.3 SCHEDULE

Mark	Class	Extinguisher UL Rating	Size	Type	Cabinet Model No. (by J.L. Industries)	Finish	Door
FE-1	Multipurpose Dry Chemical	4A-60 B:C	10 pounds	Bracket-Mounted	MB 846	--	--
FE-2	CO_2	10 B:C	10 pounds	Bracket-Mounted	-	--	--

END OF SECTION

SECTION 12352

LABORATORY CASEWORK AND EQUIPMENT

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Laboratory Casework.
   2. Laboratory work surfaces and accessories
   3. Fume Hoods and accessories

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for Laboratory Equipment:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 06100 - Rough Carpentry
   4. Section 06114 - Wood Blocking and Curbing
   5. Section 07213 – Batt and Blanket Insulation
   ~~5.~~6. Section 07900 - Joint Sealers
   ~~6.~~7. Section 09260 - Gypsum Board Assemblies
   ~~7.~~8. Section 09650 - Resilient Flooring
   ~~8.~~9. Section 13051 - Cleanroom Wall Assemblies
   ~~9.~~10. Section 15120 Piping Specialties
   ~~10.~~11. Section 15440 Plumbing Fixtures
   ~~11.~~12. Division 16 sections included in the project specifications.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 STANDARDS

A. Conform to the following, unless specified otherwise within this Section:
   1. SEFA 1.2 – Laboratory Fume Hoods.
   2. SEFA 2.3 – Installation of Scientific Laboratory Furniture and Equipment
   3. SEFA 3 – Work Surfaces
   4. SEFA 7 – Laboratory and Hospital Fixtures
   5. SEFA 8 – Laboratory Furniture

1.4 QUALITY ASSURANCE

A. Manufacturer: company specializing in the manufacture of laboratory furniture systems, casework, work surfaces, chemical fume hoods and laboratory accessories with a minimum of five year' experience.

B. Installer: company with 3 years' minimum experience and approved by the laboratory equipment manufacturer.

1.5 COORDINATION

A. Coordinate the work of this Section with Sections: 06100, Rough Carpentry, 06114, Wood Blocking and Curbing, 07213, Batt and Blanket Insulation, 07900, Joint Sealers, 09260, Gypsum Board Assemblies, 09650, Resilient Flooring, and 13051, Cleanroom Wall Assemblies.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver or install equipment until the following conditions have been met:
   1. Windows and doors are installed.
   2. Ceilings, overhead ductwork and lighting are installed.
   3. All painting is completed and finished flooring is installed.

B. Allow equipment to sit in conditioned space for a minimum of 72 hours prior to installation.

1.7 SUBMITTALS

A. Provide the following within 3 weeks of contract award:
   1. Shop Drawings: Provide 3/4 inch equal to 1 foot scale plans, elevations and sections indicating all components, rough-in and anchor placements, tolerances and clearances.
   2. Factory certification for Fume Hoods exhibiting compliance with ASHRAE 110-1995.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Casework
   1. Kewaunee Scientific Corporation
   2. Fisher Hamilton, LLC

B. Work surfaces
1. Kewaunee Scientific Corporation
2. Fisher Hamilton, LLC

C. Fume Hoods
1. TFI Inline Design
2. Fisher Hamilton

D. Fume Hood manufacturers listed above ~~is~~ are classified as sole source.

2.2 MATERIALS

A. Casework
1. Hardwood: Kiln dried hardwood, clear and free of defects; red oak or maple for exposed components.
2. Plywood: Veneer core 7-ply hardwood plywood for cabinet body.
3. Exposed face veneers: plain sliced or rift cut red oak
4. Semi-exposed or unexposed face veneers: same species as exposed veneer to provide balanced construction.
5. Banding: hardwood edge banding to match veneer door and drawer fronts.
6. Glass: as specified in Section 08800, Glazing.
7. Glue: laminating glue - type II water-resistant; assembly glue – type III water resistant.

B. Work surfaces
1. Fabricate to receive accessories as shown on the Drawings.
2. Cellulose fiber reinforced phenolic core with crosslinked polyurethane copolymer surface.
3. Dimensions: as shown in the Casework Schedule on the Drawings.
4. Thickness: 1 inch
5. Curb: 4 inches, unless shown otherwise on the Drawings, integral of same material and thickness as work surface
6. Finish: matte.
7. Color: black.

C. Fume Hoods (Vertical Laminar Flow manufactured by TFI Inline Design)
1. Type: Vertical laminar flow with 99.9% efficient ULPA filter – non boron containing composition.
2. Superstructure: White Polypropylene.
3. Work surface: White Polypropylene.
4. Sash: 3/8” clear non-staining, scratch and chalk resistant, polycarbonate.
   a. Track: High density polethylene
   b. Cable: .060 braided polyester.
   c. Pulleys: high density polyethylene.

d. Counter weights: steel sealed in polyproylene
e. Washers: Teflon®.

5. Dimensions: As shown in the Equipment schedule on the Drawings.
6. Base cabinets: Polypropylene vented to hood plenum; sized as shown on the Drawings.
7. Accessories:
   a. Polypropylene Pot sink or Cup sink as follows:
      1) VLF-FH1 - High Level Lab Acid Hood -- 12" wide, 12" long, 6" deep, with building DI supply to tap on hood side wall above, valve on hood face. Location - left side. DI gun mounted on left side of hood.
      2) VLF-FH5 - Low Level Lab Acid Hood -- 12" wide, 12" long, 6" deep, with building DI supply to tap on hood side wall above, valve on hood face, Location - left side. DI gun mounted on left side of hood.
      3) VLF-FH4 – Production Wash Hood -- 14" wide, 18" long, 3" deep, with building DI supply to tap on hood side wall above, valve on hood face, Location - right side. DI gun mounted on right side of hood.
      4) VLF-FH2 – Production Acid Hood – NO SINK, provide drainage only. DI gun mounted on right side of hood.
      5) VLF-FH3 – Production Column Hood – one small cup sink with building DI supply to tap on hood side wall above, valve on hood face. Location – left side. DI gun mounted on left side of hood.
   b. Polypropylene goose neck faucet as shown on the Drawings.
   c. Teflon Deionized water spray gun.
      1) Acceptable Manufactures:
         a) Teqcom Industries, Inc.
         b) Or other approved
      2) Description: PTFE Spray Gun and accessories, Teqcom Industries Inc. TA-SG-103, ½" FNPT inlet threads, Ethylene Propylene O-Rings.
   d. Individually switched GFI duplex receptacles on each side of hood.
   e. Work surface lighting.
   f. Provide "PERCHLORIC ACID HOOD" label to all acid hoods listed above.
   g. Provide blocking for the following hoods for ultra-pure system installation:
      1) VLF-FH5 – Production Wash Hood, right side;
      2) VLF-FH6 – Low Level Lab Acid Hood, left side;
      3) VLF-FH6 – High Level Lab Acid Hood, left side.

D. Fume Hood (Perchloric Acid Restricted Bypass Superstructure manufactured by Fisher Hamilton). Provide polypropylene fume hood alternate, same size and assembly requirements as shown below, as manufactured by TFI Inline design or equivalent. Fume hood to be furnished and installed must have Factory certification for Fume Hoods exhibiting compliance with ASHRAE 110-1995.

1. Type: Perchloric Acid Restricted Bypass – Constant Volume Exhaust System. Pre-piped down and pre-wired.
2. Dimensions: 4'-0" (W).
3. Superstructure: Rigid, self supporting assembly of double walll construction of 304 Stainless Steel.
4. Work surface: 304 Stainless Steel, joints coved, welded and ground with dished work surface.
5. Liner: ~~Type "K"~~ Seamless Stainless Steel, 16 gauge type 304, #4 grind, fully coved and furnished without access panels with Teflon coating throughout. Hood chemical use to include Hydroflouric and Hydrochloric acids.
6. Exhaust Outlet: 18 gauge stainless steel exhaust collars.
7. Blower: Coordinate blower requirements with mechanical (HVAC) contractor.
8. Sash: Standard vertical rising
   a. 7/32-inch ~~laminated safety glass.~~polycarbonate.
   b. Guides: Corrosion resistant poly-vinyl chloride.
   c. Cables: Stainless steel, uncoated, 1/8-inch military spec. quality (MIL-W-83420D-3).
   d. Pulleys: 2 inch diameter, zinc dichromate finish, ball bearing type, with cable retaining device.
   e. Pulls: Full width corrosion resistant stainless steel
   f. Counter weights: steel sealed in polyproylene
   g. Gaskets: 70 durometer PVC
9. Base cabinets: Stainless Steel by hood manufacturer. Product number: 950B2400
10. Accessories:
    a. Cup Sink (3" x 6") at left side of hood.
    b. Pre-pipe hood for fire protection connection at left side of hood. Coordinate pipe size with fire protection contractor.
    c. Concealed interior fastening devices.
    d. Exterior panel member fastening devices to be corrosion resistant, non-metallic material. Eposed screws are not acceptable.
    e. Instruction plate: Corrosion resistant or plastic plate attached to the fume hood exterior with condensed information covering recommended locations for apparatus and accessories, baffle settings and use of sash.
    f. Water washdown system: 4 each plastic fog nozzles, internal piping, control valve and two 1 ½-inch waste outlets.
    g. Services: DI water, potable water, and vacuum.

h. Service fixtures and fittings: Color coded washers at hose nozzle outlets and valves mounted inside the fume hood and controlled from the exterior with color coded index handles.
1) Valves: Needle point type with self-centering cone tip and seat of hardened stainless steel. Tip and seat shall be removable and replaceable.
2) Provide piping for all service fixtures from valve to outlet: Galvanized iron or copper for water, air and vacuum and polypropylene for DI services.
3) Fixtures exposed to hood interior: Brass with chemically resistant black powder coating.

i. Light fixture: Pre-wired incandescent vapor proof, fume resistant and UL listed, installed in roof with bulb replacement from interior.

j. Electrical services: Provide pre-wired fume hood with two - Three wire grounding type receptacles rated at 120 V.A.C. at 20 amperes. Flush plates: Black acid resistant thermoplastic.

k. Safety monitor: UL listed, tamper proof, with all alarm circuits, electric components, external tubing, and manifolds furnished complete and factory installed. The monitor shall have light emitting diode display which provides clear indication of airflow conditions.
1) Calibration is the responsibility of the owner and is required once the hood is stationed and the hood exhaust and room supply systems are balanced. A secondary calibration has been factory set into the alarm's memory only to determine that the alarm is functional and ready for shipment. **The primary calibration must be completed in the field.**
2) Airflow sensor: Thermally compensated glass-beaded thermistor, factory connected to a side-wall port on the interior of the fume hood.
3) Alarm Signal: Audible signal and a visual, red large light emitting diode:
a) Silence pushbutton, which disables the audible alarm, shall be accessible on the front of the safety monitor.
b) Provide alternate mode in which audible alarm is silenced indefinitely but visual alarm remains activated until the alarm condition is corrected.
c) When alarm condition is corrected and face velocity and volume return to specified levels, the Safety Monitor will automatically reset and begin routine monitoring.
4) Provide test circuit to verify proper Safety Monitor operation
5) Electrical rating: Maximum 12 VDC, and maximum current rating of 200MA.
6) Baffle adjustment: Non-adjustable.

l. Provide "PERCHLORIC ACID HOOD" label to all acid hoods listed above.

2.3 FABRICATION

1. Casework General: The cabinet shall be radius lip, semi-overlay. Edges of door and drawer fronts shall be radiused. All cabinet end panels shall be finished for the purpose of future relocation. The exposed grain for doors shall run vertical; exposed grain for drawer fronts shall run horizontal.
2. Base Cabinets:
   a. End Panels, Bottoms, and Shelves:
      1) All cabinet end panels shall be ¾" thick Red Oak veneer core plywood edge banded on exposed edges.
      2) End panels shall be multiple doweled, glued, and screwed to top frame members, intermediate rails, and bottoms.
      3) Cupboard bottoms shall be ¾" thick Red Oak veneer core plywood edge banded on exposed edge.
      4) All cupboard base cabinet shelves shall be full-width adjustable, ¾" thick Red Oak veneer core plywood edge banded on exposed edge.
      5) Integrally joined parts shall result in a totally enclosed cabinet.
   b. Backs:
      1) Cabinet backs shall be ¼" thick hardboard, dadoed into end panels and securely fastened to cabinet bottom and top back rail. Backs that are attached to end panels with cleats shall be unacceptable.
   c. Top Frame:
      1) The cabinet top frame shall consist of a front rail and a back rail. The front rail shall be 3-1/8" x 1" hardwood with 3mm Red Oak facing. The back rail shall be 2-1/2" x ¾" hardwood plywood.
   d. Intermediate Rails:
      1) Intermediate rails shall be 3-1/4" x ¾" hardwood plywood edge banded on exposed edge.
      2) Rails shall be multiple doweled and screwed to end panels.
      3) Intermediate rails shall be mounted at the front between the drawers and between all drawers and doors.
   e. Drawers:
      1) Drawers with Hardboard Bottom:
         a) Drawer sides, back, and sub-front shall be ½" thick, 9-ply Birch plywood.

b) Drawer heads shall be ¾" thick, solid Red Oak. A dovetail joint shall be used to attach the drawer sub-front and drawer back to the drawer sides.
c) Drawer bottoms shall be ¼" thick hardboard, set and hot-melt glued into ¼" grooves, four sides.
d) Each drawer shall have one pull mounted horizontally, drawers over 24" long shall have two pulls.
e) Drawer sub-fronts attached to drawer sides with a lock-tenon joint shall be unacceptable

f. Doors:
1) Swinging doors shall be ¾", Red Oak, core banded composite core plywood, mounted on cabinet with 1 pair of offset hinges and shall be latched with a roller catch.
2) Double doors shall have a roller catch on each door and a Red Oak astragal mounted to the left-hand door. Each door shall have one pull mounted vertically.
3) Locks, when required on double doors, shall be mounted on the right-hand door.

3. Open-leg Tables:
a. Legs shall be Red Oak, 2-1/2" square with all corners radiused ¼".
b. Legs shall be secured to the apron frame by a heavy duty corner bolt and a 14-gauge metal corner brace. Corner braces shall be locked into apron rails by accurately located grooves and shall be securely fastened with screws.
c. All apron rails exposed to view shall be ¾" thick, Red Oak, lumber core plywood.

4. Worksurfaces
a. Materials: Modified epoxy resin, or cellulose fiber reinforced phenolic core with crosslinked polyurethane copolymer surface
b. Color: Black
c. Finsh: Matte (non-glaring)
d. Edges: Marine edged top and beveled bottom with drip grooves on the underside of all exposed edges.
e. Sink cutouts: were shown on the Drawings. Edges shall be smooth and uniform with top edge beveled. Corners shall be radiused no less than ¾ inch.
f. Performance Requirements:
1) Physical Properties:
Flexural Strength (A.S.T.M. Method D790-90) = 15,000 PSI
Compressive Strength (A.S.T.M. MethodD695-90) = 30,000 PSI
Hardness, Rockwell E (A.S.T.M. Method D785-89) = 100
Water Absorption (A.S.T.M. Method D570-81)% by weight, 24 Hours = 0.04

% by weight, 7 Days = 0.05
% by weight, 2 Hour Boil = 0.04
Specific Gravity = 1.97
Tensile Strength = 8,500 PSI

g. Performance Test Results (Heat Resistance):
A high form porcelain crucible, size 0, 15 ml capacity, shall be heated over a Bunsen burner until the crucible bottom attains an incipient red heat. Immediately, the hot crucible shall be transferred to the top surface and allowed to cool to room temperature. Upon removal of the cooled crucible, there shall be no blisters, cracks or any breakdown of the top surface whatsoever.

h. Performance Test Results (Chemical Resistance):
Tops shall resist chemical attacks from normally used laboratory reagents. Weight change of top samples submerged in the reagents* listed in the next paragraph for a period of seven (7) days shall be less than one-tenth of one percent, except that the weight change for those reagents marked with ** shall be less than one percent. (Tests shall be performed in accordance with A.S.T.M. Method D543-67 at 77o F.).

*Where concentrations are indicated, percentages are by weight.

Acetic Acid, Glacial	Iso-Octane
Acetic Acid,5%	Kerosene
Acetone	Methyl Alcohol
Ammonium Hydroxide,28%	Mineral Oil
Ammonium Hydroxide,10%	Methyl Ethyl Ketone
Aniline Oil	Nitric Acid,70%**
Benzene	Nitric Acid,40%
Carbon Tetrachloride	Nitric Acid,10%
Chromic Acid,40%**	Oleic Acid
Citric Acid, 10%	Olive Oil
Cottonseed Oil	Phenol,5%
Dichromate Cleaning Solution**	Soap Solution,1%
Diethyl Ether	Sodium Carbonate,20%
Dimethyl Formamide	Sodium Carbonate, 2%
Distilled Water	Sodium Chloride,10%
Detergent Solution,1/4%	Sodium Hydroxide, 50%
Ethyl Acetate	Sodium Hydroxide, 10%
Ethyl Alcohol, 95%	Sodium Hydroxide, 1%
Ethyl Alcohol, 50%	Sodium Hypochlorite,5%
Ethylene Dichloride	Sulfuric Acid, 85%
Heptane	Sulfuric Acid, 30%

Hydrochloric Acid, 37%	Sulfuric Acid, 3%
Hydrochloric Acid, 10%	Toluene
Hydrogen Peroxide, 28%	Transformer Oil
Hydrogen Peroxide, 3%	Turpentine

NOTE: Dichromate cleaning solution is a formula from Lange's Handbook of Chemistry.

i. Performance Test Results (Chemical Spot Tests – 24 Hours): Chemical spot tests shall be made by applying 10 drops (approximately ½ cc) of each reagent to the surface to be tested. Each reagent (except those marked **) shall be covered with a 1-1/2" diameter watch glass, convex side down to confine the reagent. Spot tests of volatile solvents marked ** shall be tested as follows: A 1" or larger ball of cotton shall be saturated with the solvent and placed on the surfaces to be tested. The cotton ball shall then be covered by an inverted 2-ounce, wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire 24-hour test period and at a temperature of 77 degrees F. + 3 degrees F. At the end of the test period, the reagents shall be flushed from the surfaces with water and the surface scrubbed with a soft bristle brush under running water, rinsed, and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Spots where dyes have dried shall be cleaned with a cotton swab soaked in alcohol to remove the surface dye. The test panel shall then be evaluated immediately after drying.

Ratings:
A = No effect or slight change in gloss.
B = Slight change in color or marked loss of gloss.
C = Slight surface etching or severe staining.
D = Swelling, pitting, or severe etching.

Reagents*	Rating
Acetic Acid, 98%	A
Acetone**	A
Ammonium Hydroxide, 28%	A
Carbon Tetrachloride**	A
Chloroform**	A
Chromic Acid, 60%	C
Chromic Acid, 40%	C
Dichromate Cleaning Solution***	C
Dimethyl Formamide	A

Ethyl Acetate**	A
Ethyl Alcohol**	A
Formaldehyde, 37%	A
Formic Acid, 90%	A
Hydrochloric Acid, 37%	A
Hydrofluoric Acid, 48%	C
Hydrogen Peroxide, 28%	A
Methanol**	A
Methylethyl Ketone**	A
Nitric Acid, 70%	B
Phenol, 85%	A
Phosphoric Acid, 85%	A
Sodium Carbonate, 20%	A
Sodium Hydroxide, 40%	A
Sodium Hydroxide, 10%	A
Sodium Hypochlorite, 5%	A
Sulfuric Acid, 96%	D
Sulfuric Acid, 85%	A
Toluene**	A
Wrights Blood Stain	A
Xylene**	A

I–□ Where concentrations are indicated, percentages are by weight.
** Indicates these solvents tested with cotton and jar method.

j. *** Dichromate cleaning solution is a formula from Lange's Handbook of Chemistry.

2.4 ACCESSORIES

A. Casework:
   1. Hinges: Stainless steel.
   2. Pulls: Rounded aluminum

B. Worksurfaces:
   1. Sinks: Molded modified Epoxy Resin with integral drain board sloped to basin.
      a. Color: Black
   2. Polyethylene Cup Drains:
      Molded polyethylene cup drains shall be molded in one-piece of acid-resistant polyethylene with an integral mounting flange and an integral tailpiece with an 1-1/2" I.P.S. male straight thread outlet.

3. Electrical fixtures: Coordinate with Division 16 Sections included with the Specifications and the Drawings.
4. Service Fittings and accessories: Plastic-coated red brass or bronze and as specified in Section 15440, Plumbing Fixtures.
5. Laboratory Gas Turrets: See Section 15120 Piping Specialties

2.5 FINISHES

A. Environmental Standards:
1. The wood finish must be low VOC.

B. Wood Surface Preparation:
1. Prior to application of wood finish, all cabinet component surfaces shall be sanded smooth to remove loose fibers, scratch marks, and abrasions, with all dust thoroughly removed.
2. Interior Wood Casework Finish:
a. Interior surfaces shall receive two applications of chemical-resistant, UV cured, epoxy top coat. The first application will be cured, sanded, and cleaned. The final top coat will then be applied and fully cured.
3. Exterior Wood Casework Finish:
a. Exposed exterior surfaces, and interiors of glazed cabinets and open cabinets shall be stained and additionally sealed with two applications of chemical-resistant epoxy top coat.

C. Performance Test Results (Chemical Spot Tests):
1. Testing Procedure:
Chemical spot tests for non-volatile chemicals shall be made by applying 5 drops of each reagent to the surface to be tested and covering with a 1-1/4" dia. Watch glass, convex side down to confine the reagent. Spot tests of volatile chemicals shall be tested by placing a cotton ball saturated with reagent on the surface to be tested and covering with an inverted 2-ounce wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire test period, and at a temperature of 77° ±3° F. For both methods, leave the reagents on the panel for a period of one hour. At the end of the test period, the reagents shall be flushed from the surface with water, and the surface scrubbed with a soft bristle brush under running water, rinsed and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Immediately prior to evaluation, 16 to 24 hours after the reagents are removed, the test surface shall be scrubbed with a damp paper towel and dried with paper towels.
2. Test Evaluation: Evaluation shall be based on the following rating system.
a. Level 0 – No detectable change

b. Level 1 – Slight change in color or gloss
c. Level 2 – Slight surface etching or severe staining
d. Level 3 – Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration
e. After testing, panel shall show no more than three (3) Level 3 conditions.

3. Test Reagents:

Test No.	Chemical Reagent	Test Method
1.	Acetate, Amyl	Cotton ball & bottle
2.	Acetate, Ethyl	Cotton ball & bottle
3.	Acetic Acid, 98%	Watch glass
4.	Acetone	Cotton ball & bottle
5.	Acid Dichromate, 5%	Watch glass
6.	Alcohol, Butyl	Cotton ball & bottle
7.	Alcohol, Ethyl	Cotton ball & bottle
8.	Alcohol, Methyl	Cotton ball & bottle
9.	Ammonium Hydroxide, 28%	Watch glass
10.	Benzene	Cotton ball & bottle
11.	Carbon Tetrachloride	Cotton ball & bottle
12.	Chloroform	Cotton ball & bottle
13.	Chromic Acid, 60%	Watch glass
14.	Cresol	Cotton ball & bottle
15.	Dichlor Acetic Acid	Cotton ball & bottle
16.	Dimethylformanide	Cotton ball & bottle
17.	Dioxane	Cotton ball & bottle
18.	Ethyl Ether	Cotton ball & bottle
19.	Formaldehyde, 37%	Cotton ball & bottle
20.	Formic Acid, 90%	Watch glass
21.	Furfural	Cotton ball & bottle
22.	Gasoline	Cotton ball & bottle
23.	Hydrochloric Acid, 37%	Watch glass
24.	Hydrofluoric Acid, 48%	Watch glass
25.	Hydrogen Peroxide, 3%	Watch glass
26.	Iodine, Tincture of	Watch glass
27.	Methyl Ethyl Ketone	Cotton ball & bottle
28.	Methylene Cloride	Cotton ball & bottle
29.	Mono Chlorobenzene	Cotton ball & bottle
30.	Naphthalene	Cotton ball & bottle
31.	Nitric Acid, 20%	Watch glass
32.	Nitric Acid, 30%	Watch glass
33.	Nitric Acid, 70%	Watch glass
34.	Phenol, 90%	Cotton ball & bottle
35.	Phosphoric Acid, 85%	Watch glass
36.	Silver Nitrate, Saturated	Watch glass

37.	Sodium Hydroxide, 10%	Watch glass
38.	Sodium Hydroxide, 20%	Watch glass
39.	Sodium Hydroxide, 40%	Watch glass
40.	Sodium Hydroxide, Flake	Watch glass
41.	Sodium Sulfide, Saturated	Watch glass
42.	Sulfuric Acid, 33%	Watch glass
43.	Sulfuric Acid, 77%	Watch glass
44.	Sulfuric Acid, 96%	Watch glass
45.	Sulfuric Acid, 77% and Nitric Acid, 70%, equal parts	Watch glass
46.	Toluene	Cotton ball & bottle
47.	Trichloroethylene	Cotton ball & bottle
48.	Xylene	Cotton ball & bottle
49.	Zinc Chloride, Saturated	Watch glass

* Where concentrations are indicated, percentages are by weight.

4. Performance Test Results (Heat Resistance):
   a. Hot water (190° F – 205° F) shall be allowed to trickle (with a steady stream at a rate not less than 6 ounces per minute) on the finished surface, which shall be set at an angle of 45° from horizontal, for a period of five minutes. After cooling and wiping dry, the finish shall show no visible effect from the hot water treatment.
5. Performance Test Results (Moisture Resistance):
   a. A cellulose sponge (2" x 3" x 1") shall be soaked with water and placed on the finished surface for a period of 100 hours. The sponge shall be maintained in a wet condition throughout the entire test period. At the end of the test period, the surface shall be dried and no visible effect shall be shown on the finish.
6. Performance Test Results (Impact Resistance):
7. A one-pound ball (approximately 2" diameter) shall be dropped from a distance of 12 inches onto the finished surface of a ¾" thick plywood panel supported underneath by a solid surface. There shall be no evidence of cracks or checks in the finish due to impact upon close eye-ball examination.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine all equipment for damage immediately upon receipt of shipment.

B. Contractor shall immediately notify Owner of any equipment damage

3.2 FIELD PREPARATION

A. Prior to beginning installation of casework, check and verify that no irregularities exist that would affect quality of execution of work specified..

3.3 INSTALLATION

A. Coordination: Coordinate the work of this Section with the schedule and other requirements of other work being performed in the area at the same time both with regard to mechanical and electrical connections to and in the fume hoods and the general construction work.

B. Casework:
   1. Set casework components plumb, square, and straight with no distortion and securely anchor to wall system. Shim as required using concealed shims.
   2. Screw continuous cabinets together with joints flush, tight and uniform, and with alignment of adjacent units within 1/16” tolerance.
   3. Abut top edge surfaces in one true plane. Provide flush joints not to exceed 1/8” between top units.

C. Worksurfaces:
   1. Where required due to field conditions, scribe to abutting surfaces.
   2. Only factory prepared field joints, located per approved shop drawings, shall be permitted. Secure the joints in the field, where practical, in the same manner as in the factory.
   3. Secure work surfaces to casework and equipment components with materials and procedures recommended by the manufacturer.

3.4 FIELD QUALITY CONTROL

A. As listed in Section 01355, Cleanroom Protocol.

3.5 ADJUSTING AND CLEANING

A. Repair or remove and replace defective work, as directed by owner and/or his representative upon completion of installation.

B. Adjust doors, drawers and other moving or operating parts to function smoothly.

C. Clean shop finished casework; touch up as required.

D. Clean work surfaces and leave them free of grease and streaks.

E. Casework to be left broom clean and orderly.

3.6 TESTING

A. On-site certification and testing of the fume hoods, with a minimum of the following being performed:
   1. Check supply filters using aerosol test challenge technique.
   2. Check downflow velocity profile within the cabinet.
   3. Check cabinet work access opening airflow by measuring exhaust volume.
   4. Check airflow within the cabinet using smoke patterns.

B. Coordinate on-site testing with Owner for representation by University Risk Management personnel.

3.7 SCHEDULE

Qty.	Item	Manufacturer	Model Number	Notes
4	Balance			Owner Ordered
3	Centrifuge	IEC-Cl2	05-101-7	Owner Ordered
3	Drying Oven	Sheldon Mfg., Inc.	CE5G	Owner Ordered
3	Vortexer	VWR (75 watts)	12620-838	Owner Ordered
2	Glove Box	Terra Universal	3305-00C	Ordered by project Light and ionizer bars
2	Ultrasound (Large)	Branson	8510	Owner Ordered
2	DI Polishers	Millipore		Ordered by project
2	Heat Blocks (used in hood)	VWR	12621-088	Owner Ordered
1	Ionizer	METTLER TOLEDO U Ionizer and Point Ionizer	U Ionizer and power supply	Owner Ordered
5	Hot Plates	Most likely Presto, custom controller outside of hoods, mounted on hood wall	1000-1500 watts	Owner Ordered
1	Marble Table	VWR (700 pounds)	12568-004	Owner Ordered
2	Desk top PC	Macintosh	I-Mac 17” screen	
2	Laser Printers	HP (Hewlett-Packard)	LaserJet 1020	Owner Ordered
1	Notebook PC	Macintosh	Powerbook G4	Owner Ordered
1	Stereo System	Sony	LBT-ZX8OD	Owner Ordered

1	Espresso Maker	Briel – Chamonix	ES35AFB	Owner Ordered
3	Task Lights	iHome / iPod Docking Speaker Desk Lamp	IHL10-Black	Owner Ordered
2	Benchtop Mobile Fume Hoods	Lake Charles Manufacturing	244-0001	Ordered by project

END OF SECTION

SECTION 12485

ENTRANCE FOOT GRILLES AND MATS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Aluminum and vinyl abrasive tread rail foot grille.
   2. Adhesive (Tacky) mat and frames.
   3. Surface positioned.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for entrance foot grilles and mats:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Room Finish Schedule as shown on the Drawings.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 QUALIFICATIONS

A. Manufacturer: company specializing in the manufacture of products specified in this Section with minimum 3 years' documented experience.

B. Installer: company specializing in applying the work of this Section with minimum 3 years' documented experience.

1.4 SUBMITTALS

A. Provide the following within 4 weeks of Contract award:
   1. Product Data: indicating grille and tacky mat characteristics, component dimensions, frame, and details.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit manufacturer's standard warranties, recommended cleaning instructions, stain removal procedures, and cleaning materials, polishes, and waxes.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Foot Grilles:
1. Balco Metalines.
2. Construction Specialties Inc.
3. Pawling Corporation.

B. Adhesive (Tacky) Mats and Frame:
1. Liberty Industries.
2. Markel Industries, Inc.
3. Value-Tek

2.2 MATERIALS

A. Foot Grilles:
1. Grid Tread Rails: aluminum tread rails of 6063-T52 alloy, structurally joined to aluminum key lock bars of 6061-T6 alloy spaced 1-1/2 inches on center; finish mill.
2. Grid Treads: vinyl; color grey; treads locked and mechanically secured in the tread rails.
3. Frame: extruded aluminum ramp type; size 24 inches by 36 inches.

B. Adhesive (Tacky) Mats:
1. Adhesive (Tacky) Mat: 24 inches by 36 inches; 1.5 mil polyethylene film with high tack adhesive.
2. Frame: extruded aluminum ramp type; size per manufacturer standard for tacky mat size indicated; non-skid backing.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify that floor is clean and level and ready to receive work.

B. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

A. Surface-Mounted Grille and Mat:
   1. Place frame on the surface ensuring all corners are abutted and square in locations noted on Drawings.
   2. Follow manufacturer's installation instructions provided with each shipment.
   3. Coordinate the top of mat and grille or frame surfaces with doors in egress operation which swing across the area to provide underdoor clearance.

END OF SECTION

SECTION 13051

CLEANROOM WALL ASSEMBLIES

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install complete cleanroom wall assemblies as indicated in the data sheets at the end of this Section. The extent of the work is indicated on the Drawings and by wall type designations. Work includes the following:
   1. Frame-supported and furred cleanroom wall assemblies: including required components such as clips, anchors, screws, attachments, and supports which will provide a complete cleanroom walls.
   2. Cleanroom wall panel material, with paint, coating, or finish.
   3. Reinforcing, bracing, blocking, trim-finishing strips, and nonoutgassing-type gasketing necessary to maintain the structural and air sealing requirements of the assembly.
   4. Lateral bracing of all portions of the support system.
   5. Cleaning prior to, during, and after wall system installation for cleanroom contamination control.
   6. Glass.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specification and related Contract Documents to establish the total requirements for the referenced cleanroom wall system:
   1. The Contract.
   2. Division 1 sections included in the project specifications.
   3. Section 06100 – Rough Carpentry
   4. Door Schedule as shown on the Drawings.
   5. Section 08462 - Automatic Sliding Entrance Doors.
   6. Section 08800 - Glazing.
   7. Room Finish Schedule as shown on the Drawings.
   8. Section 09915 - Building Painting.

B. CAUTION: Use of this Section without including the above-listed item results in omission of basic requirements.

1.3 DESIGN CRITERIA

A. Seismic: Conform with project design criteria.

B. Vertical Loading: Dead load equals component weight.

C. Bending Design Pressure: 1 psf for bending stress.

D. Stiffness: L/120 at 5 psf, L/600 at 1 psf.

1.4 WARRANTY

A. Provide the following:
   1. Prior to starting work, submit sample copy of guarantee to be provided. Upon completion and acceptance of the work required by this Section, submit an executed copy of the guarantee.

1.5 QUALITY ASSURANCE

A. Contractor Qualifications: trained and approved by the separate wall component manufacturers and shall be experienced in the installation of cleanroom wall systems.

B. Contractor shall be responsible for coordination with the work of the sections stated in Related Work paragraph.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Clean wall assembly components at the factory to comply with Section 01355, Clean Zone General Requirements, double wrapped and sealed with clear plastic packaging and unwrapped only at direction of the Clean Zone director.

B. Deliver materials in their original unopened packages.

C. Exercise extreme care in handling partition components to prevent damage.

D. Store materials within the building in space designated by the Owner.

E. Store materials in such manner as to prevent damage or intrusion of foreign matter. Conspicuously mark "rejected" on materials that have been damaged and remove them from the jobsite.

1.7 SUBMITTALS

A. Provide the following within 3 weeks of award of Contract:

1. Manufacturer's Data: Provide manufacturer's literature, specifications, and installation instructions for each cleanroom wall component proposed for use, including certification and other data as may be required to show compliance with the Specifications.
2. Sample copy of manufacturer's product warranty.
3. Samples:
   a. Provide samples of wall assembly components with specified finish, gaskets, connectors, and other components necessary to illustrate a complete wall assembly.
   b. Samples for each finish and color required. Provide sample finishes on aluminum having the specified alloy, temper, finish coating, and thickness of metal required for the work. Provide 12-inch-square sections. Samples will be reviewed for color and finish only.

B. Provide the following when available:
1. Operation and Maintenance Manuals: Provide assembled and bound maintenance manuals, describing the materials, devices, and procedures to be followed in cleaning and maintaining the cleanroom wall system. Include manufacturer's brochures describing the actual materials used in the work, including metal alloys, finishes, sealants, gaskets, and other major components, as well as methods of disassembly and reassembly.
2. Executed copy of manufacturer's product warranty.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Cleanroom Wall System:
1. ASD.
2. Channel Systems Inc.
3. Gordon.
4. LSI.
5. Plascore Inc.
6. Porta-fab.

B. The use of a manufacturer's name, model, or catalog number in the Specifications and on the Drawings is for the purpose of establishing the standard of quality and general configuration only. Wall products from one of the other listed manufacturers that comply with the specifications are also acceptable.

2.2 MATERIALS

A. Metal Framing:
1. Steel: ASTM A570, Grade 33.
2. Aluminum: ASTM B221, 6063T6 alloy.
3. Stainless steel: ASTM A167, Type 304.

B. Wall Panels:
1. Sheet Aluminum: 0.032 inch minimum thickness, laminated to aluminum honeycomb core with no exposed fasteners.
2. Panel size and configuration as indicated with an allowable width tolerance of plus zero inches, minus 0.015 inch.
3. Aluminum Panel thickness: 1/4 inch and 1/2 inch~~with 3/8 O.S.B. backing as specified in Section 06100, Rough Carpentry~~.
~~4. Polypropylene Panel thickness: 5/8 inch, as an alternate to the aluminum panel system.~~
~~5.~~4. Provide special panel shapes and configuration as required for a complete installation and as shown on the Drawings.
~~6.~~5. Provide finishes as shown on the Drawings in the Room Finish Schedule and as scheduled in Section 09915, Building Painting.

C. Fittings: ASTM A36 or ASTM A635.

2.3 COMPONENTS

A. General:
1. Cleanroom wall assemblies: Provide complete wall assemblies as described on the Data Sheets and as specified in this Section.
2. The cleanroom wall system design shall require no cutting, drilling, or chipping in the cleanroom during assembly. The wall system shall have the capability to be finished flush on one as indicated on the Drawings. Fabricate the cleanroom wall components to minimize the need for field cutting. Mitering components will not be allowed.

B. Frame Supported Wall System; Framing Components:
1. Framing shall consist of metal struts and supplementary components with integral connection brackets that are capable of supporting not only the finish wall panels and glazing, but also mechanical piping, ductwork, and workstations bracketed off the framing. Wall framing shall be able to resist a 600-pound overall pullout strength as may be required.
2. Coordinate framing system with the building structure to perform under vertical, lateral design loads, and seismic restraints.

3. Provide a deflection head capable of 3/4 inch of downward movement with retainers to facilitate temporary suspension of the cleanroom wall.
4. Materials and connections shall be manufacturer's standard, capable of supporting design forces. Provide for movement of surrounding structure in design of separations and joints. Structural members shall be sufficiently stiff to allow proper operation of vibration isolation equipment and ceiling filter sealant systems.

C. Furred Cleanroom Wall (Liner Wall):
1. A nonload-bearing, nonprogressive, completely demountable wall furring system, without structural framing from the finished floor to the underside of the deck above with no exposed fasteners, attached to the existing concrete masonry unit walls.

D. Components - Head Batten: extruded aluminum, complete with closure to the ceiling grid predrilled for fastening to substrate at 12 inches on center.

E. Glazing: as indicated on the Drawings and specified in Section 08800, Glazing.

F. Doors:
1. Sliding doors: as indicated in specifications Section 08462, Automatic Sliding Entrance Doors and shown on the Drawings.

G. Supplementary Components: The following list represents the major component pieces required to assemble the clean wall system. Provide all supplementary pieces (in addition to those indicated) as may be required to provide and complete the finished system.
1. Color: as selected.
2. Finish Trim: as indicated on the Drawings; color, to match adjacent component.
3. Glazing Splines, Seals, and Gasketing: Santoprene, as manufactured by Advanced Elastomer Systems.

2.4 FINISHES

A. Wall Panel Finish - Factory-Finished Roll Coat, Baked Epoxy Paint with the Following Properties:
1. Coating Adhesion:

Test Method	Minimum Requirements
Adhesion	ASTM D3359, Method A, no liftoff
Impact resistance	ASTM D2794, no liftoff

Test Method	Minimum Requirements
Flexibility	ASTM D1737-62, ≤3T
Abrasion	ASTM D4060; Taber Abraser; 1,000 cycles of the CS-10 wheels 5.6-mg weight loss

2. Flammability:

Test Method	Panel Thickness	Minimum Requirements
ASTM E84	0.25, 2 inches	Flame spread, 10; Smoke developed, 10.

3. Paint to be nonfading, nonchalking.

B. Aluminum Extrusion Finish:
1. Aluminum Framing: powder epoxy.
2. Other Aluminum Extrusions: powder-epoxy paint, completely prefinished prior to delivery to jobsite. Paint shall be color matched, free of blemishes, voids, and streaks, and shall resist peeling, fading, scratches, and chipping.
3. Components not painted shall be stainless steel or cadmium-plated steel as indicated on the Drawings.
4. Finishes applied in the field shall be for touchup purposes only and of high solids/low volatile epoxies.
5. Color: Match manufacturer's standard panel color and custom colors to be determined.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Examine substrates and adjoining construction and conditions under which work is to be installed. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 FIELD PREPARATION

A. Verify dimensions of supporting structure by field measurements so that cleanroom wall will be accurately designed, fabricated, and fitted to the structure.

B. Coordinate cleanroom wall assemblies with the work of the Related Work paragraph and provide items to be placed during the installation of other work at the proper

time to avoid delays in the work. Place such items, including inserts and anchors, accurately in relation to the final location of the cleanroom wall system components using locking-type devices at connections.

3.3 INSTALLATION

A. The nature of the completed facility demands special attention to maintaining an overall cleanliness in the project area. Methods of construction which minimize the generation of contaminants are essential if major cleanup problems are to be avoided. The installation of the cleanroom wall system involves the major exposure of surface area within the cleanroom and, therefore, represents a potential for surface contamination unless careful attention is paid to the manner in which the erection and placement is handled.

B. Partition components shall assemble into a rigid structure with tight straight-line joints. Completed installation shall be free of exposed bolts, nuts, rivets, and fasteners within the cleanroom area, and shall interface with all mechanical and electrical work in a clearly preplanned and craftsmanlike installation.

C. Erect component parts of the cleanroom wall in accordance with the manufacturer's written instructions and recommendations.

D. Cutting and Trimming of Component Parts: Cut and trim component parts of the cleanroom wall during erection only with the approval of the wall manufacturer and in accordance with the manufacturer's written instructions. Restore damaged finish or replace materials and remove evidence of cutting and trimming. Cutting and trimming shall be done outside the cleanroom area.

E. Do not erect members which are observed to be warped, bowed, deformed, or otherwise damaged or defaced to such extent as to impair strength or appearance. Remove and replace members damaged in the process of erection.

F. Set units level, plumb, and true to line with uniform joints. Support and secure in place by bolting to clip angles and similar supports anchored to supporting structure.

3.4 TOLERANCES

A. Variation from plumb or angle: 1/8-inch maximum variation in height or 10-foot run, noncumulative.

B. Offsets in End-to-End or Edge-to-Edge Alignment of Consecutive Members: 1/16-inch maximum offset in any alignment.

3.5 CLEANING

A. Provide cleaning methods required for each component part as recommended by the respective manufacturers.

B. Cleaning methods shall be carefully selected, applied, and maintained so that finishes will not become uneven or otherwise impaired.

C. The nature of the project requires special attention to minimizing potential contamination of the fully developed cleanroom environment. Construction dust and contaminants left on surfaces or in recesses that will be exposed to cleanroom air will have the effect of unduly loading up the filter system. Daily cleanup and vacuuming of the work area is essential to an ongoing control of contaminants, especially as the cleanroom fit-up progresses.

3.6 PROTECTION

A. Protect the cleanroom walls throughout the construction period in a clean and properly protected condition so that it will be without any indication of use or damage at Substantial Completion.

B. Protect the work during shipment, storage, erection, and construction so as to avoid development of nonuniformity of appearance or other deleterious effects in the work.

C. Remove protection when requested by IDC or the Owner for inspection of finishes and replace.

D. Materials found to be defective or improperly installed shall be replaced.

END OF SECTION

SECTION 13930

AUTOMATIC SPRINKLER SYSTEMS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to provide and install, complete, the automatic sprinkler system.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for automatic sprinkler systems:
   1. Section 01355, Clean Zone General Requirements.
   2. Section 07840 - Fire Stopping.
   3. Section 07900 - Joint Sealers.
   4. Section 15050 - Basic Mechanical Requirements.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 SYSTEM DESCRIPTION

A. A designed and installed Carbon Dioxide hood containment automatic suppression system.

B. A modified existing fire protection system as required to meet the Specifications, including hydraulic calculations.

1.4 DESIGN CRITERIA

A. Material and Installation Requirements: Comply with these Specifications, including applicable codes and standards.

B. Design the hydraulically calculated sprinkler systems (zones) per the following:
   1. Calculate system pressure demand at not more than 90 percent of the available pressure at the demand flow based upon water supply information provided by the authority having jurisdiction.
   2. Minimum design density and area as shown on the Drawings.

3. Hydraulically most-demanding rectangular area with a dimension parallel to the branch lines at least 1.4 times the square root of the area.
4. Combined hose stream allowance appropriate to the hazard being protected and the following:
    a. Outside Hose Stream: flowing at a public or private fire hydrant nearest the base of the system riser.
    b. Inside Hose Stream: flowing at the base of the system riser.

C. Coordination - Coordinate sprinkler locations with the architectural reflected ceiling plans and as follows:
1. Locate heads in center of ceiling tiles or centered in the short dimension and 1 foot from the end with rectilinear arrangement throughout when the head locations are not shown on Drawings.
2. Locations shown on reflected ceiling plans are aesthetically critical; do not relocate without prior approval.
3. Coordinate locations with other trades and make revisions within the specified design criteria at no additional Owner cost.

D. Special Considerations:
1. Sprinklered Ductwork:
    a. Sprinkler Locations: within 3 feet of branch-to-main duct connection.
2. Carbon dioxide hood suppression system as indicated on the drawings.

1.5 REGULATORY REQUIREMENTS

A. Comply with the latest edition of the following:
1. NFPA 13.
2. NFPA 45.
3. International Building Code.
4. International Fire Code.
5. FM Global Property Loss Prevention Data Sheets.

B. Obtain and pay for permits for the portion of the fire sprinkler systems covered by the work.

C. Arrange and pay for inspections and tests of the fire sprinkler installation required by this Specification, codes and standards, and authorities having jurisdiction.

D. Materials and Equipment: UL-listed and FM Global-approved for fire protection service.

1.6 QUALIFICATIONS

A. Work Experience: at least 3 years' experience on similar buildings; submit a list of projects and Owner's contact person for each project.

B. Licenses: by the authority having jurisdiction.

1.7 SUBMITTALS

A. See the Submittal Schedule at end of Section.

PART 2 -- PRODUCTS

2.1 SUPERVISORY SWITCH

A. Design:
   1. Operate between the first and second revolution of the valve control wheel or operate if housing cover is removed.
   2. Electrical Rating: 0.25 amp, 24 Vdc.

2.2 FLOW DETECTOR SWITCH

A. Electrical Rating: 0.25 amp, 24 Vdc.

B. Retard Element: pneumatic with an adjustable range of zero to 70 seconds.

C. Signal Contacts: Provide with two contacts suitable for providing a signal to the local and remote fire alarm system.

2.3 FIRE ALARM BELL

A. Description: 10-inch electric bell, surface mounted.

B. Housing and Base: aluminum with red, baked-enamel finish.

C. Electrical Rating: 120 volts, single phase, 60 Hz.

2.4 DELUGE VALVE

A. Acceptable Manufacturer: Viking, Model E-1.

B. Description:
   1. Body: cast iron.
   2. Trim: Test standard trim package.

2.5 SPRINKLERS

A. Acceptable Manufacturers: from approved list of manufacturers of UL-listed and FM Global-approved products for fire sprinkler systems.

B. General Description:
   1. Orifice Diameter: 1/2 inch.
   2. Temperature Rating:
      a. 165 degrees F.
      b. 212 degrees F in mechanical and electrical rooms and elevator shafts.
      c. As required otherwise by NFPA 13.
   3. Type: quartzoid bulb, chrome plated, pendent or upright, bronze in exposed areas.
   4. Guards: listed type where subject to mechanical damage or below 7-foot height above floor.

2.6 CONTROL, TEST, AND DRAIN VALVES

A. Acceptable Manufacturers:
   1. Viking.
   2. Grinnell.
   3. Victaulic.

B. Floor Control, Zone Control, and Auxiliary Control Valves: indicating-type butterfly valves.

C. Test and Drain Valves: ball or gate valves.

D. Auxiliary Drain Valve: ball or gate valves with hose-end coupling and cap.

2.7 SYSTEM PIPING

A. Use new materials that comply with the requirements of NFPA 13, including the following:
   1. Ratings: 175 psig at minus 20 to 150 degrees F per ASTM A135andNFPA 13.
   2. Piping:
      a. 1-1/2 Inches and Smaller: ASTM A135, ERW, Schedule 40, black for wet pipe and galvanized for dry pipe, threaded.
      b. 2 Inches Through 4 Inches: ASTM A135, ERW, Schedule 40, black for wet pipe and galvanized for dry pipe, grooved.
      c. 5 Inches and Larger: ASTM A135, ERW, Schedule 10, black for wet pipe, galvanized for dry pipe, grooved end.
   3. Plain-End Pipe Fittings and Couplings: prohibited, including setscrew couplings.

4. Bushings and Grooved Reducing Couplings: prohibited.
5. Uniflanges: prohibited.
6. Mechanical Tees: prohibited.
7. Stainless Steel Flexible Connectors: complete assemblies with factory-installed sprinklers.

2.8 PIPE HANGERS AND SUPPORTS

A. General: Use hanger types and arrangements as shown on Drawings.

B. Attachments: Do not use powder-driven studs.

C. Additional Hangers: Provide hangers that meet the requirements of NFPA 13the authorities having jurisdiction, and the written approval of IDC.

D. Threaded Rod:
1. Clean Areas: cadmium-plated.
2. Other Areas: zinc-plated.

2.9 HYDRAULIC DATA SIGNAGE

A. Nameplate: Permanently attach sign to zone risers, indicating the information required by NFPA 13 at each zone control valve. Add the additional information.
1. Number of sprinklers.
2. Date of installation.

B. Description: metal or plastic with stamped or engraved lettering of contrasting colors. Do not use paper, embossed plastic tape, ink, or other erasable or semipermanent media.

C. Zone Map: plastic-laminated map indicating location of sprinkler zones within the building and the location of zone riser, attached in close proximity to control valve.

2.10 EXTRA STOCK

1. Furnish and install spare sprinkler cabinet(s) and sprinklers in accordance with NFPA 13.

PART 3 -- EXECUTION

3.1 GENERAL

A. Location: Install equipment, controls, piping, valves, and drains subject to IDC's approval.

3.2 SUPERVISORY SWITCH

A. Install on each fire system control valve.

3.3 FLOW DETECTOR SWITCH

A. Install in a straight section of pipe a minimum of 24 inches from a fitting that changes the direction of water flow.

3.4 FIRE ALARM BELL

A. Install on the exterior of the building at the location of the ground floor riser rooms or as shown on the Drawings.

3.5 PIPING

A. Joint Compound:
   1. Apply joint compound in accordance with manufacturer's recommendation.
   2. Remove excess joint compound from the exterior of pipe and fittings prior to installation.
   3. Clean compound from couplings and exposed threads in Clean Zones as required by Section 01355, Clean Zone General Requirements.

B. Escutcheon Plates - Provide chrome-plated metal escutcheon plates on exposed piping which passes through:
   1. Exterior walls.
   2. Interior walls.
   3. Ceilings.
   4. Floors in finished areas.

C. Wall and Floor Penetrations:
   1. Install pipe sleeves and provide core drilling in walls and floors where pipe penetrations are required.
   2. Seal penetrations as specified in Sections 07840, Fire Stopping and 07900, Joint Sealers and as shown on the Drawings.

D. Access:
   1. Install piping in a manner that does not block any portion of any window, doorway, stairway, and egress passageway.
   2. Provide adequate access for proper operation and code-required clearances of equipment.
   3. Seal sleeves in fire- and smoke-rated barriers to maintain the fire or smoke rating using approved materials and methods.

E. Blast-Resistant Barriers:
   1. Grout pipe to maintain the integrity of the barrier.
   2. Install flexible couplings on each side of the barrier in accordance with NFPA 13.

F. FRP Ductwork:
   1. Coordinate installation of duct sprinklers with the FRP duct installer.
   2. Locate sprinkler penetrations and install sprinkler assembly in base-mounting block attached by duct installer.
   3. Touchup: If factory-applied beeswax is damaged, repair as described in NFPA 13.

G. Vibration Isolation:
   1. Support piping independently from the structure in areas requiring vibration isolation.
   2. Do not suspend from other equipment or from hangers or supports for other equipment nor in any area where vibration isolation is required.
   3. Do not install piping and hangers with equipment, piping, conduit, or ductwork requiring vibration isolation.
   4. Do not install pipe hangers and sway bracing rigidly connected to duct walls or to any nonmasonry walls.
   5. Install piping which crosses vibration isolation breaks or structural isolation breaks using flexible couplings and vibration isolation hangers of the correct weight rating.

H. Fireproofing:
   1. Install piping to allow full thickness of required fireproofing of structural components.
   2. Install hangers fastened to structural members requiring fireproofing prior to application of fireproofing.
   3. Replace fireproofing to original condition if fireproofing must be removed.

I. Flexibility:
   1. Install flexible couplings and sway bracing as required by NFPA 13
   2. Allow for flexibility, internal pressure, and differential movement between the piping and building, earth, or other supporting structure(s) so that allowable stress will not be exceeded in any member.
   3. Install flexible coupling within 6 inches of branch piping in vertical drops greater than 4 feet in length.

J. Cleanroom Ceiling Plenum: Connect flexible pipe sprinkler assembly to cleanroom system branch piping or install flexible sprinkler module in the cleanroom ceiling and connect to the cleanroom system branch piping.

3.6 TEST AND DRAIN VALVES

A. Access: Avoid installations above ceilings or behind walls or obtain IDC's approval and install per the following:
   1. Accessible Ceilings: Install label on ceiling access location, identifying test, or drain valve location.
   2. Nonaccessible Ceiling or Wall: Install access panel and label on panel, identifying test, or drain valve location. Finish access panel to match ceiling or wall color per Section 09915, Building Painting.
   3. Coordination: Provide information on number, locations, and required sizes of access panels and coordinate location with other trades.

B. Location Required: Install in portion of system that is over 5 gallons and cannot drain by gravity to the main drain valve for that system.

C. Auxiliary Drain Connections: Provide hose connection and cap at valve discharge for standard 3/4-inch hose.

3.7 CONTROL VALVES

A. Signage: Provide identification signs on control valves and maps near risers indicating the portion of the total system controlled by the respective valve.

3.8 TESTING

A. Acceptance Test: As required by NFPA 13 and by the authorities having jurisdiction. Notify the Owner and the authority having jurisdiction 48 hours in advance of scheduled test allowing Owner or IDC to arrange a mutually agreeable time to perform tests. Provide written proof of acceptance by the inspecting authority.

3.9 IDENTIFICATION

A. Install signs, valve tags, and piping identification labels as required by NFPA 13 and Section 15190, Mechanical Identification.

3.10 WELDING AND FLAME CUTTING

A. Do not weld or flame cut sprinkler pipe or components of the fire sprinkler system on the jobsite.

3.11 FINAL APPROVAL AND ACCEPTANCE

A. Final approval and acceptance of systems will be given by the Owner when:
   1. The completed wet pipe sprinkler system has been inspected, tested, and approved by the Owner's insurance underwriters, the authority having jurisdiction, and the Owner.
   2. Required submittals, system operation and maintenance manuals, record drawings with final calculations, spare parts, and training have been provided to, reviewed, and accepted by the Owner.

Provide the submittals listed in the following Submittal Schedule.

Submittal Schedule

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	2 WEEKS PRIOR TO BEGINNING INSTALLATION	AS INDICATED
13930-001	Detailed installation shop drawings of the complete automatic fire sprinkler system created with the latest release of AutoCAD. Show information required by NFPA 13 and NFPA 45 for working plans including items 13930-002 through 13930-005.		X	
13930-002	Piping, valves, and drains.		X	
13930-003	Fabrication shop drawings that show installation dimensions and cut lengths for piping. Coordinate and make minor revisions at no additional cost and verify that hydraulic calculations remain within the criteria.		X	
13930-004	Reflected ceiling plans showing locations of sprinklers, lights, diffusers, grilles, etc.		X	
13930-005	Shop drawings approved by the state or local fire marshal and the Owner's insurance underwriters. Obtain required approvals prior to the start of installation.		X	

END OF SECTION

SECTION 15050

BASIC MECHANICAL REQUIREMENTS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the basic requirements for all sections included in Division 15 and specific sections in Divisions 11 and 13.

B. Requirements for the following are included:
   1. Related work (other Contract Documents and specification sections) which must be combined with the requirements of this Section.
   2. Design criteria.
   3. Regulatory requirements.
   4. Delivery, storage, and handling.
   5. Submittals.
   6. Product quality, basic type, and finishes.
   7. Equipment identification.
   8. Vendor representative requirements.
   9. Mounting and shimming.
   10. Inspection.
   11. Safety considerations.
   12. Cleaning, startup, and adjustments.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the project equipment and systems.
   1. The Contract.
   2. Division 1 sections included in project specifications.
   3. Section 15140 - Piping Supports and Anchors.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DESIGN CRITERIA

A. Supports, Anchors, and Restraints:
   1. General:

a. Provide design for supports, anchors, and seismic restraints for equipment and supports and seismic restraints for conduit, piping, and ductwork when they are not shown on the Drawings.
b. Support for piping shall conform to Section 15140, Piping Supports and Anchors.
c. Seismic restraints and anchors shall resist seismic forces as specified in the latest edition of the International Building Code (IBC) 2003 for the seismic zone specified in Section 01000, General Technical Requirements.
d. Consider thermal expansion and contraction when placing seismic restraints so that no thermal over stresses occur.
e. Do not allow connections to structural framing to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

B. Compliance by the Contractor with the provisions of this Specification does not relieve him of the responsibilities of furnishing equipment and materials of proper design, mechanically suited to meet operating guarantees at the specified service conditions.

1.4 REGULATORY REQUIREMENTS

A. Obtain permits and arrange inspections required by codes applicable to this Section. Submit written evidence to IDC that required permits, inspections, and code requirements have been secured.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipment:
1. The adequacy of the preparation for shipment provisions employed with respect to materials and application is the sole responsibility of the Contractor.
2. Protect flange facings by securely fastened durable covers to prevent damage during shipment.
3. Provide equipment completely free of water prior to shipment preparation.
4. Give a heavy coating of rust-inhibiting compound to exposed finished and machined surfaces, including bolting. Spray or coat with a suitable strippable rust preventative on internal metal surfaces.
5. Thoroughly clean bearings, bearing housings, and oil systems, including reservoirs, coolers, filters, and piping internally free of metal particles, dirt, and debris and coated with a suitable rust preventative prior to shipment.
6. Provide adequate protection against mechanical damage and atmospheric corrosion in transit.

7. Securely mount instruments and valves, including auxiliary systems and/or supported to eliminate damage during shipment, storage, operation, and maintenance.
8. Provide supports and rigging connections to prevent damage during transit, lifting, or unloading.
9. Provide threaded connections with a pipe plug of the same material as the connections. Use Teflon tape as a thread sealant.
10. Suitably tag openings that require rust preventative to indicate the type and nomenclature of the rust preventative used.
11. Suitably tag equipment containing insulating oils or other fluids at openings to indicate the nature of the contents and shipping and storage precautions.
12. Cap open ends of tubes (just taping is not adequate) for protection.
13. Pack, securely anchor, and weather protect equipment (skid mounted when required), for the shipment method called for in the Contract. Box separate, loose, or spare parts and each part individually protected as required. Mark each individual container both inside and outside with the equipment number and service for which the parts are intended.
14. Pack and ship with the equipment, one complete set of installation, operating, and maintenance instructions. This set is in addition to the sets that are to be sent directly to the Owner.
15. Include in each container a complete bill of materials identifying each part. In some instances, such as instruments, specific tagging is required.
16. Impression stamp piping connections furnished on the purchased equipment to agree with manufacturer's connection table listed on the general arrangement drawing. Tagging in lieu of stamping is only acceptable where the connections, because of size or geometry, cannot be impression stamped.

1.6 SUBMITTALS

A. Provide the following submittals:
1. Estimated equipment weight and support requirements.
2. Electrical power requirements, including in-rush current, and recommended fuse size.
3. Utility (cooling water, air, fuel, etc.) requirements.
4. A list of deviations to the specified requirements.
5. Adequate dimensional data to permit the design of foundation, piping, and wiring connections.
6. Clearance required for disassembly and maintenance.
7. Completed contract specification datasheets.
8. Identification data for equipment components.
9. Rotation.
10. Weight.
11. Piping connections identified with the size, rating, and facing indicated.

12. Provide the following from the manufacturer’s representative as soon as available:
    a. A record of startup events noting problems and their resolution.
    b. A record of set points for operational controls and devices.
    c. Certification that the equipment has been installed as specified and in accordance with the manufacturer's requirements.
13. Submit written notice to the Owner and IDC that the units are ready for use by the Owner upon completion of the inspections, startup, testing, and checkout procedures by the equipment manufacturer.

B. Review of manufacturer's drawings shall not relieve the Contractor from the responsibility for equipment performance and compliance with this Specification.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Provide equipment of the manufacturer's most recent standard design. Equipment designs that have not been previously used successfully in an industrial application are not acceptable.

B. Provide 1 quart and 2 spray cans of each standard paint used from each equipment and/or materials supplier for touchup. Adequately label paint cans to identify where they are to be used. When equipment is involved the label shall at a minimum, include the Owner's equipment tag number.

2.2 EQUIPMENT IDENTIFICATION

A. Provide equipment with a stainless steel identification tag pinned in place in a readily accessible location with the following information at a minimum (when applicable):
1. Manufacturer's name.
2. Manufacturer's model number.
3. Date of manufacture.
4. Design operating conditions.
5. Design pressure and temperature.
6. Serial number.
7. Materials of construction.
8. Code stamp.
9. RPM.
10. Electrical power requirements.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Install in accordance with the requirements of the equipment manufacturer.

B. Equipment Manufacturer's Responsibility and Services:
   1. Provide a manufacturer's representative for major equipment and operating systems to assist the Contractor during installation.
   2. Provide the manufacturer's representative onsite during initial startup of equipment in the presence of IDC and Owner.
      a. Provide a prestart check of piping, valves, control devices, control panels, and equipment.
      b. Calibrate and adjust equipment and controls for operation at the specified design conditions.
   3. Upon the completion of equipment startup, provide instructional time with the Owner's personnel to review the operations and maintenance manuals and perform each step necessary for startup, shutdown, troubleshooting, and routine maintenance. Schedule the instructional time through the Owner.

3.2 INSPECTION

A. Inspect the work to ensure the installation and workmanship is in accordance with these specifications and acceptable industry standards for the work being done.

B. The extent of testing, whether witnessed or not, is listed in the individual data sheets. Such testing may include full and/or part load performance tests, basic mechanical spin tests, etc. It may also include various nondestructive tests as required by specified codes, including those normally required by the manufacturer's own manufacturing standards.

C. It is a requirement of this Specification that IDC's inspection work be minimized by assigning to the Contractor the responsibility of furnishing the inspector with necessary material certifications, shop test data, radiographic plates, and the like necessary to verify the Contractor's compliance with the specifications for Contractor-furnished equipment.

D. Where shop inspection is specified, no surfaces or parts are to be painted until the inspection is complete.

E. Make materials, equipment, and workmanship available to inspection at any time by the Owner. Correct any work, materials, or equipment not in accordance with the Contract Documents.

3.3 SAFETY CONSIDERATIONS

A. Install equipment with suitable access clearances for maintenance or removal of replaceable parts and components and with necessary unions or flanges to perform the maintenance or removal without removing the connecting appurtenances.

B. Where equipment requiring periodic maintenance cannot be reached by normal walkways because of interference with ductwork, piping, or other obstructions, provide an alternate safe means of access. These may include construction of an overhead platform with stairway or ladder ends and safety railings or handholds or walk-through duct plenums with hinged access doors or as required to meet OSHA standards for safe maintenance procedures.

3.4 CLEANING, STARTUP, AND ADJUSTING

A. The Contractor is responsible for proper operation of systems, minor subsystems, and services provided under this Section. Coordinate startup procedures, calibration, and system checkout with all subcontractors involved. System operational problems shall be diagnosed; correctional procedures shall be initiated with the various contractors as required to bring the system into compliance with the design and the problem then shall be rechecked to verify that the system operates normally. Bring remaining difficulties to the attention of IDC.

B. Thoroughly clean parts of the installation at the completion of the work. Clean up and remove from the premises refuse material, crates, and rubbish arising from the work. Remove, clean, and reinstall all filters. Check belt-drive tensions and alignments. Lubricate motors and bearings in accordance with the manufacturer's service manuals prior to equipment startup. Provide a lubrication schedule for every item of equipment furnished under this Section. Include the type of lubricant and the application frequency.

END OF SECTION

SECTION 15060

PIPE AND PIPE FITTINGS - GENERAL

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install the plant piping systems specified in the pipe class specification sheets and in the individual piping system specifications provided hereinafter. The work includes, but is not limited to, pipe, tubing, hangers, supports, restraints, isolators, pipe cleaning, testing, and cleaning. In addition, this Section covers the installation of in-line valves and instruments and piping specialties.

B. Piping Line Class System Description: Table 1.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the project piping systems:
1. Section 07840 - Fire Stopping.
2. Section 07900 - Joint Sealers.
3. Section 09920 - Painting Equipment and Piping.
4. Section 15050 - Basic Mechanical Requirements.
5. Section 15060.dat – Pipe and Pipe Fittings – General Data Sheets.
6. Section 15140 - Pipe Supports and Anchors.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 QUALITY ASSURANCE

A. Maintain a program to monitor the manufacturing process, in-process product quality, and final product quality. The program shall have the following features:
1. A change control process.
2. Standard manufacturing procedures.
3. Standard calibration and test methods.
4. Calibration records.
5. Calibration standard traceability.
6. A sampling plan.
7. Test records.

8. Documentation of upset conditions and corrective actions.

B. For components with additional cleaning and packaging and/or testing requirements, monitor the following as appropriate:
   1. Quality of cleaning and packaging materials.
   2. Cleanliness of the cleaning and packaging facilities.
   3. Surface finish of component bodies and tube stubs in Ra.
   4. Outgassing and leaching rates.
   5. Particle generation.
   6. Chrome-to-iron ratio, chrome-oxide to iron-oxide ratio, and chromium enrichment depth.
   7. Surface flaw counts by SEM.
   8. Surface contaminants.
   9. Porosity by SEM.

C. The Owner may elect to provide an independent quality assurance representative (QAR). This QAR is known as the Inspector as defined in Chapter VI of ASME/ANSI 31.3. The QAR will be responsible to the Owner. The QAR will aid the Contractor in monitoring manufacturing and installation product quality and activities. Quality issues on the project will be resolved jointly by the Contractor, QAR, IDC, and Owner.

D. Identify and provide a quality control representative (QCR). This QCR is known as the Examiner as defined in Chapter VI of ASME/ANSI 31.3. The QCR has the primary responsibility for the following:
   1. Setting up project quality program.
   2. Implementing and monitoring Contractor conformance to the project quality program.
   3. Maintaining appropriate logs, shipping, materials, inspection, and test documentation for the project.
   4. Resolving quality issues arising during the project jointly with the Contractor, Owner, IDC, and the QAR.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Components with Special Cleaning and Packaging Requirements:
   1. Handle and store material and equipment in a controlled environment throughout the progress of the job to prevent damage and/or contamination.
   2. Repackage incoming material, which is defective or contaminated, document the problem, and provide this to IDC and quality assurance representative (QAR) for final disposition.
   3. Do not use material or equipment that becomes damaged or contaminated in handling on the job unless it is repaired or recleaned to the original purchase

requirements by the Contractor at his expense. Segregate such material from the new, clean material and reinspect and approve by the QAR before its use.

1.5 SUBMITTALS

A. Provide bolt torque tables for each gasket type by size and service 4 weeks before gaskets are installed.

B. When special cleaning and/or testing procedures are specified (i.e., CP-2, T-2), provide the following 6 weeks prior to beginning cleaning or testing as appropriate:
   1. Quality specifications for DI water, nitrogen, argon, helium, IPA, oilfree air, and other materials used in the cleaning or testing process.
   2. Description of the manufacturer's cleaning procedures, testing procedures, and sample plan, including quality assurance program.
   3. Specifications for the cleanroom to be used to clean, test, and package the components.
   4. Detailed description of the procedures and materials used in packaging.
   5. Leak rate (external and across the seat) test method and guarantees.
   6. Interior surface finish roughness and chrome-oxide levels test method and guarantees.
   7. Outgassing test methods and guarantees (for H_2O, THC).
   8. Particle generation test methods and guarantees.
   9. Provide the following items with the shipment as appropriate:
      a. Certificate of compliance.
      b. Alloy, heat number, and sulfur content of tube extensions.
      c. Leak test results.
   10. Confirmation the component was assembled with no lubricants.

C. If the Contractor has developed alternative techniques or intends to apply alternative methods considered equivalent to those indicated herein, submit a proposal on such techniques or methods in writing to IDC for review at least 14 days before intended date of use.

PART 2 -- PRODUCTS

2.1 PIPE CLASS

A. The pipe class specification sheets provided at the end of each detail piping system specification specify the pipe, fittings, and miscellaneous materials required for each pipe class. A two-letter, two-number code is used. The first two letters identify pipe

material; the two numbers designate unique pipe data sheet identifiers (see Table 1 at the end of this Section).

2.2 CLEANING AND PACKAGING LEVELS FOR HIGH-PURITY SERVICE

A. The specific cleaning and packaging criteria below apply to valves and components that specifically reference the below criteria; valve, or component data sheet or schedule. The criteria listed in Section 15060.dat Data Sheet 1 and Data Sheet 2 apply to valve and component manufacturing requirements prior to shipment.

2.3 TESTING FOR HIGH-PURITY SERVICE

A. The specific testing criteria below applies only to valves and components that specifically reference the below criteria in the valve or component data sheet or schedule. The criteria below applies to valve and component manufacturing requirements prior to shipment.

B. Test Methods and Sampling:
1. Perform inboard helium leak test by maintaining a 100 percent helium atmosphere in a bag or other enclosure around the component.
2. Perform outboard helium leak test by maintaining 100 percent helium at 150 psig inside the component.
3. Perform across-the-seat helium leak testing by maintaining 100 percent helium at atmospheric pressure on the inlet side of the component.
4. Perform particle testing per ASTM FT394-92.
5. Perform testing on samples selected per the vendor's sample plan, except where noted on data sheets.

C. See Section 15060.dat, Data Sheet 2 for description of test required.

2.4 INSULATING FLANGES, COUPLINGS, AND UNIONS

A. Provide insulating flanges, couplings, or unions wherever copper and ferrous metal piping are connected, wherever cathodically protected steel lines enter buildings, wherever submerged metallic piping is connected to unsubmerged piping, wherever new galvanized pipe is connected to existing galvanized pipe and where shown on the Drawings. Install insulated joints connecting submerged piping to exposed piping above maximum water surface elevation and before the first pipe support not having coated anchor bolts or adhesive-bonded concrete anchors. Isolate submerged metallic from the concrete reinforcement.

B. Acceptable manufacturers of insulating flanges and unions are Epco and Capitol Insulation Unions. Provide Dresser STAB-39, or R. H. Baker Series 216 insulating couplings.

2.5 CORROSION PROTECTION FOR BURIED PIPING, PIPE COATING, AND WRAPPING

A. Protective Coatings:

1. Give uninsulated carbon steel piping a field coat as specified in Section 09920, Painting - Equipment and Piping.
2. Install underground carbon steel pipe with a shop-applied fully pasticized coal tar enamel coating system in accordance with NAPCA Specification TGF-3. Clean pipe in accordance with SSPC-SP6, Commercial Blast Cleaning. Electrically inspect coated and wrapped pipe as specified by AWWA C203. Provide underground fittings and field welds with a SSPC-SP3 power tool cleaning to remove loose mill scale, loose rust, loose paint, weld flux, and other loose detrimental foreign matter. Prime and tape wrapped in accordance with AWWA Standard C209, Cold-Applied Tape Coatings for Special Sections, Connections, and Fittings for Steel Water Pipelines. Provide tape of a Type I material and electrically inspect as specified by AWWA C209. Maximum operating fluid temperature is 90 degrees F.
3. The coating system specified in paragraph 2 above is preferred; however, where approved by IDC, the following coating methods for steel pipe may also be used as an alternate.
    a. Hot-applied, fusion-bonded epoxy coating system in accordance with AWWA C213. Tape coat joints in accordance with AWWA C209. Maximum operating fluid temperature is 140 degrees F.
    b. Cold-applied tape coating system in accordance with AWWA C214 Polyken YGIII, or IDC-approved equal. Tape coat joints in accordance with AWWA C209. Maximum operating fluid temperature - 200 degrees F.
    c. Hot applied, 100 percent solids, polyurethane coating system. Maximum operating fluid temperature is 140 degrees F. Madison Corropipe FSX or IDC approved equal, Madison Chemical, Inc., St. Louis, Missouri.

B. Encase underground cast iron or ductile iron piping buried in areas identified where exceptional exposure to corrosion may occur in a polyethylene sleeve as specified on the Drawings in accordance with AWWA C105.

2.6 BOLTS, NUTS, AND WASHERS

A. Provide corrosion-resistant bolts, nuts, and washers, and other attachment hardware constructed of stainless steel, galvanized or cadmium-plated carbon steel, aluminum-bronze, or similar IDC-approved material suitable for the service intended or the area of use.

B. Bolting: Contain bolts, studs, and nuts in marked boxes denoting material and conformance to ASTM A193, ASTM A194. Use flat washers matching the bolt/nut material for nonmetallic piping.

BC-1	Bolts, studs	Alloy Steel ASTM A193 GR-B7
	Nuts	Heavy hex head ASTM A194 GR-2H
BC-2	Bolts	Carbon steel ASTM A307, GR- B plated
	Nuts	Heavy hex head, plated ASTM 536 GR-B
BC-3	Bolts	Carbon steel, ASTM A307, GR B
	Nuts	Heavy hex head ASTM 536 GR B
BS-1	Bolts, studs	Stainless steel ASTM A193 GR B8A, 304 SS
	Nuts	ASTM A194 GR-8A, 304 SS
BS-2	Bolts, studs	Stainless steel ASTM A193 GR B8M, 316 SS
	Nuts	ASTM A194 GR-8M, 316 SS

2.7 GASKETS

A. Dimensional Requirements: Conform to the following gasket dimension standards, unless otherwise noted.

1. ASME B16.21: Covers nonmetallic flat gasket dimensions for cast iron and steel pipe flanges of the flat-face, raised-face, large-male and -female, and large-tongue-and-groove system through Class 1,500 rating.
2. ASME B16.20: Covers ring-joint gaskets for steel pipe flanges.
3. ASME B16.5: Covers gaskets other than ring-joint in sizes through 24 inch and ratings through Class 2,500.
4. ASME B16.47: Covers dimensions for steel flanges in sizes 26 inch through 60 inch and ratings through Class 900.
5. AWWA C110/C115: Covers ring and full-face rubber gaskets used with cast and ductile iron flanged pipe and fittings through 54-inch size.
6. AWWA C207: Covers dimensions for steel slip-on and plate flanges used for waterworks service in sizes 4 inch through 144 inch.
7. API 601: Covers double-jacketed corrugated and spiral-wound metallic gaskets.
8. API 605: Covers dimensions for steel flanges and sizes 26 inch through 60 inch and ratings through Class 900.
9. MSS SP-44: Covers dimensions for steel flanges in sizes 12 inch through 36 inch and ratings through Class 900.

10. Pattern gaskets for large-diameter flanges not covered by ASME B16.21 or B16.5 to match flanges made to AWWA C207, Class E, unless noted otherwise.

B. Unless otherwise noted, establish dimensions for nonmetallic flat gaskets using the following guidelines (which agree with AWWA C110/C115, and ASME B16.21 and B16.5):
   1. Provide self-centering flat ring gaskets having an outside diameter equal to the bolt circle diameter less than one bolt diameter.
   2. The gasket inside diameter for steel pipe flanges equal the inside diameter of the mating steel pipe. Provide the gasket inside diameter for cast or ductile iron pipe flanges equal the nominal pipe size of the mating iron pipe.
   3. Full-face gaskets have an outside diameter equal to the outside diameter of the mating flange and an inside diameter as stated above. Punch holes in accordance with the size and number of the mating flange holes.
   4. When a cast or ductile iron flanged pipe is mated to a steel flange, provide the gasket inside diameter equal to the nominal pipe size of the mating pipes.

C. Provide spiral-wound gaskets with a centering-ring outside diameter equal to the bolt circle diameter less one bolt diameter and a gasket inside diameter as specified in API Standard 601. Provide gaskets furnished with a solid metal inner ring with an inner ring ID that is 1/8 inch greater than the flange bore unless noted otherwise.

D. Gaskets shall be branded with manufacturer and type in order to identify material and rating.

E. Gaskets Materials: The following groups designate the gasket types and approved manufacturers for each group. There are no alternatives acceptable.

	SERVICE
G-1	General service. Nonasbestos. Durabla 8500. Frenzelit 825. Garlock 3000. Flexitallic SF 2400.
G-3	High-purity water and select chemical services. Virgin, unpigmented PTFE, expanded or encapsulating either

	SERVICE
	an EPDM or Viton elastomer. Sizes 1/2 inch to 24 inch, use 1/8-inch thick Gore Triguard or Garlock Stress Saver or Asahi AV. Provide cleaned for high-purity service, purged in double bags.
G-4	Steam, condensate high-temperature hot water. Flexatallic CG. Leader LG-13. Signum CD.
G-8	No hub. One-piece moulded neoprene, ASTM C564 sleeve with sealing beads.
G-9	Full-face, Class 125, Old ANSI, 1/8-inch thick EPT rubber.
G-12	One piece compression gasket, moulded neoprene, ASTM C564.

F. Furnish IDC with the constants Gb, a, and Gs for each type of gasketand the following criteria:
   1. Maximum allowable bolt stress is based on 60 percent of yield.
   2. New Nuts and Bolts: nonmetallic lubricant is used on bolts, nuts, and washers.
   3. Include washers for nonmetallic pipe.
   4. Base these calculations on the PVRC (Pressure Vessel Research Council) Convenient method.

2.8 THREAD SEALANTS

A. Use the following thread sealant groups per call outs in Section 15059, Service Index:

TS-1	1 inch and under - Teflon tape
	Over 1 inch - Rectorseal T plus 2.
TS-2	Rectorseal T plus 2.
TS-3	Rectorseal 7 (wait 24 hours before pressure).
TS-4	Joint manufacturer standard (push-on joints).
TS-5	Teflon tape.

2.9 SERVICE SADDLES

A. General: Service saddles may be used only when allowed in the applicable detail piping system specification or specifically approved in advance by IDC.

B. Service Saddles for Ferrous Metal Piping: Provide Rockwell Series 313 or 366, Dresser Style 91 pipe service saddles for ferrous metal piping except stainless steel. Provide service saddles capable of withstanding 150-psi internal pressure without leakage or overstressing. Provide the run diameter compatible with the outside diameter of the pipe on which the saddle is installed. Taps have American National pipe threads. Provide saddles of malleable or ductile iron bodies and galvanized steel straps, steel hex nuts with washers, and neoprene seals. Provide service saddles of double-strap design.

C. Service Saddles for Plastic Pipe: Do not use service saddles for CPVC, PVC, and polypropylene pipe without written approval from IDC.

2.10 AIR VENTS AND LOW-POINT DRAINS

A. Waterline vents and drains required for normal operation is shown on the piping and instrumentation drawings (P&IDs). However, vents and drains at high and low points in the piping that are required for complete venting and draining may not be shown on these Drawings. Add such items during detail piping design and/or piping installation.

B. Unless otherwise noted on the Drawings, vent the high point and drain the low point with 3/4-inch block valves on those pipelines 2-1/2 inches and larger, and 1/2-inch block valves on those pipelines 2 inches and smaller; valve types to be as shown on

the Drawings. Plug each drain or vent valve with a pipe plug or nipple and threaded cap.

2.11 FLOW SENSORS

A. Install piping adjacent to flow sensors in accordance with the requirements of the manufacturer of the flow sensor and commonly accepted design practices.

2.12 SAFETY CONSIDERATIONS

A. Cover piping that must be installed across aisles or other main access walkways with a protective checkered plate steel ramp, pitched a maximum of 2:12 to allow safe wheeled or foot traffic, and painted with a prime coat and two finish coats of safety yellow. Support ramp from the floor and do not rest directly on the pipe.

B. Do not install liquid piping immediately over or within a 3-foot plan view clearance of any electrical panel, motor starter, or control panel. Where piping must be located within these zones, either install piping inside a PVC conduit or shield the electrical device to prevent direct liquid access to electrical equipment.

PART 3 -- EXECUTION

3.1 GENERAL

A. Inspect components with special cleaning/packaging requirements upon receipt by the Contractor's QCR. Inspect the components to verify there is no physical damage, caps are in place, bags are not torn, and the necessary documentation is included with the shipment. Replace rejected material from the same manufacturer at no additional cost to Owner.

3.2 PIPE ASSEMBLY AND WELDING QUALITY CONTROL PROCEDURES

A. Responsibilities:
1. Owner will designate an inspector (QAR) whose responsibility it will be to verify that required examinations and testing have been completed and to inspect the piping to the extent necessary to be satisfied that it conforms to applicable examination requirements of the applicable codes and this Specification.
2. Provide inspector and the inspector's delegates access to any place where work concerned with the piping installation is being performed. This includes manufacture, fabrication, heat treatment, assembly, erection, examination, and

testing of the piping. They have the right to audit any examination, to inspect the piping using any examination method specified by IDC, and to review all certifications and records necessary to satisfy the inspector's responsibilities as stated in paragraph 3.2.A.1 above.

3. Contractor, fabricator, or manufacturer, as applicable, is responsible for quality control examinations as required by this Specification. Provide the services of an examiner (QCR) for this purpose. Furnish an examiner qualified and certified in accordance with ASNT-TC-1A and the minimum requirements of ASME B31.3, Article 342.1.
4. Certify records of examination procedures employed, showing dates and results of procedure qualifications, and maintain them and make them available to the inspector.
5. Examiner has the overall responsibility for defining, identifying, and tracking welds requiring in-process and final inspection in accordance with applicable codes and design specification requirements. Additional welds may be identified by IDC for nondestructive examination (NDE) as allowed by design specifications. The examiner shall furnish by a biweekly summary report to IDC outlining the following:
   a. Nonconformances identified.
   b. Status of nonconformance remedies.
   c. Receiving report for compliance with specification of all piping materials and components.
   d. Summary of systems cleaning status.
   e. Summary of systems pressure testing status.

B. Procedures of Examiner:
1. Examiner is to become thoroughly acquainted with all Drawings, Specifications, and codes as applicable to the assignment(s).
2. Perform and document visual inspection on all piping welds.
3. Provide examiners certified by an ASNT-TC-1A, Level III examiner.
4. Examine piping per ANSI/ASME B31.3 piping code (as identified on the pipe class specification sheets) and as modified in this Specification.
5. Prior to performing examinations, the examiner review the latest revisions of the applicable drawing(s), specification(s), P&IDs, field orders, and design clarification variation requests (DCVRs).
6. Examiner will utilize the applicable documents in conjunction with this Specification when performing the inspection.
7. Bring to the attention of IDC conflicting requirements between this Specification, its checklists, drawings, and referenced standards.
8. Ensure that weld stamps and/or other required documents are utilized as defined by IDC.

C. Material Certification, Identification, and Storage Examinations by Examiner:

1. Ensure that the receiving inspection has been completed by verification of the receiving accept tag.
2. Perform a 25 percent random sampling for materials compliance of fittings, pipe, valves, and flanges. Accept materials accepted if the examiner can visually identify foundry or mill markings and the ASTM markings comply with the Specifications.
3. In addition to the checklist requirements, ensure that piping and components are handled carefully and protected from damage, dirt, and rust and stored segregated by like materials.

D. Pipe Assembly and Erection Examinations by Examiner:
1. Perform a random inspection of the preparation, alignment, bolting, threading and welding of pipe joints for conformance with ASME B31.3, Article 335, and manufacturer's recommendations.
2. Post Installation Cleaning and Flushing of Piping System: Verify that the cleaning and flushing operations are performed and accepted in accordance with procedures specified.
3. Piping System Test Inspections:
   a. Prior to hydrostatic or pneumatic tests, the Contractor shall develop the pressure test data sheet per the requirements of the applicable specification section.
   b. IDC will review the Specification sections and pressure test data sheet and verify that the applicable procedural requirements have been satisfied.

E. Welding Inspection and Surveillance by Examiner:
1. In addition to the checklist requirements:
   a. Ensure that steel piping and components are handled and protected per the Specifications.
   b. Notify IDC when weld repair rates are excessive or there is justifiable reason to question a welder's qualification.
2. Welder Qualifications:
   a. Welders are required to be qualified to ASME, Section IX, WPS, and identified in the welders' status chart by WPS and piping service. Limitations of each qualification, including extension of qualification to other procedures, are as defined in the cross-qualification matrix.
   b. Perform a periodic review of the welders' status chart to ensure the welders' qualifications for all active welders are being identified and maintained and their expiration dates are being updated. Bring discrepant conditions to the attention of IDC.
3. Inspection and surveillance attributes for piping components are identified in Table 1, Examiner Inspection and Surveillance Checklist:

a. Attributes marked X in the I column are required inspection points, and verify these and document this verification on a surveillance inspection report, in process verification, weld data sheet, or weld maps at a frequency defined by IDC. This direction will comply with applicable code and design/specification requirements.
b. Attributes marked X in the S column are surveillance inspection points and monitored by the examiner on a random basis and documented on the surveillance inspection report, Table 2. Note: Random is defined as often and for as long a time as is necessary to ensure that the activity is being properly administered as determined by IDC.
c. Items identified as inspection points denote attributes applicable for 5 percent random in-process inspection as defined by IDC and in accordance with ANSI/ASME B31.3. IDC will select the attributes to be sampled and the frequency. Document this inspection on the surveillance inspection report, Table 2.
d. Accomplish visual inspection in accordance with the visual weld acceptance criteria.

4. Perform examinations in accordance with the piping code. In addition, all Category D fluid services have a minimum of 5 percent of the circumferential butt welds randomly radiographed in accordance with B31.3, Normal Fluid Service Requirements. This 5 percent is defined as one weld out of 20 for an individual welder but not less than one weld for each welder.
5. Perform examinations for every pipe thickness and for each welding procedure progressively for all piping covered by this Section.
6. For all welded branch connections, complete the examination of and any necessary repairs to the pressure-containing weld before any reinforcing pad or saddle is added.
7. Examine at least one of each type and position of weld made by each welder or welding operator.
8. For each weld found to be defective under the acceptance standards or limitations on imperfections contained in the piping code, examine progressively two additional welds made by the same welder that produced the defective weld. Repair or replace each defective item and reexamine. Such additional examinations are in addition to the minimum required in paragraph 3.2.E.4 above. Examine progressively two additional welds for each tracer examination found to be unsatisfactory until all defective items have been repaired or replaced and successfully reexamined.

F. Documentation:
1. Completed testing and inspection reports and checklists will be reviewed by IDC.
2. Forward completed documentation to IDC.

3. Weld maps and/or other documentation will be reviewed by IDC as often as necessary for ensuring that all scheduled NDE, tests, and inspections are being or have been performed and properly identified.

G. Discrepancies and Nonconformances:
1. Report discrepancies and nonconformances that are identified but not corrected prior to completion of the inspection to IDC, processed, and controlled.
2. Note discrepancies and nonconformances that are identified and corrected prior to completion of the inspection noted in the remarks section of the applicable inspection report.

3.3 FABRICATION AND TESTING MEDIA

A. When specific liquid or gas media is required by individual piping, valve, or component specification sections, comply with the minimum media quality criteria below. Specific liquid and gas media are required in other sections for welding, purging, cleaning, testing, and packaging. Such applications use the media quality requirements of this Section for both factory and field activities.

B. Deionized (DI) Water:
1. Microelectronics:
a. 16 megohm-cm minimum resistivity.
b. 100 ppb maximum TOC.
c. Filtered to 0.1 micron.

C. Reverse Osmosis (RO) Water:
1. Microelectronics:
a. 0.5-megohm-cm minimum resistivity or RO product quality.
b. Filtered to 0.2 micron.

3.4 DRAWINGS

A. Spool drawings indicate the complete line, showing welded and assembly items, except for insulation shoes or nonstress-relieved lines.

B. Except for ring-joint flanges, dimensions are to the centerline of pipe and the contact face of flanges. This includes the contact face of male and female tongue-and-groove flanges. Ring-joint flanges are dimensioned to the centerline of pipe and to the extreme face of the flange and not to the contact surface of the groove.

C. Reducers are concentric unless otherwise noted.

3.5 MATERIAL INSTALLATION

A. Flanges:
   1. Orient flange bolt holes as follows, unless otherwise indicated on the spool drawings.
      a. Flange Face Vertical: bolt holes to straddle the vertical centerlines.
      b. Flange Face Horizontal: bolt holes to straddle plant north-south centerlines.
   2. Provide welds at orifice flanges with internal surfaces ground smooth to the pipe wall.
   3. Weld slip-on flanges inside and outside. Allow a distance of approximately 1/16 to 1/8 inch between the edge of the fillet weld and the face of the flange. Apply the seal weld so that the flange face is free of weld spatter and does not require refacing. Drill hole in flange between welds. Hole shall be at 6 o'clock position.
   4. Use flat-faced flanges when mating to Class 125 flanges. Use full-face gaskets with flat-faced flanges and ring gaskets with raised-faced flanges.
   5. Unless otherwise specified in the data sheets, use weld-neck flanges with butt-weld fittings.
   6. Match the bore of weld-neck flanges with the pipe wall thickness.

B. Seal Welding:
   1. When seal welding is required, make connections without using sealing compound or Teflon tape.
   2. Do not seal weld-threaded joints that have failed a pressure test, unless all thread compound and Teflon tape have been removed.
   3. Cover exposed threads when seal welding threaded connections

C. Bolts:
   1. Unless otherwise specified in the Section 15059, Service Index, or in other piping sections, coat bolt threads with Never-Seez (catalog No. NSBT-16) prior to being made up with nuts. Use alternate coating only with prior review of IDC.
   2. Tighten bolts in a star sequence. Tighten based on three passes of the bolts. Torque bolts to levels in the tables provided to the Contractor by the gasket vendor being used for that service. Accomplish bolt torques with a calibrated torque wrench. Recalibrate torque wrench at the end of each day.

D. Piping Expansion and Flexibility:
   1. Allow for pipe expansion in mains, runouts, and risers by means of natural flexibility in piping swing joints and by expansion loops where indicated on the Drawings.

2. Install with sufficient flexibility to avoid or minimize the use of flexible couplings or expansion joints. Provide flexible couplings or expansion joints for piping connections to equipment where shown on the Drawings. Use of additional flexible couplings or expansion joints, other than those indicated on the piping drawings, requires approval of IDC.
3. Support piping in accordance with the requirements of Section 15140, Piping Supports.

E. Dimensional Tolerances:
1. These tolerances apply to in-line items and connections for other lines.
2. Accomplish general dimension tolerances, such as face-to-face, face-on-end-to-end, face- or end-to-center, and center-to-center at plus or minus 1/8 inch.
3. Provide inclination of flange face from true of no more than 2 degrees in any direction. The inclination is considered 90 degrees in relation to the adjoining pipe centerline.
4. Rotation of flange bolt holes shall not exceed 1/16 inch.

F. General Considerations:
1. Install instruments and specialty items according to the manufacturer's instructions and with sufficient clearance and access for ease of operation and maintenance.
2. Use flanges or unions for connections to equipment as required by the piping specifications.
3. Isolation valves for equipment and instruments in a manner that will allow ease of access and removal of the isolated items.
4. Install piping without springing or forcing the pipe in a manner that would set up stresses in the pipe, valves, or connected equipment.
5. Where piping connects to equipment, support it by a pipe support and not by the equipment.
6. Vibration Compensation Joints:
   a. Comply with manufacturer's requirements of installation for all vibration compensation units.
   b. Do not use vibration compensation units to make up for misalignment of piping, poor workmanship, or pipe-to-equipment connections.
   c. Tack weld the locking nuts to the retaining (or control) rods supplied on vibration joints and pump bellows connectors at the position set by the manufacturer. Do not remove or adjust these rods from their factory settings. When retaining rods are not installed by the manufacturer, install the rods with sleeves at the settings specified by the manufacturer of the compensator.

d. When shipping retainers are supplied on the compensators by the manufacturer, leave the retainers until after the compensator is installed and the permanent piping supports are completed and any temporary supports are removed. Shipping retainers are typically tack welded to the flanges. Be certain that retaining rods are not removed.

e. Do not use gaskets with compensators that have elastomeric or Teflon flange faces.

f. Install compensators with internal sleeves with the fixed end of the sleeve on the inlet side of the compensator.

g. Compensators Installation Sequence:

1) Connect a pipe spool with the same face-to-face dimension as the compensator.
2) Install loose piping flange to the compensator spool.
3) Route piping to the loose flange on the compensator spool.
4) Make the final weld in the piping to the compensator spool. Fabricate piping such that no springing or forcing of the pipe is necessary to make this final weld.
5) Install piping anchors, supports, and guides as specified on the Drawings.
6) Replace compensator spool with actual compensator. A representative of the compensator manufacturer witness removal of the compensator spool and take measurements to certify that the axial, torsional, and angular alignments are within the manufacturer's allowable tolerance for an acceptable installation. Furnish certification furnished to the Owner after installation.
7) Remove shipping supports (not the control rods) provided on the compensators.

h. After the installation of the compensators is complete, reinspect the units to determine if the compensators are within the manufacturer's allowed offset, compression, and extension limits or if any units have been pulled tight against the retaining rods or compressed against the sleeves. Repeat the inspection after the piping system has been pressurized. Notify IDC of units that have moved to the maximum allowed position or are outside the manufacturer's limits, including offset before attempting to adjust the piping.

i. Final: Align motor shafts to pumps (if applicable).

G. Piping that Penetrates Floors, Ceilings, and Walls:

1. Provide chrome escutcheon finish plates where piping passes through walls, floors, or ceilings in finished areas and cabinets.
2. Provide major piping penetrations of footings, slabs, floors, walls, and roofs as shown on the Drawings. Verify the size and location of building and structure

penetrations prior to pouring concrete or finishing. Provide sealers in accordance with the requirements of Section 07900, Joint Sealers.

3. Provide necessary penetrations of footings, slabs, floors, walls, and roofs as required to complete the work. This includes design, arrangement, installation, and finishing of such penetrations in conformance with required fire ratings and other sealing requirements as stated in this Section and elsewhere in the project bid documents.
4. Embed wall pipes and pipe sleeves embedded in concrete walls, floors, and slabs as shown on the Drawings. Support pipes embedded in concrete walls, floors, and slabs with formwork to prevent contact with the reinforcing steel.
5. Use galvanized steel pipe sleeves on standard wall penetrations. Provide waterproof pipe sleeves manufactured by Link-Seal that incorporate waterproof membrane seals for piping penetrating exterior walls, roof, and floor slabs on grade.
6. Use galvanized or PVC sleeves on penetrations of footing walls and grade beams as shown on the Drawings.
7. Piping that penetrates fire-rated or smoke-rated walls, floors, or ceilings shall be in accordance with Section 07840, Fire Stopping.
8. Install piping which is parallel to horizontal and vertical building lines except as indicated otherwise in the Drawings.
9. Maintain uniform slope between bottom-of-pipe elevations defined on the Drawings.

3.6 PIPING FABRICATION

A. General:

1. Employ only labor that has been qualified by training and experience to capably perform the specified activities required to accomplish the work in a satisfactory manner.
2. Designate a quality-assurance inspector who is acceptable to the Owner to inspect the installation, cleaning, and testing of the piping systems. The inspector is also responsible for maintaining records for spools and appurtenances for inspection and approval by IDC.
3. If there is a conflict between the piping drawings and piping and instrumentation drawings (P&IDs), request clarification from IDC.
4. Deviations from the Specifications and Drawings require prior review and written approval by IDC.

3.7 PRESSURE TESTING

A. General:

1. The pressure testing requirements defined herein apply to piping systems.

2. Perform testing on piping after erection, but before installation of insulation. Furnish necessary equipment and material and make taps in the pipe, as required. IDC will review the results of these tests as documented by the Contractor. Test pressures, media, and durations are as specified in ANSI/AASME 31.3.
3. Hold test pressure for Class D fluids for a minimum of 2 hours, and hold test pressure for Class N fluids for a minimum of 4 hours.
4. Unless otherwise required by the Specifications, shop-fabricated pipe spools are not required to be hydrostatically tested at the shop. Field test spools after erection. Be responsible for the cost of correction of defects revealed during field hydrostatic tests.
5. Do not subject the following piping and equipment to pressure testing:
    a. Rotating machinery, such as pumps, turbines, compressors, and chillers.
    b. Pressure-relieving devices, such as rupture discs and pressure safety relief valves when the relief pressure is within 10 percent of the test pressure.
    c. Vessels that do not satisfy impact requirements at the piping test temperature.
    d. Locally mounted pressure-indicating gauges, where the test pressure would exceed their scale range.

B. Test Procedures:
1. Submit calibration records for gauges used for testing to IDC.
2. Install two pressure gauges for each testing system. Install gauges for testing as close as possible to the low point of the piping system.
3. When starting the filling of lines to be hydrostatically tested, open vents and other connections that can serve as vents during filling so that all air is vented prior to applying test pressure to a system.
4. If the maximum operating conditions of piping attached to a vessel are the same as those of the vessel, the piping and the vessel may be tested together. However, if the vessel has different maximum operating conditions, isolate and test it separately.
5. Examine joints and connections for leakage. Visual evidence of weeping or leaking of the piping system is not acceptable. Correct visible leakage at the Contractor's sole expense.
6. If the pressure falls after the pressurizing system is shutoff, the source of pressure loss must be determined and corrected. The system must be able to hold the test pressure for the test duration specified in Section 15059, Service Index, without detectable loss.
7. Provide piping designed for vapor or gas which is specified to be hydrostatically tested with additional temporary supports, if necessary, to support the weight of the test liquid.

8. If the ambient air temperature is less than 40 degrees F at the time of the pressure testing, the test medium heat as required to achieve the following temperatures when filling is complete:
    a. For pipe wall thickness 1 inch or less, 70 degrees F minimum.
    b. For pipe wall thickness greater than 1 inch, 100 degrees F minimum.

C. Special Requirements for Pneumatic Testing (Note - In the context used, pneumatic means any gaseous media.):
1. Recognize the hazards associated with compressible fluid testing and take necessary precautions to protect all personnel. Secure piping to be tested to prevent damage to adjacent piping and equipment in the event of a joint failure. Remove instruments or devices that may be damaged by the test from the piping or suitably isolated prior to applying the test. Prior to starting the test, notify IDC.
2. Apply a preliminary pneumatic test, not to exceed 25 psig, to the piping system prior to final leak testing as a means of locating major leaks. Check for leaks at joints and connections using a water-detergent mixture. After visible leaks have been corrected, gradually increase the pressure in the system to not more than 1/2 of the test pressure, after which increase the pressure in steps of approximately 1/10 of the test pressure until the required test pressure has been reached. Continuously maintain the pneumatic test pressure for a minimum duration of 10 minutes, or as specified in Section 15059, Service Index, and for such additional time as may be necessary to conduct an examination for leakage. The piping system, exclusive of possible localized instances at pump packing, shall not show evidence of leakage. Correct visible leakage at the Contractor's sole expense.

D. Testing Media Requirements:
1. Use clean, fresh, city water for hydrostatic testing where water is listed as the test media.
2. Provide other hydrostatic and pneumatic test media, listed as DI, Ar, and N_2, or other abbreviations, with the minimum quality standards in compliance with this Section.
3. Use water for testing austenitic stainless steel materials with chlorine content below 100 ppm.
4. After hydrostatic testing, all water be drained immediately. Open all vents to avoid pulling a vacuum during draining.

E. Test Repairs:
1. Replace materials such as gaskets, bolting, etc., damaged during tests and flushing.
2. New gaskets shall be used each time a flanged joint is made up.

3. Repair welded joints that are defective in accordance with the applicable pipe specifications. Examine repaired components by the original method to determine freedom from defects. The Contractor is responsible for costs of such repair.

F. Test Records: Record testing results for each piping installation. Include at a minimum the following items.
   1. Date of test.
   2. Description and identification of piping tested.
   3. Test fluid.
   4. Test pressure.
   5. Test duration.
   6. Remarks to include such items as:
      a. Leaks (type and location).
      b. Repairs made on leaks.
   7. Signature and date of person witnessing the test.
   8. Certification by Contractor and reviewed by IDC.

G. Defective joints shall be repaired in accordance with the applicable requirements. Re-examine repaired components by the original method to determine freedom from defects, and retest repaired joints. Costs for such repair is the responsibility of the Contractor.

3.8 CLEANING OF PIPING SYSTEMS

A. Following assembly and testing, flush with water piping systems not specifically listed as not to be wetted to remove any debris and other foreign material. Provide flushing velocities at a minimum of 2.5 feet per second.
   1. Dry lines designated as requiring drying immediately after the completion of the flushing. Before forced drying is started, remove control valves and in-line instruments that may be damaged and replaced as necessary with pipe spools. Provide instrument air (minus 40 degrees F dew point) or nitrogen to purge the piping until a minus 20 degrees F dew point is reached. Blow each low-point drain and the end of each branch line until the minus 20 degrees F dew point is reached. After each section of piping is dried and approved by IDC, replace the in-line instruments.

B. General Comments:
   1. Reference to the method of cleaning required for a given system will be indicated in the service index or design documents.
   2. Allow the Owner access to the premises to witness all cleaning and testing operations.

3. Contractor is responsible for all pumps, compressors, etc., to provide the motive force for cleaning and flushing piping systems. Provide electrical or other fuel requirements for operation of the cleaning equipment.
4. Blank off permanent plant equipment and fabricate spool pieces to provide a pathway around each piece of equipment. Common types of equipment may share the same spool piece. Move spools from piece to piece until the respective supply and return lines are cleaned. Removal of temporary blanks is the responsibility of the Contractor.
5. Boil out boiler using the manufacturer's recommended procedures and chemicals. Coordinate this procedure with the manufacturer's startup personnel.
6. Identify, provide, and install temporary branches, fittings, vents, drains, etc., required for performance of cleaning.
7. Remove control valves and other in-line devices that may be damaged by the cleaning method employed or bypassed and cleaned separately.
8. Incorporate sections of piping which are removed for temporary connections in the piping circuit being cleaned, or cleaned separately.
9. Return the piping system to its original integrity following the cleaning process.
10. Procedures listed are recommended procedures only. The Contractor may optionally submit proposals that include alternate cleaning procedures. Alternate procedures are subject to approval by IDC. Regardless of the procedure used, the Contractor is responsible for achieving the required cleanness.
11. Safety Considerations:
    a. Hold a safety and coordination meeting attended by all cleaning personnel to assure the site safety rules are adhered to. These rules typically include posting cleaning schedules prominently and well in advance, confined space entry permit procedures, audible warnings, flashing lights, etc.
    b. Notify the Owner of special safety precautions that must be taken to protect noncleaning personnel working in the area of systems being cleaned. Take steps necessary to protect these people from the hazards identified.
    c. Designate pipe systems utilizing steam blowdown or hot liquid or hot vapor cleaning. Accommodate thermal expansion in these piping systems. Accomplish this even if the system normally operates at ambient temperature.
12. Environmental Considerations:
    a. Contractor is required to manage the disposal of leftover and used chemicals incorporated in the cleaning procedures performed. Meet federal, state, and local regulations and the procedures shall be in a written form approved by the Owner before cleaning is started.

b. Use of chemicals classified by the EPA as nonhazardous is preferred for onsite cleaning. The Owner must approve variance from this in writing.

C. Cleaning Methods and Procedures: The cleaning methods described in Section 15060.dat, Flushing and Cleaning Data Sheet 3 apply to field-installed piping

3.9 ACCEPTANCE

A. IDC reserves the right to have any section of the piping system that is suspected to be faulty cut out of the system by the Contractor for inspection and testing. Should the joint prove to be sound, the Owner will reimburse the Contractor on a time-and-material basis as specified in the Contract. Should the joint prove to be faulty, the destructive test shall continue joint by joint until sound joints are found. The Contractor is responsible for costs for replacement of faulty work and/or materials.

Table 1
LINE CLASS DESIGNATIONS CONVENTION

First Two Letters: Pipe Material Identifier.
Third and Fourth Digits: Pipe Data Sheet Unique Identifier.
Note: One piping data sheet per line class designation.
For double-contained piping systems, use:
Inner pipe callout by outer pipe callout.
i.e., ST05 x ST04.
or 1/2-inch PA04 by 2-inch PC03.

Piping Material	Pipe Specification Summary	Specification Number
AB01	ABS pipe	
CC01	CPVC, Schedule 80	15090
CC02	CPVC, Schedule 80, enhanced QA	15090
CT01	Copper tubing, soldered (type L AG, type K BG)	15080
CT02	Copper tubing (DWV)	15080
CT03	Copper tubing, cleaned for O_2 service, brazed	15080
HS01	Hastelloy-C tubing, clean	15073
HS02	Hastelloy-C tubing, electropolished (Future)	15073
HS022	Alloy C22 SS piping Schedule 40 butt weld	15070
HS276	Alloy C-276 stainless steel pipe Schedule 10S butt weld	15070
PC01	PVC, Schedule 40	15090
PC05	PVC, Schedule 80	15090
PC07	PVC, Schedule 80, clean	15090

Piping Material	Pipe Specification Summary	Specification Number
PP01	PP, clean, pressure-rated IR butt-weld, SDR-11	15094
ST04	316L stainless steel tubing, clean	15073

Piping Material	Pipe Specification Summary	Specification Number

TABLE 1
INSPECTION AND SURVEILLANCE CHECKLIST

	I	S
Material type and size specified by drawing and/or specifications.	X	
Specifications in accordance with ASME.	X	
Welder qualified to ASME IX.	X	
Weld end preps and base metal clean per ASME.	X	
Preheat to include weld prep and 3 inches each side of the joint.	X	
Provide weld end preps and adjacent base metal free of damage and ends, and root gaps be per ASME.	X	
Weld filler material and position in accordance with ASME.	X	
Ensure that field welding is protected from airborne contamination or rust.		X
Power source leads, grounding, voltage, polarity, and amperage per specification.	X	
Weld bead sequence and in-process cleaning are approved.	X	
Travel speed per ASME.	X	
Tack welds used in the weld grooves are made by qualified welders.		X
Remove tacks containing cracks, slags, and porosity.		X
Lineup clamps, if used, left in position until a continuous bead equal to 1/4 of the circumference of the pipe has been completed on opposite sides of the pipe.		X
Radial misalignment at joining end of piping components shall be limited to 1/8 inch or 1/4 of the pipe wall thickness, whichever is less. Taper trim internal radial misalignment exceeding 1/16 inch so that the adjoining internal surfaces are flush. Provide the resulting thickness of the weld joint not less than the minimum design thickness plus corrosion allowance.		X
Socket and fillet weld fit-up and size, if the gap exceeds 1/16 inch, increase the fillet by the gap dimension; evaluate gaps exceeding 1/8 inch on a case-by-case basis.		X
Peening will not be allowed.		X
Slag is removed from the outside of all welds.	X	
Evaluate arc strikes and repaired.	X	

	I	S
Provide reinforcement per specification.	X	
Do not exceed weld projections of 1/8 inch except in piping 2 inches and smaller and pigged lines not to exceed 1/16 inch. Plastic- or elastomeric-lined pipe, fill internal porous areas, cavities, and pockets with weld metal; grind internal welds to a smooth uniform surface; orifice flanges, orifice fittings. Provide meter tubes to pipe or fittings having an ID smooth and flush with the ID of the pipe. Grind smooth and flush internal welds of the intake and interstage piping for reciprocating and rotary screw compressor with the ID of the pipe; if this cannot be done, make the root pass by the TIG process.	X	
Make socket weld size per specification.	X	
Provide slip-on flange and socket weld flange per specification and bolts properly torqued.	X	
When weld is completed, permanently apply on the work the welder or welders' identification.	X	
Removal of temporary attachments.	X	
Make all welding of supports to piping prior to filling pipe.		X
Complete visual inspection/acceptance per Attachment Table 2.	X	
Provide NDE other than visual per specification and program requirements.	X	
Weld metal and base metal repairs per specifications.	X	
Installation of pipe supports per manufacturer's instructions.	X	
Installation of vibration isolation joints per manufacturer's instructions and Specification Section 15060.	X	

This statement defines the intent of the (I) and (S) in Attachment 1.

(I) Is to be understood as inspection: a phase of quality control which by means of examination, observation, or measurement determines the conformance of items or services to predetermined quality requirements. Document through the use of checklists or weld stamps at the frequency required by the code and programs approved by IDC.

(S) Is to be understood as surveillance: a review, observation, and/or examination of activities that affect quality are being performed per approved programs. Document on the surveillance inspection report at a predetermined frequency directed by IDC.

TABLE 2
SURVEILLANCE INSPECTION REPORT

Weld Number	Bld.	ISO/Sheet Number	Weld Sym	Attribute Verified 5 Percent Random In Process Surveillance	Circle Y/N Y/N	Inspection Results N/A	Accept	Reject
				Material type and size specified by drawing and/or specification.				
				WPS in accordance with program requirements.				
				Welder qualified.				
				Weld end preps and base metal clean per program requirements.				
				Provide weld end preps and adjacent base metal free of damage, and ends and root gaps per ASME.				
				Weld filler material and position in accordance with ASME.				
				Ensure that field welding is protected from airborne contamination or adverse weather conditions.				
				Purge when required by IDC the content of oxygen in the exiting gas shall be 1 percent or below.				
				Power source leads, grounding, voltage, polarity, and amp.				
				Preheat in accordance with code include weld prep and 3 inches each side of the joint.				
				Tack welds may be used in the weld grooves and made with approved WPS by qualified welders.				
				Tacks containing cracks, slags, and porosity shall be removed.				
				Socket and fillet weld fit-up and size shall, if the gap exceeds 1/16 inch, increase the fillet by the gap dimension; gaps exceeding 1/8 shall be evaluated on a case-by-case basis.				
				Radial misalignment at joining end of piping components shall be limited to 1/8 inch or 1/4 of the pipe wall thickness, whichever is less; internal radial misalignment exceeding 1/16 inch shall be taper trimmed so that the adjoining internal surfaces are flush; the resulting thickness of the weld joint shall not be less than the minimum design thickness plus corrosion allowance.				
				Lineup clamps, if used, shall be left in position until a continuous bead equal to one-quarter of the circumference of the pipe has been completed on opposite sides of pipe.				
				Weld bead sequence and in-process cleaning.				
				Travel speed per WPS.				
				Slag shall be removed from the outside wall of SMAW welds.				
				Slag shall be removed from the back side of SMAW stainless and nickel alloy welds.				
				Peening will not be allowed.				

Weld Number	Bld.	ISO/Sheet Number	Weld Sym	Attribute Verified 5 Percent Random In Process Surveillance	Circle Y/N Y/N	Inspection Results N/A	Accept	Reject
				Weld projection shall not exceed 1/8 except in piping 2-inch NPS and smaller pigged lines not to exceed 1/16; plastic- or elastomeric-lined pipe, internal porous areas, cavities, and pockets shall be filled with weld metal; internal welds shall be ground to a smooth uniform surface.				
				Orifice flanges, orifice fittings, and meter tubes to pipe or fittings shall have an ID smooth and flush with the ID of the pipe; internal welds of the intake and interstage piping for reciprocating and rotary screw compressor shall be ground smooth and flush with the ID of the pipe; if this cannot be done, the root pass shall be made by the TIG process.				
				Reinforcement shall be per branch reinforcement matrix.				
				Arc strikes shall be evaluated and repaired.				
				Socket weld size shall be per code.				
				Slip-on flanges and socket weld flanges shall be per specification and bolts properly torqued.				
				Removal of temporary attachments.				
				Welding of supports to piping shall be made prior to PWHT.				
				Upon completion of the weld, the welder or welders' identification shall be permanently identified on the work.				
				PWHT shall be in accordance with Code.				
				Visual inspection/acceptance shall be per Attachment 341.4.1 in ASME/ANSI 31.3				

Comments: _____

_____

_____

Quality Control Inspector: _____ Date: _____

Lead Inspector: _____ Date: _____

END OF SECTION

SECTION 15061

CARBON STEEL PIPING SYSTEMS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements for materials, fabrication, and installation of carbon steel piping systems. In accordance with the requirements of ASME/ANSI 31.3 Process Piping.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the carbon steel piping systems:
   1. Section 15060 - Pipe and Pipe Fittings, General.
   2. The individual pipe class specification sheets included at the end of this Section.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

C. In the event of conflict regarding carbon steel piping systems requirements between this Section and another section, the provisions of this Section govern.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Material requirements are specified in the pipe class specification sheets provided at the end of this Section.

B. Special Requirements for Fabricated Fittings Over 48 Inches in Diameter: Fabricate carbon steel fittings over 48-inch nominal pipe size from the same materials as the pipe in accordance with the dimensions shown in AWWA C208. Fabricate elbows in accordance with the dimensions shown in the following tables contained in AWWA C208.
   1. 15 to 29 degree elbows, two pieces, Table 2A.
   2. 30 to 44 degree elbows, three pieces, Table 2B.
   3. 45 to 59 degree elbows, four pieces, Table 2C.
   4. 60 to 90 degree elbows, five pieces, Table 2D.

C. Increase elbow wall thickness over that of the pipe in accordance with the equation shown in the cautionary statement below Figure 2 of AWWA C208. Reinforce tees and branch fittings with crotch plates, collars, or wrappers where indicated on the Drawings. Use a working pressure of 125 psi in all pipe fabrication calculations. Fitting wall thicknesses must never be less than the pipe wall thickness.

D. Fabricate forged steel flanges over 48 inches in accordance with AWWA C207, Class D, hub type, faced and drilled 125-pound flat face, ANSI B16.1.

PART 3 -- EXECUTION

3.1 WELDERS AND WELDING OPERATORS

A. Qualify welders and welding operators at the Contractor's expense by an approved independent testing laboratory before performing any welding. Provide qualification tests in accordance with the requirements of Section IX of the ASME Code.

B. Prior to the start of the work, submit a list of the welders the Contractor proposes using and the type of welding for which each has been qualified. Copy of certification for each welder. Qualification tests may be waived if evidence of prior qualification is deemed suitable by IDC.

3.2 FILLER MATERIALS

A. Deposited weld metal shall conform to the standards listed below and have essentially the same alloy content as the metal being joined and be of essentially the same tensile strength:
   1. ASTM A233 for covered carbon steel electrodes.
   2. ASTM A558 for bare mild steel electrodes and fluxes for submerged arc welding.
   3. ASTM A559 for mild steel electrodes for gas metal arc welding. Tensile strength of the MIG weld deposit must be essentially the same as the tensile strength of the steel being welded.

B. Store welding rods in a warm, dry area per manufacturer's recommendation.

3.3 BACKING RINGS AND INSERTS

A. Do not use backing strips or rings except with specific written authorization by IDC as to use, material, and design. Root gap inserts that are completely melted and consumed in the weld bead are acceptable only with prior review of IDC.

3.4 JOINT PREPARATION AND ALIGNMENT

A. Provide weld bevels suitable for the welding process used. Fabricate the contour to permit complete fusion throughout the joint. Conform bevels to those used in the procedure qualification; however, when not specified, provide in accordance with the requirements of ANSI B31.3. Pipe having a nominal thickness less than 3/16 inch may have a slight chamfer or may be square, depending upon the fabricator's preference.

B. Make weld bevels by machining, grinding, or thermal cutting, and the surfaces to be reasonably smooth and true.

C. Position adjacent sections of welded pipe that are joined by butt welding so that the longitudinal weld seams do not match (minimum 30 degrees apart).

D. Wherever possible, do not match the position of the longitudinal weld seam with branch connections (couplings, stubs, etc.).

E. Where the ends of piping components are to be joined by welding and the internal surface misalignment exceeds 1/16 inch, that component, with the wall extending internally, internally trim (see Figure 328.4.3 of ANSI B31.3) so that the adjoining internal surfaces are flush. However, the resulting thickness of the welded joint shall not be less than the minimum design thickness plus any corrosion allowance.

F. Preheat materials that require preheating for welding at the same temperature for thermal cutting or gouging.

G. Clean surfaces to be welded free from paint, oil, dirt, scale, and other materials detrimental to welding.

H. Make fit-up by tack welding or using lugs.

I. Make tack welds with a qualified welder under a qualified welding procedure. Make tack welds that are part of the root pass with the same electrodes as are to be used for the first pass. Remove cracked tack welds by grinding.

J. Provide clear distance between centerlines of adjacent girth butt welds not be less than four times the pipe wall thickness or 1 inch, whichever is greater.

K. Provide end connections of shop-fabricated spool pieces as follows. Any exception to the following will be indicated on the piping drawing and reviewed by IDC prior to fabrication:
   1. Where field welding is required to join the ends of two pieces of fabricated pipe or a piece of pipe and a welding fitting or flange, the shop fabricator shall furnish both adjacent ends beveled for field welding and fabricated to the Drawing dimensions.

2. Where field fit-up is required to allow for adjustment in the field, one spool piece at the fit-up weld provide a plain end 6 inches longer than the dimension indicated on the piping drawing. Bevel the adjacent spool end and be fabricated to the dimension indicated.
3. Furnish where field welds occur at stub-ons to a field-fabricated straight run, the shop fabricator, the spool end contoured, and ready for welding. Should a reinforcement fitting (i.e., weldolet) be required, include in the shop spool.

3.5 WELDING PROCESS

A. Make field welds by the shielded metal arc process. Accomplish shop welding and fabrication in accordance with the submitted welding procedure qualifications reviewed by IDC.

B. Do not perform welding if there is impingement of rain, snow, sleet, or high wind on the weld area. If the ambient temperature is less than 32 degrees F, local preheating of the surfaces to a temperature warm to the hand is required.

3.6 WELD CONTOUR AND FINISH

A. Welding requirements are as follows:
1. Thoroughly clean each layer of deposited weld metal prior to the deposition of each additional layer of weld metal, including the final pass, with a power-driven wire brush. Surface defects, which affect the soundness of weld shall be ground out.
2. Provide a minimum of three weld passes on pipe sizes 6 inches through 24 inches, using the specified covered electrode. Provide minimum of a full root and second pass on all welded pipe 4 inches and under.
3. Cracks will not be permitted. Other reasons for rejecting welded joints will be incomplete penetration, weld undercutting, excessive weld reinforcement, porosity, and slag inclusions in excess of the limits prescribed in Chapter V of ANSI B31.3.

3.7 GROOVED END JOINTS

A. Make grooved end provisions on pipe ends in accordance with the following:
1. Schedule 10 piping grooves formed by rolling.
2. Schedule 40 piping grooves made by machining.

PIPE CLASS SPECIFICATION SHEET

PIPE CLASS SPECIFICATION SHEET

Pipe class	CS02
Rating	Pressure 125 psi at minus 20 to 150 degrees F
Code	ANSI B31.3
Pipe	
3/4 inch and under	ASTM A53B, Seamless Schedule 40, black, plain end
1 inch and over	ASTM A53B, ERW, standard weight, black, plain end
Nipples	Schedule 80

	2 Inches and Under	Over 2 Inches
Fittings	Forged steel, 2,000-psig socket weld, ASTM A105	Butt weld, ASTM A234
Flanges	Forged steel, socket weld, Class 150 RF, ASTM A105	Same, except slip-on and weld neck
Unions	Use flanges	None
Sockolets	3,000 psi, ASTM A105	None
Weldolets	None	Standard weight, ASTM A105

END OF SECTION

SECTION 15066

CAST IRON PIPING SYSTEMS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish, install, and test cast iron piping systems.

1.2 RELATED SPECIFICATIONS

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for cast iron piping systems:
   1. Section 15060 - Pipe and Pipe Fittings, General.
   2. Section 15140 - Piping Supports and Anchors.
   3. Section 15440 - Plumbing Fixtures.
   4. The individual pipe class specification sheets included at the end of this Section.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 REGULATORY REQUIREMENTS

A. International Plumbing Code (IPC).

1.4 SUBMITTALS

A. See the Submittal Schedule at the end of this Section.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Material requirements concerning the pipe and fittings are specified in the pipe class specification sheets provided at the end of this Section.

B. Approved Coupling Manufacturers:
   1. AB&I Sure-Grip.
   2. Clamp-All (Heavy Duty).
   3. Husky, Series 4000.

PART 3 -- EXECUTION

3.1 PIPING INSTALLATION

A. Piping Assembly: Assemble piping in accordance with the pipe manufacturer's recommendations and as specified below.
   1. Hubless Coupling Installation:
      a. Cut the hubless pipe smooth and square.
      b. Place neoprene gasket on end of the pipe or fitting to be joined. Place the stainless steel housing with clamps on the end of the other pipe.
      c. Butt the ends of the pipe together within the gasket until both are firmly seated against the inner ring.
      d. Slide the housing into position directly over the gasket. Alternately tighten clamps with a torque wrench to the coupling manufacturer's recommended torque.
   2. Compression (Hub and Spigot) Joint Installation:
      a. Clean internal surface of hub and external surface of the spigot end of pipe and/or fitting.
      b. Insert gasket into the hub with the retaining flange or collar of the gasket adjacent to the face of the hub.
      c. Apply lubricant to the inside of the gasket and/or to the exterior of the spigot end of the pipe or fitting.
      d. Align the spigot and hub in a straight line and with the use of manufacturer's recommended tools, force the spigot end of the pipe or fitting into the gasket.

B. Above-Grade Piping:
   1. Support piping as specified in Section 15140, Piping Supports and Anchors, and as indicated in CISPI 310.
   2. Piping requiring insulation shall be as specified in Section 15270, Equipment and Piping Insulation. Test piping as specified in Section 15059, Service Index before the piping is insulated.
   3. Coordinate piping connections with plumbing fixtures as specified in Section 15440, Plumbing Fixtures.
   4. Support vertical piping at each stack base and at each floor not to exceed 15 feet between supports. Where floor-to-floor distance exceeds 15 feet, provide intermediate vertical and lateral support. Stake or brace freestanding pipes during construction to maintain alignment. Route exposed risers as close as possible to walls or vertical structural members.
   5. Support horizontal piping within 18 inches of each joint and at a maximum of 10 feet on center. Runs of four feet or less may be supported at every other

joint. Place supports and hangers to maintain alignment and grade with provisions to prevent shear. Brace large-diameter pipes (5 inches and larger) at changes in direction to prevent horizontal movement and joint separation.

6. Secure closet bends against movements in any direction.

3.2 TESTING:

A. Use test plugs and test tees where vertical testing is executed in sections.

PIPE CLASS SPECIFICATION SHEET

Pipe class	CI01 (no hub)
Rating	
Domestic waste and vent, above and below grade	Coupling shall have no leaks at a pressure of 30 feet of water at ambient temperature
Storm and overflow drains	Coupling shall have no leaks for the entire height of system
Codes	CISPI 301 (ASTM A888) and local plumbing
Pipe	Cast iron soil pipe with no-hub ends; all cast iron soil pipe and fittings shall be bituminous-coated inside and out and shall bear the manufacturer's name or trademark and the Cast Iron Soil Pipe Institute (CISPI) symbol
Joints	No-hub couplings shall be made of heavy-duty, corrugated AISI 304 stainless steel shield with a minimum of four heavy-duty clamps and AISI 305 stainless steel screws; gaskets shall be one-piece molded neoprene, ASTM C564, sleeve with sealing beads <u>1 1/2 Inches to 10 Inches</u>
Fittings	Cast iron, no hub

Submittal Schedule

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	2 WEEKS PRIOR TO BEGINNING INSTALLATION	PRIOR TO SUBSTANTIAL COMPLETION
15066-001	Pipe manufacturer and specifications for pipe material.		X	
15066-002	Coupling manufacturer and specifications for coupling material including gasket material.		X	

END OF SECTION

SECTION 15073

STAINLESS STEEL AND SPECIALTY-METAL TUBING SYSTEMS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section provides requirements for furnishing materials and installing, including cleaning, fabricating, and testing stainless steel and specialty-metal tubing systems in accordance with the requirements of ASME/ANSI B31.3 Process Piping

B. This Section establishes requirements for work to be performed by the Contractor in Contractor-furnished offsite or onsite cleanroom(s), as well as work to be performed in the permanent facility.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for stainless steel and specialty-metal tubing systems:
   1. Section 15060 - Pipe and Pipe Fittings, General.
   2. Section 15140, Pipe Supports and Anchors.
   3. The individual tube-class specification sheets included at the end of this Section.

B. CAUTION: Use of this Section without including all of the above-listed items will result in omission of basic requirements.

1.3 QUALITY ASSURANCE

A. Provide a dedicated quality control representative (QCR) who shall have primary responsibility for the following:
   1. Setting up the Contractor's project quality program.
   2. Implementing and monitoring Contractor conformance to the project quality standards.
   3. Maintaining appropriate logs for shipping, inspection, welder qualification, weld samples, test welds, and test documentation for the project.
   4. Resolving Contractor quality issues jointly with the QAR, Owner, and IDC.

B. The Owner may elect to provide an independent quality assurance representative (QAR). The QAR will be responsible to the Owner and will:

1. Monitor Contractor fabrication and installation product quality and activities. QAR will jointly resolve quality issues with the Contractor, IDC, and Owner.
2. Perform and direct final sampling and analysis of the tubing systems covered by this Section.
3. Have authority to reject all or any part of the system that does not conform to the requirements of this Specification. The QAR will have full technical jurisdiction over the Contractor in matters relating to quality control.

C. Industry standards to be followed for testing:
1. AES of Interior Finishes: Sematech 91060573B-STD.
2. ESCA or XPS of Interior Finishes: Sematech 90120403B-STD.
3. EDX of Interior Finishes: Sematech 90120402B-STD or ASTM F1375.
4. SEM of Interior Finishes: Sematech 90120401B-STD or ASTM F1372.
5. Profilometry of Interior Finishes: Sematech 90120400B-STD or ASME B46.1.
6. Helium Leak Checking: Sematech 90120391B-STD.

1.4 SUBMITTALS

A. Provide the following with the Bid:
1. A detailed description of Contractor-furnished temporary onsite cleanroom(s).
2. Contractor's proposed protocol for work to be performed in the temporary cleanroom(s).
3. The resume of the proposed QCR individual.
4. The specific makes, models, and serial numbers of cutting tools, joint preparation tools, and automatic welding equipment to be used.
5. Weld procedures, weld procedure specification format, and procedure qualifications record format.
6. Installation quality control and quality assurance procedures.
7. Proposed tubing and fittings manufacturer for each tubing class.
8. Tubing and fittings cut sheets indicating materials of construction, leak rates, surface finish, testing and quality assurance procedures, and dimensional details to demonstrate Contractor/bidder understanding and compliance with this Specification.
9. Packaging details including materials, thicknesses, and procedures for tubing and fittings.
10. Manufacturer’s preshipment cleaning and packaging procedures for tube and fittings.
11. Contractor's cleaning procedure for tubing and fittings.

B. Provide the following at least 4 weeks prior to ordering materials:
1. Workmanship samples of each size of tubing and butt-weld fittings required for the project.

2. Identification (trade names) of consumables to be used in cleaning, preparation, and installation.

C. Provide the following at least 6 weeks prior to fabrication:
1. Tubing system isometrics for tubing greater than 3/4 inch diameter and for all tubing of clean and/or high-purity systems.
2. Completed weld procedure specification and weld qualification record for each size and type of tubing to be installed.
3. Welder qualification certificates.
4. Contractor inspection certificates for tube, fittings, and components.
5. Pressure test and analytical test procedures, equipment, and test record forms.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are identified on the tube class specification sheets at the end of this Section.

2.2 TUBING AND FITTINGS

A. Tubing:
1. Identify tubing with the mill heat number. Minimize the number of mill heats for a given tube size. Identify certification of material with the mill heat number, and provide a copy of certificates to the Owner.
2. The tubing interior surface roughness shall meet the requirements indicated on the tube class specification sheet(s) at the end of this Section per ANSI B46.1
3. Provide tube in 20 foot (or 4 meter) nominal lengths and packaged in quantities easily hand-transported by two personnel.
4. Source inspection of the tubing and fittings may be required and performed by the Owner or their designated representative.

B. Fittings: Refer to the tube specification data sheet(s) at the end of this Section for fitting requirements.

2.3 CLEANING AND PACKAGING

A. Cleaning and Packaging Class CL-2:
1. The cleaning process shall minimize residual organics and particles and shall not use chlorofluorocarbons or organic solvents.
2. Clean and inspect tubes and fittings per Compressed Gas Association (CGA) Pamphlet 4.1. The cleaned tube or fitting exterior shall be suitable for use in a Class M4.5 (1,000) environment.

3. Dry tube interiors with nitrogen after the final rinse.
4. Cover tubing and fitting ends with vinyl caps over polyamide sheet. Heat-seal each tube or fitting in a polyethylene bag.

PART 3 – EXECUTION

3.1 SUPPORTS AND HANGERS

A. Support piping in accordance with the requirements of Section 15140, Pipe Supports and Anchors.

3.2 QUALITY

A. The QCR will be responsible for welder training, weld coupon inspection, pressure tests, implementation, and standardization of procedures required to meet this Specification.

B. The QCR will assist the QAR in the final analytical testing and commissioning of clean and high-purity systems.

C. Workmanship Samples:
1. To demonstrate understanding and intended compliance with the materials quality requirements of this Specification, each bidder is required to submit cut sheets for each size of tubing and butt-weld fittings required on the project that would be furnished by the bidder. Inadequately prepared or missing cut sheets or may be cause for rejection of the Bid.
2. The successful bidder will be required to submit samples of each type and size of tubing and butt-weld fittings required on the project. The samples represent the actual tubing and butt-weld fittings to be furnished for the project. The submitted samples will be kept by the Owner and the QAR and used to evaluate tubing components sent to the jobsite by the successful bidder. Tubing and butt-weld fittings that are not the same as the submitted and Owner-approved samples shall be rejected.

3.3 MATERIALS

A. In addition to furnishing the tubing, fittings, and components identified in the Drawings, furnish the following, in accordance with requirements of Section 15060, Pipe and Pipe Fittings, General:
1. Argon gas used for welding and pressure testing.
2. Nitrogen gas used for tube preparation.
3. Helium gas used for testing.
4. DI water used for tube preparation and cleaning.

5. IPA used for cleaning.

B. Furnish consumable materials and supplies required to perform and complete the work.

3.4 STORAGE AND HANDLING

A. Handle and store materials and equipment in a sheltered location through the progress of the job in such a manner as to prevent damage and/or contamination. Store clean and high-purity tubing, fittings, and components in an enclosed controlled environment.

B. Physically separate stored tubing and fittings by tube class.

C. Seal under a positive nitrogen pressure components transported between the Contractor's cleanroom and the installation point.

D. Do not use material or equipment that becomes damaged or contaminated unless it is repaired and recleaned to the original requirements. Segregate such material from the clean material and obtain inspection and approval by the QAR before its use.

3.5 WORK PERFORMANCE

A. Perform work of this Section in the full-time presence of the Owner-approved QCR and for clean and high-purity systems, the QAR as well.

3.6 FABRICATION

A. Welding Procedure:
1. Required Welding Process: tungsten inert gas (GTAW) arc welding with argon shielding and inside tubing purge.
2. Required Welding Machines: automated, orbital. Only welding machines identified in submittals and reviewed by the Owner may be used. Substitutions are not allowed without specific Owner review.
3. Use the Contractor's welding procedure specification sheets to determine initial prediction of the welding conditions required for any tube diameter, weld position, material specification, and welding machine.
4. Qualify welding procedures before they are approved for fabrication. Prepare a minimum of two test spools in accordance with the welding procedure specification, one for destructive testing and one to remain on site as a visual example. The following items require inspection and/or testing to qualify a weld:
   a. Weld bead reinforcement (internal and external).
   b. External weld bead width.

c. Internal weld bead width.
d. Porosity.
e. Inclusions.
f. Dendrites.
g. Cracks.
h. Oxidation: haze (internal and external).
i. Helium leak test.
j. Tensile test.

5. Document the results of these inspections and tests on a procedure-qualifications record containing the same information as the associated welding procedure specification.
6. Prepare a new weld procedure specification and procedure-qualifications record if any of the following change:
   a. Wall thickness.
   b. Diameter.
   c. Weld position (vertical, horizontal, inclined).
   d. Welding machine type (vendor and model).
   e. Change in material heat number.

3.7 WELDING QUALIFICATIONS

A. Fabricate and install stainless steel and specialty-metal tubing systems only with qualified welders.

B. Qualification of Welders:
   1. Designate specific welders to work on the stainless steel and specialty-metal tubing systems.
   2. Demonstrate each of the designated welder's skill in welding technique in the presence of the QCR and QAR This demonstration must closely duplicate actual field conditions at the jobsite, including the use of precleaned pipe and fittings, purging, and welding. Identify completed or welded joints with the welder's name, then cut and inspect for insufficient or excessive penetrations, deburring, oxidation, cleanliness, and workmanship.
   3. Qualify each welder on the automatic orbital welding equipment for the Contractor-established procedures to be used on the project.
      a. Make automatic welds consisting of a one-pass fusion weld with no filler added.
      b. Make the interior root pass with interior root contour having a projection of not greater than 0.02 inch.
      c. Inspect the weldment for the amount of discoloration, mismatch, workmanship, and cleanliness.

4. QCR demonstrates to the Owner or QAR that the welders are qualified. Notify the welders whose work is judged to be below standard that they are not permitted to work on the stainless steel tubing systems.
5. QCR ensures a weld coupon is taken from each orbital welder as follows:
   a. At the beginning of the project.
   b. At the start of the day.
   c. After each change of tubing size, wall thickness, or lot number.
   d. After any change of welding machine or power source.
   e. After maintenance of a welding machine.
6. QCR ensures the weld coupon is properly tagged with the welder's name, welding machine number, the date, and the time of day.
7. Retain weld coupons as reference for future comparison. For clean and high-purity systems, QCR shall give the coupons to the QAR.

C. Installation:
1. Before performing work on the material, visually inspect material to ensure material meets cleanliness expectations. Present tubing materials not meeting specification requirements to the QAR for inspection.
2. Maintain clean tube, fittings, and cutting tools. Keep cutting tools separated for industrial-grade tubing fabrication.
3. Deburr each cut and square ends. Clean outside and inside diameter and cap.
4. Minimize field welding by fabricating subassemblies in the cleanroom. Purge and cap or bag subassemblies for subsequent installation in the field.
5. Make welds located outside the cleanrooms in an enclosed, clean, nondusty area. If welds are to be made outdoors, provide a temporary shelter around the affected area to minimize particles around the tube.
6. During welding, continuously purge gas lines with argon. Allow argon to escape through a purge restrictor. Measure and control back pressure at the weld area.
7. Filter purge gas with a 0.01-micron filter. Provide purge gas regulators, valves, flow meters, and filters of the same quality as in the system being constructed.
8. Perform only one weld at one time within the system.
9. Maintain positive purge pressure on tubing at all times during fabrication and installation. To minimize argon consumption, temporary compression caps with nylon ferrules may be used to cap tees to contain the purge during overnight and weekend periods.
10. Welded joints which show evidence of overheating, lack of fusion, misalignment, cracking, pin holes, undercut, inadequate or excessive weld bead width, incomplete penetration, or other defects of fit-up or workmanship shall be subject to removal and replacement.

11. Ensure valves are located to allow space to operate valve handle and connect purge ports. Report any conflicts between actual to-be-installed conditions and the Drawings to the IDC before installation.
12. If the system becomes contaminated due to fabrication technique, Contractor is required to, at Contractor's expense, clean or replace the system as necessary to meet the specification requirements.

3.8 INSPECTION AND EXAMINATION

A. Materials and workmanship are subject to inspection and examination by the Owner or the QAR at any place where fabrication, cleaning, erection, and testing are performed.

B. Upon request of the Owner, remove random samples of installed work sufficient to establish the quality of materials and workmanship. If one or more samples show evidence of oxidation, contamination, or insufficient or excessive penetration, the Owner may require testing of additional samples. If the additional samples are acceptable, the Owner will pay for the direct labor and materials required for the cutting out and restoration of these samples. If they are not acceptable, the cost shall be paid in full by the Contractor.

C. If the number of unacceptable samples exceeds 1/3 of the total number of samples tested in that system, all joints must be removed and new tubing installed with new fittings at the Contractor's expense. The reinstalled system shall meet the requirements for a new system.

D. QCR provides the QAR a schedule of all testing with sufficient notice that the QAR is able to witness the testing.

E. Before testing of the system, QCR verifies with the QAR and IDC that the installation is in compliance with the latest drawings. Correct any deviations before testing proceeds.

F. Repairs and rework resulting from work not passing required inspections and testing are at Contractor’s expense.

3.9 PRESSURE TEST

A. Perform the system proof pressure and pressure decay test.

B. Provide the necessary test gauges as follows:
1. Provide gauges that are cleaned for oxygen service by the manufacturer. Seal and label gauges by manufacturer.
2. Gauge accuracy to ANSI 1A (1 percent over entire dial arc).

3. 4-1/2-inch dial face.

C. The test media and pressure are defined in Section 15059, Service Index. The QAR will calculate the duration of the pressure decay test. Detectable loss of pressure after compensation for ambient temperature changes for the specified period is not allowed.

D. Repair or replace defective tubing and/or components until tests are accomplished successfully and no detectable leaks or loss in pressure is noted.

3.10 OUTBOARD HELIUM LEAK TEST

A. Perform the helium leak test. Inform the Owner's QAR of the test schedule.
   1. Install sealed plastic (bagged) envelopes on weld points, connections, fittings, VCR connections, and components.
   2. Correct and retest weld points, connections, fittings, VCR connections and components with leak rates above levels identified on the tube class specification sheet(s) until successful results are obtained.

3.11 CERTIFICATION TESTS

A. Perform the certification tests as specified on the tube class specification sheets at the end of this Section.
   1. Final Particle Test:
      a. Perform this test after the systems are installed and have passed the pressure and outboard helium leak tests.
      b. Perform testing in the intended direction of gas flow with a minimum velocity of 20 fps.
      c. Use the sampling device identified in the Contractor procedure that was reviewed by the Owner.
   2. Moisture and Oxygen Tests:
      a. Perform these analytical tests after the systems have passed the final particle tests.
      b. Minimum required flow velocity through the tubing systems is 2 to 5 fps.
      c. Use the analytical equipment identified in the Contractor procedure that was reviewed by the Owner.
   3. Costs incurred for analytical testing, including any rework or subsequent testing to meet requirements identified on the tube class specification sheet(s) are at Contractor's expense.
   4. Record results on Owner-approved test form.

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ST04 TUBE CLASS SPECIFICATION SHEET

Tubing	Single-melt, clean 316L stainless steel per ASTM A269 and A632
Interior finish	As drawn or mechanical polish
Cleaning and packaging	Class CL-2
Sulfur content	0.005 percent to 0.017 percent

Tube Size	Wall Thickness	Manufacturing Method	Surface Finish
1/4- and 3/8-inch ODS	0.035 inch	Seamless	180 grit/30-microinch Ra
1/2-inch ODS	0.049 inch	Seamless	180 grit/30-microinch Ra
3/4- through 3-inch ODS	0.065 inch	Welded and drawn	180 grit/30-microinch Ra
4-inch ODS	0.083 inch	Welded and drawn	180 grit/30-microinch Ra
6-inch ODS	0.109 inch	Welded and drawn	180 grit/30-microinch Ra

	1 Inch and Below	1-1/2 through 6 Inches
Fittings	316L butt weld, fabricated from tubing listed above, or compression fittings	316L butt weld, fabricated from tubing listed above
Flanges and unions	Use compression fitting	316L lap joint, ASTM A403WP, with CS Class 150 backup flanges

Bending tube sizes	1/2 inch and smaller is acceptable. 1/4-inch tubing - 10 times tube diameter bend radius 3/8-inch tubing - 7.5 times tube diameter bend radius 1/2-inch tubing - 5 times tube diameter bend radius
Testing by manufacturer	
SEM	No
Auger	No
ESCA	No

Interior surface roughness	Yes
Dimensional	Yes
Testing by Contractor and criteria	
Helium leak check	10 E-4 atm-cc/sec
Particles per cubic foot	Less than 30 size 0.1 micron and larger and less than 10 size 0.5 micron and larger.
Moisture test	None
Oxygen test	None
Acceptable manufacturers	
Tube and tube fittings	Valex, HTC, Cardinal, McJunkin
Machined weld fittings	Cajon (Microfit), Parker (Minibutt), HTC (Mini Butt), Ewal (Mini Weld)use only as required and Owner approved for tight piping configurations such as VMBs or gas cabinets
Mechanical fittings	Swagelok (Swagelok), HTC (Let-Lok), Parker, (CPI)

END OF SECTION

SECTION 15080

COPPER TUBING SYSTEMS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install copper tubing systems.

B. This Section establishes requirements for work to be performed in the permanent facility for both nonhigh purity and clean copper tubing and for work to be performed in the copper cleanroom for clean copper tubing.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for copper tubing systems.
   1. Section 15060 - Pipe and Pipe Fittings, General.
   2. Section 15140 - Pipe Supports and Anchors.
   3. The individual pipe class specification sheets included at the end of this Section.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

C. In the event of conflict regarding copper tubing system requirements between this Section and another section, the provisions of this Section govern.

1.3 QUALITY ASSURANCE

A. Provide an independent quality control representative (QCR) who shall be identified and shall have primary responsibility for the following:
   1. Setting up the project quality program.
   2. Implementing and monitoring Contractor conformance to the project quality standards.
   3. Maintaining appropriate logs for shipping, inspection, welder qualification, weld samples, test welds, and test documentation for the project.
   4. Resolving quality issues arising during the project jointly with the Contractor, quality assurance representative (QAR), and IDC.

B. The Owner may elect to provide an independent QAR. The QAR will be responsible to the Owner. The QAR will:
   1. Aid the Contractor in monitoring fabrication and installation product quality and activities. Quality issues on the project will be resolved jointly with the Contractor, IDC and Owner.
   2. Perform and direct final sampling and analysis of the clean copper tubing systems covered by this Section.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Material or installation equipment that is damaged in handling shall not be used. Clean material or installation equipment that becomes contaminated shall be returned to the manufacturer for replacement. Clean materials that are supplied without properly sealed packaging shall be rejected and replaced with new, clean, and properly packaged material.

B. Equipment and materials received for installation shall be transported, handled, and stored indoors in a sheltered location with protection from sunlight and weather elements in such a manner as to prevent damage and/or contamination.

1.5 SUBMITTALS

A. Provide the following with the Bid:
   1. Fabrication quality control plan and field quality assurance procedures, including incoming material inspections, cleaning, and installation.
   2. Pipe manufacturer and specifications for piping material.
   3. Proposed QCR to be provided by the Contractor.
   4. Where labeled clean on the pipe class data sheets, provide:
      a. A detailed description of the factory manufacturing, cleaning, and packaging criteria.
      b. A detailed description of the copper cleanroom to be supplied.
      c. Purge gas quality.
      d. Proposed protocol for work performed in the copper cleanroom and in the field.
      e. A sample of each size of tubing and butt-weld fittings required on the project. The samples shall represent the quality level of tubing, fittings, and brazing to be supplied if the bidder is chosen for the project. Inadequately prepared samples may be cause for rejection of the Bid. The accepted samples will be kept by the Owner and the QAR to evaluate tubing components sent to the jobsite by the successful bidder. Tubing, fittings, and brazed connections that are not of the same level of quality as the accepted samples shall be rejected.

B. Provide the following at least 4 weeks prior to fabrication:
   1. Copy of the field soldering, brazing, and material handling procedure specifications to be used.
   2. List and certificate of qualification for each fitter of clean copper tubing.
   3. Shop drawings of proposed work showing welds (shop and field) and identifying which joints will be made in the field.
   4. Pressure and analytical test procedures and standard forms.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are identified on the pipe class specification sheets at the end of this Section.

2.2 MATERIALS

A. Material requirements concerning the tubing, fittings, flanges, unions, solder, brazing, and filler metal are specified in the pipe class specification sheets provided at the end of this Section.

B. Clean Tubing Systems:
   1. Hard-drawn virgin copper, with minimum purity of 99.9 percent, with no more than 0.02 percent phosphorus.
   2. Provide tubing and fittings precleaned, dried, inspected, and sealed in accordance with the requirements of NFPA 99, Health Care Facilities and with CGA-G4.1, Clean for Oxygen Service.
   3. The cleaning process shall minimize residual organics and particles and shall not use chlorofluorocarbons or organic solvents.
   4. Cleaned and dried tubing and fitting ends shall be covered with vinyl caps over poly sheets. Each tube or fitting shall then be heat sealed in polyethylene bags.

PART 3 -- EXECUTION

3.1 QUALITY

A. The QCR will be the point of contact for the Owner's QAR. The QCR will be responsible for training, coupon inspection, pressure tests and implementation, and standardization of procedures required to comply with this Section.

B. The QCR will assist the QAR in the final analytical testing and commissioning of clean systems.

C. Site installation procedures and activities shall comply with the requirements of the procedures of the reviewed Contractor submittals.

D. For Clean Copper Tubing Systems: Provide the following, in accordance with requirements of Section 15060, Pipe and Pipe Fittings - General.
   1. DI water

E. Consumables used in the process of performing the work shall be supplied by the Contractor.

F. Tools: Use flat-faced wrenches and vises on copper systems. Pipe wrenches and vises with toothed jaws will damage copper materials and are prohibited.

3.2 TUBING PREPARATION

A. Cut tubing square with sharp wheeled cutters (no hacksaws) and remove burrs. Clean both inside of fittings and outside of tubing with steel wool and muriatic acid before sweating. Take care to prevent annealing of fittings and hard-drawn tubing when making connections.

B. Bends in soft temper tubing shall be long sweep, wherever possible. Shape bends with bending tools without causing appreciable flattening, buckling, or thinning of the tube wall at any point.

3.3 BRAZING QUALIFICATION

A. The qualification of brazing procedures, brazers, and brazing operators shall be in accordance with the requirements of Section IX of the ASME Pressure Vessel Code.

3.4 VALVE INSTALLATION

A. Prior to brazing of valves, remove Teflon and elastomer seats and seals to prevent damage.

3.5 INSTALLATION OF INSTRUMENT AIR TUBING

A. Instrument air supply lines shall be minimum 3/8 inch nominal unless otherwise shown. Instrument air control lines shall be 1/4 inch nominal.

B. Keep tubing and conduit runs a minimum of 12 inches from hot pipes.

3.6 CLEAN TUBING INSTALLATION

A. Inspection, cutting, and prefabrication operations shall occur in a dedicated copper cleanroom fabrication area, per the requirements of this Section.

B. Inspect incoming material in the copper cleanroom.

C. Threaded connections in clean copper tubing systems shall not incorporate pipe dope, only Teflon tape is allowed on threads.

D. Tube and fittings shall be purchased clean per the requirements of this Section and inspected for cleanliness as follows inside the cleanroom:
   1. Verify packaging not torn. Components with torn packaging shall be replaced by the manufacturer.
   2. Unpackage component and remove end caps. Examine openings with a 10-power (minimum) magnification device in bright light. Components with visible contamination, staining, or discoloration shall be replaced by the manufacturer.
   3. Clearly label rejected components.
   4. Activities within the copper cleanroom shall be in compliance with the protocols and procedures of the reviewed Contractor submittals.

E. Tubing Inspection and Cleaning - Inspection procedures for 100 percent of the incoming product shall include the following cleanroom activities as a minimum:
   1. Copper tubing shall be delivered to the jobsite with plastic end caps inserted. Prior to verifying the cleanliness of the tubing, the end caps shall be cut off with the last few inches of copper at each end.
   2. Blow a lintfree cloth wad through each tube with clean nitrogen. Soak each wad in DI water. The wads shall have a minimum length of three times the diameter of the tubing and shall be tight fitting and wrinklefree so as to provide maximum surface contact with the tube interior.
   3. Visually examine the wad for contamination. If the wad is dirty, repeat the above wad-blowing operation. Tubing that shows dirty wads after five cycles shall be labeled rejected with the date. The QAR shall be notified of rejected tubing.
   4. While each tube is under a positive purge, cap and seal the ends. Use baggies with tape and external caps. The tape should be wrapped at least 1 inch beyond the end of the cap and the bags. Label the tube inspected with the date.

F. Fitting and Other Component Inspection: When possible and acceptable with the construction schedule, fittings valves, gauges, and regulators shall be delivered to the jobsite precleaned and double bagged for oxygen service per NFPA 99 and CGA Pamphlet G-4.1. Prior to installation, inspect 100 percent of these components for visual defects, such as particulates or grease. Components with visual contamination shall either be recleaned on site or labeled rejected and shipped back to the manufacturer.

G. Fittings, valves, and other piping components not delivered precleaned and bagged or that have failed the visual inspection shall be cleaned as follows:
   1. Soak components in an IPA bath for 5 minutes.
   2. Remove components from the bath and scrub them with a nylon brush in a second IPA bath.
   3. Rinse scrubbed components in a DI bath then blow dry with nitrogen. Change bath as necessary to maintain a clean rinsing solution.
   4. After blow drying, place components in a cleanroom bag and seal partially. Insert the nitrogen probe into the bag opening and displace the area of the bag with nitrogen then seal the opening. Clean only the number of fittings that will be used within 48 hours.
   5. Take components from the bag only as they are placed into a purged line for fabrication; reseal the bag with cleanroom tape. Reclean components that sit overnight in an open bag.

D. Only qualified fitters shall install clean copper tubing systems. Each qualified fitter shall demonstrate their skill in welding technique in the presence of the QCR and QAR. This demonstration must closely duplicate actual field conditions at the jobsite, including the use of precleaned pipe and fittings, purging, and brazing. Completed or welded joints will be identified with the craftsman's name then cut and inspected.

E. Prefabrication of piping sections shall be performed as much as feasible in a controlled area or the dedicated copper cleanroom so that the number of brazing operations required in the field is minimized. This includes prefabrication of possible subfab laterals, skid piping spools, and other subassemblies.

F. Components transported between the Contractor's cleanroom and the installation point shall be sealed under a positive nitrogen pressure.

3.7 SUPPORTS

A. Continuously support individual pipe, tubing runs, and instrument capillary tubing 3/8 inch and smaller in channels, trays, conduit, or form structures so that mechanical damage will not occur. Clamp pipe and tubing in place. Locate tubing trays and channels in such a manner that they will not catch spillage, overflow, or dirt from above.

B. For piping and tube larger than 3/8 inch, support in accordance with the requirements of Section 15140, Pipe Supports and Anchors.

3.8 INSPECTION AND EXAMINATION OF CLEAN TUBING SYSTEMS

A. Materials and workmanship shall be subject to inspection and examination by the Owner or the QAR at any location where fabrication cleaning and erection are performed.
   1. For each system and upon request of the Owner or QAR, the Contractor shall remove up to six designated samples of installed work to establish the quality of materials and workmanship. If one or more samples show evidence of oxidation or contamination, the Owner may require testing of up to six additional samples. The Contractor shall bear the cost of obtaining and restoring these samples.
   2. If the number of unacceptable samples exceeds one-third of the total number tested in that system, all joints and tubing must be removed and new tubing installed with new fittings at Contractor's expense. The reinstalled system shall meet the requirements for a new system.

3.9 TESTING OF CLEAN TUBING SYSTEMS

A. Prior to testing, check all systems to ensure compliance with the latest drawings.

B. During installation of the high-purity systems, the Contractor shall make necessary arrangements for testing and analyzing the purity of the systems in accordance with the Contractor’s approved protocol. Costs of the laboratory analysis shall be borne by the Contractor.

C. Flow through the pipe system during testing shall be a minimum of 2 to 5 fps. Test gas shall be clean nitrogen. Gas components and acceptable results shall include:
   1. Oxygen, 1 ppm increase maximum inlet to outlet.
   2. Total hydrocarbons, 1 ppm increase maximum inlet to outlet.

D. Particulate testing at the same sample locations shall be conducted by the Contractor on the piping systems at the completion of the work of each piping distribution system. The system shall contain no more than five particles per cubic foot greater than 0.2 micron in size as analyzed by an on-line laser scatter particle counter with a minimum test gas velocity of 20 fps.

PIPE CLASS SPECIFICATION SHEET

Pipe class	CT01
Rating	Pressure 125 psig at 180 degrees F
Codes	ANSI B31.3 (except systems falling under plumbing jurisdiction)
Pipe	
Above ground	Copper, smls, Type L, hard drawn, ASTM B88
Below ground	Copper, smls, Type K, hard drawn, ASTM B88 (Note 1)
	2 Inches and Under (Note 2)
	2 1/2 Inches and Above (Note 3)
Fittings	Wrought copper, ANSI B16.22 socket joint, B75
Flanges	Copper, socket joint, Class 125 FF
Unions	Copper, socket joint, Br ring nut
Solder	95-5 tin-antimony
Brazing	Silver brazing, B260; melting range, 1,185 degrees F to 1,300 degrees F; Aircosil 15 or Silphos

Notes:

1. Trap primer lines below grade may be Type K annealed copper.
2. For copper pipe 2 inches and below, use solder.
3. For copper pipe 2 inches and above, use brazing.

PIPE CLASS SPECIFICATION SHEET

Pipe class	CT02
Rating	Pressure 100 psig at 180 degrees F
Codes	Applicable plumbing codes
Pipe - aboveground	Copper, DWV, ASTM B306, 1-1/4 inches to 8 inches
Fittings	Wrought copper, ANSI B16.29, solder joint, DWV
Brazing	Silver brazing ASTM B260, melting range of 1,185 degrees F to 1,300 degrees F; Aircosil 15 or Silphos

PIPE CLASS SPECIFICATION SHEET

Pipe class	CT03
Rating	Pressure 150 psig at 200 degrees F
Codes	ANSI B31.3
Pipe	Aboveground, 4 inches and under; copper, seamless, Type L tubing cleaned for oxygen/medical gas service and conforming to ASTM B88
Note	Tubing and filters shall be cleaned for oxygen/medical gas service, nitrogen purged, and bagged by the manufacturer per NFPA 99, health care facilities and with CGA-G4.1, clean for oxygen service

4 Inches and Under

Fittings	Wrought copper, ANSI B16.22, socket joint, ASTM B75
Flanges	Copper, socket joint, Class 125 FF
Unions	Copper, socket joint, brass ring nut
Brazing	Copper phosphorus (BcuP) series without flux for copper tubing to wrought copper joints
Flux	None permitted unless QAR approves limited use on copper tubing to brass joints. The use of flux shall be avoided to the greatest extent feasible
Acceptable Manufacturers	
Tube and tube fittings	High Purity Technology (HPT)
Mechanical fittings	Swagelok, Parker

END OF SECTION

SECTION 15090

PVC AND CPVC PIPING SYSTEMS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements for materials, fabrication, and installation of PVC and CPVC piping systems.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for PVC and CPVC piping systems:
   1. Section 09920 - Painting - Equipment and Piping
   2. Section 15060 - Pipe and Pipe Fittings - General.
   3. Section 15140 - Piping Supports and Anchors.
   4. The individual pipe class specification sheets included at the end of this Section.

B. CAUTION: Use of this Section without including all of the above-listed items will result in omission of basic requirements.

1.3 DEFINITIONS

A. Carrier pipe or tubing: refers to the inner or primary piping or tubing continuously subjected to fluid.

B. Containment pipe and fittings: refers to the outer pipe or secondary pipe subject to the fluid only on leakage from the carrier pipe.

C. Centralizers: refers to the clip device which keeps the carrier pipe or tubing located in the center of the containment pipe.

D. Containment boxes: refers to an enclosure on a contained piping system that maintains containment while accommodating another function such as valves containment or level switch/leak detection containment.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Material requirements are specified in the pipe class specification sheets.

B. Store pipe, fittings, valves, and materials in an indoor location with an ambient temperature of between 40 and 90 degrees F. Handle pipe, fittings, and valves in such a manner as to prevent damage and/or contamination. Replace material that becomes damaged with new, clean material.

2.2 MATERIALS

A. Obtain primer and solvent cement from the same manufacturer.

B. Solvent cement manufacturer and viscosity shall be as recommended by the pipe and fitting manufacturer to ensure compatibility and shall comply with Part X3 of ASTM D2855.

C. In the event the following procedures vary from those of the materials manufacturer, the manufacturer's procedure shall govern. Notify IDC in writing of any such variance.

D. Containment:
1. Secondary containment shall be provided as shown in the Drawings.
2. Identify the minimum size for containment piping. The table below is for reference, and should be modified based on the tubing/piping pull length and the number of bends. In general, the carrier pipe cross-sectional area should not exceed 25 percent of the containment pipe cross-sectional area.

Carrier Pipe or Tube(s), Nominal Size	Containment Pipe, Minimum Nominal Size
Tubing:	
1 tube at 1/4-inch	1-inch
1 tube at 3/8-inch	1-inch
1 tube at 1/2-inch	1-inch
1 tube at 3/4-inch	1-1/2-inch
1 tube at 1-inch	2-inch
2 tubes at 1/4-inch	1-1/2-inch

Carrier Pipe or Tube(s), Nominal Size	Containment Pipe, Minimum Nominal Size
2 tubes at 3/8-inch	2-inch
2 tubes at 1/2-inch	3-inch
2 tubes at 3/4-inch	3-inch
2 tubes at 1-inch	4-inch
1 tube at 3/8-inch and 1 at 1/4-inch	1-1/2-inch
1 tube at 3/8-inch and 1 at 1/2-inch	2-inch
1 tube at 3/8-inch and 1 at 3/4-inch	3-inch
1 tube at 3/8-inch and 1 at 1-inch	3-inch
1 tube at 1/4-inch and 1 at 1/2-inch	2-inch
1 tube at 1/4-inch and 1 at 3/4-inch	2-inch
1 tube at 1/4-inch and 1 at 1-inch	2-inch
1 tube at 1/2-inch and 1 at 3/4-inch	3-inch
1 tube at 1/2-inch and 1 at 1-inch	3-inch
1 tube at 3/4-inch and 1 at 1-inch	3-inch
1 tube at 3/8-inch and 2 at 3/4-inch	3-inch
1 tube at 3/8-inch, 1 at 3/4-inch, and 1 at 1-inch	3-inch
1 tube at 3/8-inch and 2 at 1-inch	3-inch
1 tube at 1/2-inch and 2 at 3/4-inch	3-inch
1 tube at 1/2-inch, 1 at 3/4-inch, and 1 at 1-inch	4-inch
1 tube at 1/2-inch and 2 at 1-inch	4-inch
Pipe:	
3/4-inch	2-inch
1-inch	2-inch
1-1/4-inch	3-inch

Carrier Pipe or Tube(s), Nominal Size	Containment Pipe, Minimum Nominal Size
1-1/2-inch	3-inch
2-inch	4-inch
2-1/2-inch	6-inch
3-inch	6-inch
4-inch	8-inch
6-inch	10-inch

3. Provide valve or in-line instrument containment by joining the containment piping to a containment box constructed of PVC or polypropylene. Extend the box a minimum of 4 inches beyond the valve or instrument in all directions, and provide a drain valve at the bottom of each box.

PART 3 -- EXECUTION

3.1 PREPARATION

A. Inspect pipe and fittings prior to installation. Do not use materials showing defects or irregularities.

B. Fabricate and install the pipe and fittings in a covered area following manufacturer's procedures and ASTM D2855.

C. Schedule 40 pipe shall not be threaded. Use Schedule 80 threaded nipples where necessary to connect threaded valves or fittings.

D. Use strap wrenches for tightening threaded plastic joints, being careful not to overtighten these fittings. As a guide, it is recommended to tighten two full turns after resistance is first encountered turning by hand.

E. Provide adequate ventilation when working with pipe joint solvent cement.

F. 2-Inch and Larger PVC Gluing Procedures:
   1. Install a positive room ventilation system approved by the Owner.
   2. Leave fabrication low points disconnected to allow for fume dispersement.

3. Place a fan near fabrication low points to dissipate fumes in enclosed rooms; provide and maintain full room exhaust and monitor air on a regular basis to ensure that all quality standards are being maintained.
4. Flag out an area 10 feet around the open ends of pipe.
5. Leave open ends of pipe disconnected for 8 hours, allowing fumes to dissipate (with fan running).
6. Valves in a system are to be left in the open position until ventilation of the system is completed.
7. Tie in pipe, completing fabrication, at the low point.

G. For pipe size 6 inches and larger, a crew of two men is recommended, and the following additional steps are necessary:
1. Hold joint together for 1 to 3 minutes depending on pipe size.
2. As an aid in joining these larger sizes, it is recommended that a come-along be used in pulling the pipe and fitting together.

H. Do not thread male metal pipe threads into female plastic fittings.

I. Do not expose piping or fittings to direct sunlight either in storage or after installation.

J. PVC pipe installed in direct sunlight outdoors shall be painted with two coats of white high-pigment water-based latex paint per Section 09920, Painting - Equipment and Piping, to prevent UV degradation.

3.2 INSTALLATION

A. Cement and join piping only when the ambient temperature is between 40 degrees F and 90 degrees F.

B. When the atmospheric temperature is above 90 degrees F, use the following precautions to avoid excessive evaporation of solvent from the cement:
1. Shade joint surfaces from sun at least 1 hour prior to joining.
2. Make joints in early morning hours and as quickly as possible after applying cement.

C. When the ambient temperature is below 40 degrees F, joints must be prefabricated in a heated space, or a temporary heat enclosure shall be provided during the entire joining period and for 2 hours after joint is made up. Materials shall be stored in a heated area.

D. Joints and adjacent piping shall not be moved after joining for the set time periods identified in ASTM D2855.

E. Test pressure shall not be applied after joining for the minimum times specified in Table X2.1 of ASTM D2855.

F. Hanger rod sizing shall be as specified in Section 15140, Piping Supports and Anchors.
   1. Spacing for PVC piping system supports shall not exceed the values in Section 15140, Piping Supports and Anchors.
   2. Spacing for CPVC piping system supports shall not exceed the values given in Section 15140, Piping Supports and Anchors.
   3. The data in Section 15140, Piping Supports and Anchors is for uninsulated lines. For insulated lines, reduce spans to 70 percent of the tabulated value. Use continuous support for spans of less than 2.5 feet. Cable tray with cross supports at least every 12 inches meets the intent of continuous supports.

G. Assembly:
   1. Align piping vertically and horizontally and at right angles unless otherwise specified by design.
   2. Do not make alignment corrections by applying force to piping.
   3. Bolt flanges using a calibrated torque wrench and following manufacturer's procedures. Follow instructions in Section 15060, Pipe and Pipe Fittings, General.

H. Install containment piping according to the following sequence:
   1. Carrier piping with the appropriate centralizers in place. Do not use centralizers for flexible tubing carrier piping.
   2. Containment piping over the carrier pipe and centralizers.
   3. Fittings on the carrier piping.
   4. Testing of the carrier piping.
   5. Fittings on the containment piping (when split fittings specified in attached Appendix).
   6. Testing of the containment piping by either of the following approaches:
      a. Use 5 psig CDA with soaped weld and fitting connections (i.e., using "Snoop").
      b. Hydrostatic pressure test with the pressure loss not exceeding 0.2 psi over a 15-minute duration. Use a pressure gauge with 0.1-psi resolution increments.
   7. For carrier tubing pulled through containment piping, no fittings shall be pulled through the containment piping. Remove any section of carrier tubing that is kinked and install a new section.
   8. Slope horizontal runs of containment pipe at 1-percent minimum slope to low points. Do not pocket containment piping with high or low points unless required by the Drawings.

I. Replace leaking joints. Repair practices such as back welding shall not be used to seal leaking joints.

J. Flange bolts shall not be torqued beyond manufacturer specifications to seal joints.

K. Clean PVC/CPVC:

1. When required on the piping data sheets, clean PVC/CPVC fabrication and installation practices shall be followed as described below:
    a. Inspect, store, fabricate, and bag ends for clean PVC/CPVC pipe in a designated clean PVC construction area. Keep this area clean and free of dust, oils, and other contamination sources. No oil- or fuel-powered engines shall exhaust into the area and no grinding or welding of pipe other than PVC shall be allowed in this area.
    b. Inspect all components for physical deformities or contamination. Reject problem materials.
    c. As much as practical, prefabricate clean PVC/CPVC in the clean area to minimize field welding.
    d. Fitters shall wear clean gloves when handling clean pipe.
    e. Prior to fabrication, pipe and fittings shall be cleaned as follows:
        1) Using nylon brushes, clean city water, and a surfactant (Triton X100, Micro, or approved equal), scrub pipe and fitting interior and exterior until clean.
        2) Rinse with clean city water.
        3) Dry completely with filtered oil-free air (OFA). OFA quality shall be as specified in Section 15060, Pipe and Pipe Fittings, General.
2. Cut, face, debur, join, and install pipe and fittings in accordance with the pipe manufacturer's written recommendations. When chamfering or deburring pipe ends, install a Kleenwipe and plug the pipe inside the location of the deburring such that, at completion of pipe end dressing, removal of the Kleenwipe removes debris. Wipe interior and pipe edge after deburring to remove particulate.
3. Bag and tape ends before transporting clean spools out of the clean area.

PVC AND CPVC PIPING SYSTEMS

Pipe Class	Description
CC01	Schedule 80 CPVC
CC02	Schedule 80 CPVC, enhanced QA
PC01	Schedule 40 PVC
PC05	Schedule 80 PVC
PC07	Schedule 80 PVC, clean

PIPE CLASS SPECIFICATION SHEET

Pipe class	CC01
Rating	100 psig at 150 degrees F through 12 inches
Pipe	Schedule 80 CPVC, ASTM F441, Class 23447B
Fitting	Schedule 80, ASTM F439, Class 23447B; socket-weld all dimensions
Flanges	Dimensions conform to ANSI B16.5 for steel flanges
Unions	Through 2 inches, socket-weld, Schedule 80, O-ring material to match flange gaskets in Section 15059, Service Index.
Cement	ASTM F493, equivalent to Weld-On 714
Primer	Equivalent to Weld-On P70 purple

PIPE CLASS SPECIFICATION SHEET

Pipe class	CC02
Rating	100 psig at 150 degrees F through 12 inches
Pipe	Schedule 80 CPVC, ASTM F441, Class 23447B
Fitting	Schedule 80, ASTM F439, Class 23447B; socket-weld all dimensions
Flanges	Dimensions conform to ANSI B16.5 for steel flanges
Unions	Through 2 inches, socket-weld, Schedule 80, O-ring material to match flange gaskets in Section 15059, Service Index.
Cement	ASTM F493, equivalent to Weld-On 714
Primer	Equivalent to Weld-On P70 purple
Quality assurance	Enhanced

PIPE CLASS SPECIFICATION SHEET

Pipe class	PC01
Rating	100 psig at 73 degrees F through 12 inches
Pipe	Schedule 40 PVC, ASTM D1785, Class 12454B
Fitting	Schedule 40, ASTM D2466, Class 12454B; socket-weld
Flanges	Dimensions conform to ANSI B16.5 for steel flanges
Unions	Up through 2-inch diameter, socket-weld, Schedule 40, O-ring material to match flange gaskets in Section 15059, Service Index.
Cement	ASTM D2564, equivalent to Weld-On 705 under 6 inches, and Weld-On 711 for 6 inches and over
Primer	Equivalent to Weld-On P70 purple

PIPE CLASS SPECIFICATION SHEET

Pipe class	PC05
Rating	100 psig at 100 degrees F through 12 inches
Pipe	Schedule 80 PVC, ASTM D1785, Class 12454B
Fitting	Schedule 80, D2467, Class 12454B; socket-weld all dimensions
Flanges	Dimensions conform to ANSI B16.5 for steel flanges
Unions	Up through 2 inches, socket-weld, Schedule 80, O-ring material to match flange gaskets in Section 15059, Service Index.
Cement	ASTM D2564, equivalent to Weld-On 711 or 717 gray under 8 inches, and Weld-On 719 for 8 inches and over
Primer	Equivalent to Weld-On P70 purple

PIPE CLASS SPECIFICATION SHEET

Pipe class	PC07
Rating	100 psig at 100 degrees F through 12 inches
Pipe	Schedule 80 PVC, ASTM D1785, Class 12454B
Fitting	Schedule 80, ASTM D2467, Class 12454B; socket-weld all dimensions
Flanges	Dimensions conform to ANSI B16.5 for steel flanges
Unions	Up through 2 inches, socket weld, Schedule 80, O-ring material to match flange gaskets in Section 15059, Service Index.
Cement	ASTM D2564, equivalent to Weld-On 711 or 717 gray under 8 inches, and Weld-On 719 for 8 inches and over
Primer	Equivalent to Weld-On P70 purple
Cleaning	Clean, per this Section

END OF SECTION

SECTION 15094

POLYPROPYLENE PIPING SYSTEMS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements to furnish and install polypropylene (PP) piping systems.

B. This Section establishes requirements for work to be performed in the permanent facility for both standard grade and clean PP piping.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for PP piping systems:
   1. Section 15059 - Service Index.
   2. Section 15060 - Pipe and Pipe Fittings, General.
   3. Section 15140 - Piping Supports and Anchors.
   4. The individual pipe class specification sheets included at the end of this Section.

B. CAUTION: Use of this Section without including all of the above-listed items will result in omission of basic requirements.

1.3 QUALITY ASSURANCE

A. Provide an independent quality control representative (QCR) who shall have primary responsibility for the following:
   1. Setting up the project quality program.
   2. Implementing and monitoring Contractor conformance to the project quality standards.
   3. Maintaining appropriate logs for shipping, inspection, welder qualification, weld samples, test welds, and test documentation for the project.
   4. Resolving quality issues arising during the project jointly with the Contractor, QAR, and Engineer.

B. The Owner may elect to provide an independent QAR. The QAR will be responsible to the Owner. The QAR will:

1. Aid the Contractor in monitoring fabrication and installation product quality and activities. Quality issues on the project will be resolved jointly with the Contractor, IDC, and Owner.
2. Perform and direct final sampling and analysis of the PP systems covered by this Section, both nonpurity and clean.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Do not use material or installation equipment that has been damaged in handling. Clean material or installation equipment that becomes contaminated shall be returned to the manufacturer for replacement. Clean materials that are supplied without properly sealed packaging shall be rejected and replaced with new, clean, and properly packaged material.

B. Equipment and materials received for installation shall be transported, handled, and stored indoors in a sheltered location with protection from sunlight and weather elements in such a manner as to prevent damage and/or contamination:
1. Piping, fittings, and valves shall be stored in their original factory sealed packaging.
2. Piping material shall be stored horizontally and supported at less than 2-foot intervals.
3. Use nylon banding or poly rope for slings or tie-downs used to lift, load, or transport pipe.
4. The quantity of pipe stored on one rack shall not create stress or distort the bottom pipe.
5. Store piping indoors a minimum of 12 hours prior to fabrication for thermal stabilization.

C. Where labeled clean on the pipe class data sheets, the following shall apply:
1. Cutting and cleaning operations shall occur in a dedicated clean PP fabrication area, per the requirements of this Section.
2. Prefabrication of piping sections shall be performed as much as feasible in a controlled area or the dedicated PP clean area, so that the number of fusion welding operations required in the field is minimized. This includes prefabrication of all possible subfab laterals, skid piping spools, and other subassemblies.

1.5 SUBMITTALS

A. Provide the following with the Bid:
1. Recommended support spacing and supporting method.
2. Where labeled clean on the pipe class data sheets, provide:

a. A detailed description of the factory manufacturing, cleaning, and packaging criteria.
b. A detailed description of the dedicated clean PP area to be supplied.
c. Proposed protocol for work performed in the clean area and in the field.

3. Fabrication quality control plan and field quality assurance procedures.
4. Pipe manufacturer's specifications for piping and fitting material.
5. Proposed QCR to be provided by the Contractor.
6. The specific make and model of proposed cutting and joint preparation tools and fusion-joining equipment.

B. Provide the following at least 6 weeks prior to fabrication:
1. Copy of the fusion welding procedure specifications to be used.
2. List and certificate of qualification for each PP welder.
3. Shop drawings of proposed work showing welds (shop and field) and identifying which joints will be made in the field. Shop drawings shall identify components by size, material specification, and quantity on an itemized material list keyed to the spool drawing. Spool drawings shall be keyed to a plan drawing, identifying clearly where the spool will be installed.
4. Sampling plan for monitoring of weld quality in the field and in the PP prefabrication areas.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Clean PP Piping:
1. George Fischer.
2. Agru (Asahi America).

B. Pressure-rated PP Piping:
1. George Fischer.
2. Agru (Asahi America).

C. Drainage DWV PP Piping:
1. George Fischer/Fuseal.
2. Enfield.
3. Orion.

2.2 GENERAL

A. Pipe and fittings shall be provided by a single manufacturer.

B. Piping pigmentation and resin criteria are indicated in the pipe class data sheets at the end of this Section.

C. Where labeled clean on the pipe class data sheets, the following shall apply:
   1. Piping, components, gaskets, and O-rings shall be manufactured and assembled without lubricants.
   2. Piping, components, gaskets, and O-rings shall be cleaned with DI water (Section 15060, Pipe and Pipe Fittings - General) in a Class 10,000 or better environment, dried with CDA or Nitrogen, fittings single-bagged, piping ends wrapped and sealed, then labeled for clean service.

D. Manufacture and assemble nonpurity PP piping and components with no lubricants and package in a single bag for shipment.

E. Permanently mark PP pipe, fittings, and components with the manufacturer's name and size.

F. PP pipe and fittings may be manufactured to DIN metric standard sizes. However, references to it in the Specifications and Drawings are by English standard pipe size. The following table lists the English standard pipe sizes and the corresponding PP metric size:

Inch Size	Metric Size (mm)
1/2	20
3/4	25
1	32
1-1/4	40
1-1/2	50
2	63
2-1/2	75
3	90
4	110
6	160
8	225*
10	250

*Do not use 200mm piping in lieu of 225mm piping for 8-inch nominal applications.

PART 3 -- EXECUTION

3.1 FIELD QUALITY CONTROL

A. Fitters who fabricate and install PP piping shall be:
   1. Verifiable journeymen pipe fitters or welders.
   2. Certified by the PP manufacturer in each fusion process.
   3. Previously qualified for this project (at the Contractor's expense) by being trained and by making at least three typical pipe joints on a test spool piece that withstands a test pressure of 1-1/2 times the design pressure. The spool shall include one flanged joint. Testing shall be witnessed by the QCR and QAR.
   4. For clean PP piping, fitters shall be trained in clean protocol and installation procedures for clean PP piping.

B. Make a sample available of correctly welded pipe and fittings in the work area to serve as a reference check of welds.

C. Completely over-wrap outdoor PP piping exposed to sunlight with either insulation or insulation covers for UV protection.

D. Workmanship: In addition to IDC-approved procedures and provisions stipulated in the Contractor's quality assurance program, the following weld sampling procedures shall apply as a minimum.
   1. Each qualified fitter shall submit sample fused joints to the QCR for inspections as follows:
      a. Start of each shift.
      b. Indication of a defective weld.
      c. A 20 degrees F change in weld area temperature.
      d. As directed by the QCR.
   2. The Contractor may have to suspend joint formation operations for noncompliance with specified procedures or upon the recommendation of the QAR or IDC.

E. Fitters shall wear approved gloves when handling PP pipe, valves, and fittings.Oils on the PP surface can reduce weld integrity.

F. The Contractor may be requested to remove any system joint deemed not in compliance with the specifications or that is otherwise unacceptable to the Engineer or QAR. Should the suspected joint prove to be sound, the Contractor will be

reimbursed for time and materials. Should the suspected joint prove to be faulty or the adjacent piping found to be unclean, the destructive test will continue joint-by-joint until sound, clean joints are found. Replacement of faulty work and/or materials shall be at no additional cost to the Owner.

G. Cut, face, debur, join, and install PP pipe and fittings in accordance with the pipe manufacturer's written recommendations and as indicated in this Section.

H. For clean piping:
   1. Double-bag and tape ends of components and prefabricated spool assemblies transported between the PP cleanroom and the installation point.
   2. Keep ends sealed in the field until the piping spool connections are made.
   3. Components and prefabricated spools shall be installed within 72 hours of removal from the cleanroom.

I. Inspect piping and fittings after fabrication of piping spools and before field installation, for scratches or gouges. Report scratches and gouges to the QCR and QAR. Remove and replace rejected materials with scratches or gouges.

J. The QCR shall review and approve:
   1. Material incoming inspections.
   2. Qualification of PP pipe fitters.
   3. Compliance with the manufacturer’s written procedures.
   4. Visual weld inspections.
   5. Pipe system pressure testing.
   6. The QAR will monitor the QCRs performance on the above activities.

K. Pipe Cutting:
   1. Cut PP using electronics-grade cutters. Pipe cutters shall be designated for use on this system only and shall be kept clean at all times. Use of any type of saw is prohibited.
   2. For clean piping, cutting, and facing operations shall be done in the PP clean area.
   3. Remove burrs, chips, and filings from both the interior and exterior of the pipe before joining.
   4. Equipment and tools used for fabrication of the PP piping system shall be used exclusively on this system.

L. Dedicated Clean PP Fabrication Area:
   1. The requirements of this cleaning section apply to prefabrication of spools for pipe class data sheets labeled clean.

2. PP pipe, fittings, and components shall be purchased clean and shall not be recleaned on the jobsite prior to installation. Contaminated PP or material with damaged bags shall be replaced by the piping manufacturer.
3. The dedicated clean PP fabrication area shall comply with the following:
   a. Temperature control between 60 degrees F and 90 degrees F.
   b. Isolated from dirty project activities such as grinding, welding, cutting of metals, or aerosol-intensive activities such as painting or blasting.

3.2 JOINING METHOD

A. Tools and Equipment:
1. Provide dedicated clean tools for PP piping system fabrication and installation. Keep these tools separate from other tools and use exclusively on the PP piping system.
2. Special attention shall be paid to fusion heaters, keeping them clean and free from material buildup that could prevent proper fusion bonding.
3. Clean tools at the start of each shift with IPA, rinse with DI water, and blow dry with nitrogen.
4. Tools, fusion equipment, and heating elements for direct contact with PP shall be Teflon coated or stainless steel, to prevent metal or lubricant contamination of the weld surface.
5. Maintain and clean tools and equipment throughout the construction activity.
6. Cutting and fusion tools and equipment shall be only as recommended by the manufacturer, operated per the manufacturer's instructions.

B. Threaded Connections: make up with Teflon tape.

C. Label welds with weld number, welder, and fitter ID. Cross-reference the weld number to the fusion machine printout and weld log. Print labels in permanent ink on white tape and affix to the pipe adjacent to the weld.

D. Minimum ambient temperature for welding is 50 degrees F.

E. PP thermal fusion welds shall be made by heating the appropriate connections only once. Repair practices such as back-welding that reheat pipe connections are unacceptable. Hot-air and rod-welding of PP is also unacceptable. Connections that are faulty or improperly welded shall be cut out and replaced at no additional cost to the Owner.

F. Welds made with hand-held heating devices are not allowed. Use flanges and unions in lieu of hand-welds where necessary.

G. For clean piping systems, valves and other piping components shall be fitted to minimize dead legs as much as possible.

H. Protect small projections from the piping system that are susceptible to breakage. These may include sample ports, vents, and drains.

3.3 SUPPORTS

A. Provide piping supports, hangers, hanger rod sizing, and anchors as specified in Section 15140, Piping Supports and Anchors.

B. Do not exceed spacing values recommended by the PP pipe manufacturer for PP piping system supports.

C. Support PP piping smaller than 1 inch with a continuous support. Cable tray with support rods every 12 inches meets the intent of continuous support.

D. Support piping at temperatures greater than 140 degrees F continuously.

E. Support piping larger than 6 inches at a maximum spacing between supports of 6 feet.

F. Incorporate rubber grommets (neoprene pads) in pipe clamps and hangers for pipe protection. Provide a stress free pipe clamp as recommended by the PP pipe manufacturer.

G. Support valves so their weight is carried by the support not the piping.

H. Allow pipe movement due to thermal expansion with the support system, but provide a single fixed, clamped point in each horizontal pipe run as recommended by the manufacturer.

I. Locate pipe supports such that no fusion weld rests directly on a pipe support or clamp.

3.4 TESTING

A. Before pressure testing, the Contractor and the Owner's representative shall thoroughly examine the completed pipe system for the following items:
   1. System is complete per piping drawings with valves and supports in place.
   2. Pipe, valves, and equipment are supported correctly as shown on the Drawings and with no concentrated loads on the system.
   3. Pipe is in good condition with no visible cracks, gouges, or other evidence of abuse. Pipe flanges are well aligned and correct slopes maintained. Correct gaskets and bolting, including washers are used at flanges. Fittings and flanged joints are free from visible cracks.

4. Adequate vent valves and drain valves exist to remove entrained air during pressure testing and to drain pipe for repairs.
5. If the examination reveals any deficiencies in the above items, correct as specified by the Engineer or QAR.

B. Pipe System Pressure Test:

1. For clean piping systems, fill, flush, and test fluid shall be DI water in compliance with Section 15060, Pipe and Pipe Fittings, General. For nonclean piping systems, potable water may be used.
2. Fill piping slowly, carefully venting the system while filling.
3. When piping has been filled and vented, use a flashlight while walking the piping system to look for entrapped air. Physically touch the light source to the pipe and verify the air is removed prior to proceeding with the pressure test.
4. For larger sections or loops, begin with a low-pressure flush. While flushing, open and monitor vents again to verify entrapped air is gone.
5. During and after flushing, walk the system again with a flashlight to look for drips, leaks, entrapped air, or other problems.
6. After flush is complete, slowly pressurize the system at a rate no faster than 5 psi per minute. At least every 10 minutes, cease increasing pressure and hold for 15 minutes. Walk the system with a flashlight again looking for drips, leaks, or entrapped air.
7. When the required test pressure has been reached, hold for a minimum of 1 hour. Note leaks, if any, release pressure, and proceed with any system cleaning criteria.
8. Repair leaks per procedures approved by the Engineer and QAR.
9. Retest replaced joints.
10. For clean piping systems, no stagnant water should be left in pipe longer than 4 hours.

3.5 ACCEPTANCE

A. The PP piping system shall be tested in the presence of the Owner. Replacement of faulty work and/or materials shall be at no cost to the Owner.

PIPE CLASS SPECIFICATION SHEET

Class	PP01
Rating	150 psi at 68 degrees F
Codes	ANSI B31.3, PPI
Resin and purity criteria	Clean piping system. Material to be pigmented PP for UV stability.
	10 inches and Under
Piping	ASTM D2837 and DIN 8077 (SDR 11).
Fittings	Molded PP, clean, IR butt-weld
Flanges	Molded PP, clean, IR butt-weld, and Class 150 thermoplastic-coated flange ring
Unions	Molded PP, clean, IR butt-weld
Joints	IR butt-weld per manufacturer's requirements

END OF SECTION

SECTION 15100

VALVES - GENERAL

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the general requirements for the following types of valves:
   1. Manual.
   2. Control (modulating and on/off).
   3. Self-contained control valves (regulators).

B. The specific general requirements included in this Section are:
   1. Related specifications.
   2. Acceptable manufacturers.
   3. General product requirements.
   4. General installation requirements.
   5. Testing.

1.2 RELATED SPECIFICATIONS

A. Use this Section in conjunction with the following other specification and related Contract Documents to form the complete requirements for valves:
   1. Section 15050 - Basic Mechanical Requirements.

B. CAUTION: Use of this Section without including the above-listed item results in omission of basic requirements.

C. In the event of conflict regarding valves–general requirements between this Section and another section, the provisions of this Section govern.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are listed in the applicable detailed valve specification sections.

2.2 GENERAL

A. Provide valves complete with necessary operating hand wheels, chain wheels, extension stems, floor stands, worm and gear operators, operating nuts, chains, and wrenches which are required.

B. Provide valves with the name of the manufacturer and the nominal size of the valve on the body or bonnet or shown on a permanently attached plate in die-stamped letters.

PART 3 -- EXECUTION

3.1 GENERAL

A. Before installation, carefully clean valves of foreign materials and inspect valves in open and closed positions.

3.2 INSTALLATION

A. Prior to installing flanged valves, thoroughly clean the flange faces. After cleaning, insert the gasket and bolts and tighten the nuts progressively and uniformly.

B. Thoroughly clean threads of screwed joints by wire brushing, swabbing, or other acceptable methods. Apply suitable joint compound or Teflon tape to threads prior to making joints.

C. Do not tighten valve stem packing glands beyond hand tight unless a leak is detected during testing and then only tighten enough to stop the leak.

D. Do not thread pipe or nipples into valves beyond the makeup distances of American NPT.

E. Install high-performance butterfly valves in the closed position in the piping systems. Leave all valves in the closed position at the completion of the installation.

F. Use flat-face wrenches, not pipe wrenches, on copper alloy and plastic valves.

3.3 TESTING

A. Test valves at the same time that the adjacent pipeline is tested. Joints showing visible leakage under test are not acceptable. Repair joints that show signs of leakage prior to final acceptance. Properly protect special parts of control systems or operators that might be damaged by the pipeline test. Repair or replace valves damaged by the testing.

END OF SECTION

SECTION 15101

MANUAL VALVES

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements to furnish and install the manual valves in the facility's piping systems, which include general purpose, high-purity gas, clean-for-oxygen-service gas, UPW, and high-purity bulk chemical service valves.

B. The valve identification code used is explained in Table 1,Valve Identification.

Table 1
Valve Identification

Valve Designation	Valve Type
BA	Ball
BF	Butterfly
CK	Check
DA	Diaphragm
GA	Gate
GL	Globe
PL	Plug
SP	Special

1.2 RELATED WORK

A. Use this Section with the following other specifications to form the complete requirements for manual valves:
1. Section 15060 - Pipe and Pipe Fittings, General.
2. Section 15100 - Valves, General.
3. The valve data sheets listed in the Appendix.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 QUALITY ASSURANCE

A. Monitor the following for valves:
   1. Incoming raw material composition.
   2. Dimensions.
   3. External leak rates.
   4. Across-the-seat leak rates.
   5. Pressure capability.

1.4 SUBMITTALS

A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are identified for each valve on the data sheet.

2.2 GENERAL

A. Valves shall be line size as indicated on the Drawings unless indicated otherwise.

B. Standard Operator Type: Unless otherwise indicated in the data sheets, valve operators shall be lockable using a padlock. The following shall also apply unless otherwise indicated:
   1. Butterfly Valves:
      a. 6 Inches and Smaller: lever with ten-position notch plate.
      b. 8 Inches and Larger: gear.
   2. Ball Valves:
      a. 4 Inches and Smaller: lever.
      b. 6 Inches and Larger: gear.
   3. Plug Valves:
      a. 3 Inches and Smaller: lever.
      b. 4 Inches and Larger: gear.

C. When cleaning and packaging requirements are indicated in the attached data sheets, refer to Section 15060, Pipe and Pipe Fittings, General.

D. When testing requirements are indicated in the attached data sheets, refer to Section 15060, Pipe and Pipe Fittings, General.

2.3 MATERIALS

A. Valves shall not contain asbestos packing or gasket material.

2.4 ACCESSORIES

A. Chain Wheel Operators:
   1. When chain wheel operators are specified, provide Roto Hammer.
   2. Match chain wheel operators with the size of the hand wheel on the valve.
   3. Do not mount hammer blow-type operators on cast iron valves.
   4. Provide chains for the operators of the size and type required by the operator. Extend plated chains to within 4 feet of the ground. Where chains hang in normally traveled areas, provide appropriate L-type tieback anchors.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Install manual valves in accordance with manufacturer's written instructions.

B. Generally, unless otherwise indicated on the Drawings, install valves, located in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above the finish floor, with their operating stems vertical. Install valves, located in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above the finish floor, with their operating stems horizontal. If adjacent piping prohibits this, the stems and operating hand wheel shall be installed above the valve horizontal centerline as close to horizontal as possible. Valves installed in vertical runs of pipe shall have their operating stems orientated to facilitate the most practicable operation, as reviewed by IDC.

C. Install high-performance butterfly valves with the seat on the upstream side.

D. Install valves per techniques and welding practices consistent with the applicable piping system installation specifications.

Provide the submittals listed in the below Submittal Schedule.

Submittal Schedule

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	NO. OF WEEKS AFTER	AS INDICATED
15101-001	Dimensional data and materials of construction for all components, including valve operator.	X		
-002	Flow versus pressure drop and/or flow coefficient (Cv) data.	X		
-003	Confirmation that the valve operator is lockable.	X		
-004	When required for lugged butterfly valves, confirmation that the valve pressure rating applies to dead-end service with no downstream flange.	X		
-005	Provide fabrication details for PVDF tee/valve fabricated assemblies.	X		

END OF SECTION

APPENDIX

Tag Number	Rev.
BA-1	0
2	0
3	0
PL-1	0

END OF SECTION

BALL VALVE INDEX

VALVE DATA SHEET

BA-1

Configuration
Design pressure @ temperature — 400 psi at 350 degrees F
Function — On/off, low-pressure throttling

Materials	
Body	Bronze/brass
Trim/Stem	Bronze/brass chrome plated ball bronze/brass stem
Seats	RTFE
Seals	TFE
Packing	RTFE

Construction	
End Connection	Threaded
Body Construction	Two piece
Operator Type	Lever
Main Line End Connection	N/A
Valve Branch End Connection	N/A

Protocol	
Cleaning	N/A
Testing	N/A

Specialty	
Surface Finish/ Internal Finish	N/A
Purge Ports	N/A

MANUFACTURER	FIGURE NUMBER	SIZE RANGE
Apollo	70-1XX	1/4 inch to 3 inches
Jomar	T-100N	1/4 inch to 4 inches
Watts	B-6000	1/4 inch to 4 inches

Configuration
Design pressure @ temperature — 150 psi at 68 degrees F
Function — On/off, low-pressure throttling

Materials	
Body	Polypropylene
Trim/Stem	Polypropylene ball
Seats	EPDM
Seals	EPDM
Packing	TFE

Construction	
End Connection	Threaded
Body Construction	True Union,Two piece
Operator Type	Lever
Main Line End Connection	N/A
Valve Branch End Connection	N/A

Protocol	
Cleaning	N/A
Testing	N/A

Specialty	
Surface Finish/ Internal Finish	N/A
Purge Ports	N/A

MANUFACTURER	SERIES	SIZE RANGE
George Fischer	346	3/8 inch to 2 inches
Chemtrol	Tru-Bloc	1/2 inch to 2 inches

BA-3

Configuration
Design pressure @ temperature — 150 psi at 68 degrees F
Function — On/off, low-pressure throttling

Materials	
Body	PVC
Trim/Stem	PVC ball
Seats	EPDM
Seals	EPDM
Packing	TFE

Construction	
End Connection	Threaded
Body Construction	True Union,Two piece
Operator Type	Lever
Main Line End Connection	N/A
Valve Branch End Connection	N/A

Protocol	
Cleaning	N/A
Testing	N/A

Specialty	
Surface Finish/ Internal Finish	N/A
Purge Ports	N/A

MANUFACTURER	SERIES	SIZE RANGE
George Fischer	346	3/8 inch to 2 inches
Chemtrol	Tru-Bloc	1/2 inch to 2 inches

END OF SECTION

SECTION 15120

PIPING SPECIALTIES

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. Component Name and Tag Format:
   1. Air Vents.
   2. Pressure Indicators.
   3. P-trap Primer.
   4. Strainers.
   5. Temperature Indicators.
   6. Pressure/temperature Test Ports.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the listed piping components:
   1. Section 15050 - Basic Mechanical Requirements.
   2. Section 15060 - Pipe and Pipe Fittings, General.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Provide specialty piping components in compliance with the requirements identified in the Drawings and in this section.

B. Select component construction materials based on compatibility with the fluids identified in the attached appendix.

C. Where special cleaning, packaging, and testing criteria are identified for a component, refer to Section 15060, Pipe and Pipe Fittings, General for criteria.

2.2 GATE VALVE

A. General service gate valve, solid disc, non-rising stem with threaded ends. ASTM B62 bronze body, bonnet, wedge and stem. Brass stuff nut, check nut, and wheel nut. Malleable iron handwheel and graphite packing. 125 lb SWP WOG.

2.3 BALL VALVE

A. General service bronze ball valve, two piece standard port, 600 psig O WOG/150 SWP with threaded or solder ends. Cast bronze body and tail piece, stainless steel ball, RPTFE seat, Brass stem, PTFE packing, brass packing nut, zinc plated steel handle and handle nut.

2.4 PRESSURE GAUGE

A. All stainless steel construction, dial type pressure gauge with 4'inch dial, laminated safety glass lens, full blow-out protection and fillable case. Select pressure range for operating pressure at approximately 50 percent of range. Provide gauge where shown on the Drawings.

PRESSURE GAUGE GUIDE

Water (process)	4-inch dial size

Pressure Gauge Dial Size Versus Readable Distance

2.5 CHECK VALVE

A. Bronze Y strainer, NPT or solder connections, self aligning stainless steel screen, Teflon O-ring and PTFE gasket. Working pressure 400 PSI at 150F WOG.

2.6 P-TRAP PRIMER

A. Acceptable Manufacturers: Precision Plumbing Products, PR-500 Prime Rite.

B. Description:
   1. Pressure-pulse mechanically operated.
   2. 75 psi rated.
   3. Inlet of 1/2-inch MNPT, outlet of 1/2-inch FNPT.

C. Materials: Brass or bronze.

2.7 STRAINERS

A. Provide where shown on the Drawings.

2.8 TEMPERATURE INDICATORS

A. Provide where shown on the Drawings.

2.9 PRESSURE/TEMPERATURE TEST PORTS:

A. Acceptable Manufacturers:
   1. Peterson Engineering.
   2. Sisco.

B. Materials:
   1. TP-1: brass body, neoprene valve core.
   2. TP-2: brass body, Nordel valve core.
   3. TP-3: 316 stainless steel body, Viton valve core.
   4. TP-4: 316 stainless steel body, neoprene valve core.

C. Installation: Provide one complete test kit for pressure/temperature test ports for the Owner.

2.10 LABORATORY GAS TURRET

A. Acceptable Manufacturers:
   1. Chicago Faucets.
   2. WaterSaver Faucet Co.

B. Description: Turret with single ball valve, chrome plate finish, 0.5-125psi operating pressure, inlet shank assembly,

2.11 SPRAY NOZZLE

A. Acceptable Manufacturers.
   1. Spraying Systems Co.
   2. or other approved

B. Description: Spraying Systems Co. HHSJ, Threaded round PVC, solid cone-shaped spray pattern, see drawings for spray angles.

2.12 SOLENOID VALVE

A. Acceptable Manufacturers
   1. Spraying Systems Co.

2. Or other approved.

B. Description: Spraying Systems Co. Part No. 11438-32, 3-Way normally closed, 110/60 Volts/Hz.

2.13 BALANCING VALVE – SP-29

A. Acceptable Manufacturers:
1. Bell & Gossett.
2. Tour and Anderson.

B. Description: Circuit setter balancing valve with dial or digital readout and flow ports, 150 psi at 250 degrees F, Body-Bronze, Trim- Bronze disc or brass ball, Seats- Glass and carbon-filled TFE or pressure die-cast copper alloy, Seals- PTFE, threaded end connection, solid body construction with integral trim.

PART 3 -- EXECUTION

3.1 GENERAL

A. Install specialties in accordance with manufacturers' installation instructions and recommendations.

B. Install indicating devices so they may be easily read from floor level and are readily accessible for maintenance and service.

END OF SECTION

SECTION 15140

PIPING SUPPORTS AND ANCHORS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements to design, furnish, and install pipe and equipment hangers and supports which includes; spring hangers, guides, slides, seismic, and anchors.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for piping supports and anchors:
   1. Section 09920 - Painting - Equipment and Piping.
   2. Section 15050 - Basic Mechanical Requirements.
   3. Section 15240 - Mechanical Sound and Vibration Control.
   4. Section 15250 - Mechanical Insulation Schedule.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DESIGN CRITERIA

A. The piping supports and anchors shall be in accordance with the requirements of the following as applicable:
   1. NFPA 13 - Standard for the Installation of Sprinkler Systems.
   2. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.
   3. Manufacturers Standardization Society MSS-SP-58, Pipe Hangers and Supports - Material, Design and Manufacture.
   4. Manufacturers Standardization Society MSS-SP-69, Pipe Hangers and Supports - Selection and application.
   5. Manufacturers Standardization Society MSS-SP-89, Pipe Hangers and Supports - Fabrication and Installation Practices.

B. Supports, Anchors, and Restraints: in accordance with Section 15050, Basic Mechanical Requirements.
   1. Contractor engineered support systems shall be designed, detailed and the submittals, as required below, shall bear the seal of a professional engineer registered in the state in which the project site is located.

1.4 SUBMITTALS

A. Provide the following submittals:
   1. Product data and equipment supports including rods, pipe shields, clamps, springs, inserts, etc.
   2. Details for the piping attachment methods to rack-type frames and trapeze supports (i.e., slides, guides, rollers, u-bolts, etc.)
   3. Shop drawings of piping, indicating point loads, and seismic restraint locations, along with applicable pipe support details keyed to layouts.
   4. Shop drawings for pipe support frames, equipment supports and anchors along with engineer's calculations keyed to the layouts drawings.

1.5 DEFINITIONS (SPECIFIC TO THIS SECTION)

A. Hot Pipes: pipe systems with operating temperature greater than 100 degrees F.

B. Cold Pipes: pipe systems with operating temperature less than or equal to 100 degrees F.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe Hangers and Supports:
   1. Grinnell.
   2. Pipe Shields.
   3. B Line.
   4. Unistrut.
   5. Fronek Company.
   6. Piping Technology and Products.
   7. Bergen-Paterson.

B. Pipe Hanger Isolation Shields:
   1. Pipe Shields Incorporated.
   2. Insul-Shield.
   3. Rilco.
   4. Bergen - Paterson.

C. Metal Framing Systems:
   1. Unistrut.
   2. Superstrut.
   3. Kin-Line.
   4. Hilti.

5. Power Strut.

2.2 GENERAL

A. Provide hangers, rods, clamps, protective shields, metal framing support components, and hanger accessories electrogalvanized or cadmium plated for indoor applications. Provide hot dipped galvanized coating for outdoor applications.

B. Provide oversized hangers for insulated piping to accommodate insulation thickness specified in Specification Section 15250, Mechanical Insulation.

C. Do not exceed the load limits for manufacturer's hanger components.

D. Do not support piping with wire either temporarily or permanently.

E. The maximum deflection of a channel member supporting at midpoint of span shall not be greater than 1/8 inch.

F. Install piping plumb to vertical and horizontal planes.

G. Stainless steel piping or tubing touching bare carbon steel is not allowed. Coat supports as referenced above or provide an elastomeric isolator capable of withstanding the system design temperature between the pipe and the support.

2.3 PIPE HANGERS AND SUPPORTS

A. General:
1. Pipe hanger and support components are listed below. Where more appropriate items are required to accommodate the pipe loading, displacements, or other conditions, submit these items the Owner.
2. Individual Hangers for Cold Pipe: carbon steel, adjustable, clevis type, Grinnell Figure 260 black; stainless steel pipe use stainless steel materials.
3. Individual Hangers for Hot Pipe: insulated two-bolt hanger; pipe shields, Model D1000 through D6300.
4. Trapeze Hanger Type Supports: Construct field-fabricated back-to-back channels compatible with Grinnell channel assembly Figure 45.
5. Vertical Support - Uninsulated Piping: steel riser clamps. Grinnell Figure 261 with steel members, and Figure 40 with rods. Minimum of two shear lugs sized to accommodate the applicable load welded to pipe 180 degrees apart are required for riser clamps. Furnish the lug material compatible with pipe materials.
6. Interior Floor Support for Pipe Systems: cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support; Grinnell Figure 264, black only.

7. Copper Pipe Support: carbon steel ring, adjustable, copper plated; Grinnell Figure CT-99, CT-65, or plastic-coated Grinnell Figure CT-99C.
8. Shield for Insulated Piping 2 Inches and Smaller: 18-gauge galvanized steel shield over insulation in 180 degree segments, minimum 12 inches long at pipe support; Grinnell Figure 167
9. Shield for Insulated Piping: Pipe Shields, with waterproof high-density crushproof insulation encased in a galvanized metal cover.
10. Slotted Channel Framing: Provide galvanized channel unless noted otherwise on the Drawings or in the Specifications.
11. Steel Hanger Rods: Threaded both ends or continuous threaded. Grinnell Figure 140 or 146 black. Electrogalvanized rods for corrosion-resistant areas or areas exposed to moisture.
12. Anchors: Pipe Shields Model C4000 through C4300 for insulated Ferrous piping.

2.4 CONCRETE EXPANSION ANCHOR BOLTS

A. Hilti-Kwik II, Drop-ins, may be used in accordance with the manufacturer's recommendation and the PCI Design handbook.

B. Use of expansion nail type anchors, power-driven fasteners and friction spring-type clips are prohibited.

2.5 FABRICATION

A. Fabricate piping and equipment supports in accordance with the requirements of paragraph 1.3 of this Specification.

B. Design hangers without disengagement of supported pipe.

C. Provide copper-plated hangers and supports for copper piping. Where copper plating is not available on support components, provide sheet neoprene or other approved insulating material.

2.6 FINISH

A. Prime coat exposed black steel hangers and supports. Hangers and supports located in crawlspaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

B. Paint pipe supports in accordance with Section 09920, Painting - Equipment and Piping.

PART 3 -- EXECUTION

3.1 GENERAL

A. No attempt has been made to show all required pipe supports in all locations, either on the Drawings or in the details. The absence of pipe supports and details on the Drawings shall not relieve the Contractor of the responsibility for furnishing and installing them as required.

B. Design pipe support system components to withstand piping dead loads, thermal loads, seismic, pressure thrust, etc. Do not exceed the allowable load published by the component manufacturer.

C. Support piping in a manner which will prevent over stress on any valve, fitting, or piece of equipment. In addition, provide pipe at changes in direction or elevation, adjacent to flexible couplings, and where otherwise shown. Do not install pipe supports and hangers in equipment access areas, walkways, or other access areas.

D. Do not allow copper pipe to contact a pipe support or hanger of dissimilar metal. Copper plate, plastic coat, or isolate hangers with insulating neoprene strips.

E. Do not support piping from another pipe or any other equipment.

F. Use oversized pipe hangers on insulated piping to allow insulation to run continuous through the hanger or to allow clearance for pipe shields.

G. Do not allow metallic pipes to contact hangers, clamps, brackets, or any other pipe support mechanism where sound and vibration control is required. See Section 15240, Mechanical Sound and Vibration Control.

H. Attach piping hanger support rods to steel beams either utilizing center-loading I-beam clamps such as Grinnell Figure 133, 134, 218, 228, 292, or welded beam attachment with a swivel connection such as Grinnell Figure 66 with Figure 290 or 290L. Use of welded beam attachments without use of a swivel connection is prohibited for hot piping.

I. Install hangers without disengagement of supported pipe.

J. Radius, deburr, and prime saw-cut ends in accordance with Section 09920, Painting - Equipment and Piping. In areas where support members encroach into aisles, egress, etc., provide protection cap on ends.

K. Install rods supporting hot piping free to pivot at the connection to the upper steel or concrete attachment.

3.2 VIBRATION ISOLATION

A. In accordance with Section 15240, Mechanical Sound and Vibration Control.

3.3 PIPE HANGERS AND SUPPORTS

A. Support individual horizontal piping as follows:

PIPE HANGER REQUIREMENTS FOR DEAD LOAD SUPPORTS

Pipe Size	Steel Pipe Maximum Hanger Spacing Water Service	Steel Pipe Maximum Hanger Spacing Stm. Gas or Air Service	Copper Pipe Maximum Hanger Spacing	Rod Hanger Diameter
1/2 thru ¾ inch	7’	8’	5’	3/8”
1 thru 1-1/4 inches	7’	9’	6’	3/8”
1-1/2 inches	9’	12’	8’	3/8”
2 inches	10’	13’	8”	3/8”
2-1/2 inches	11’	14’	10’	1/2”
3 inches	12’	15’	10’	1/2”

Notes:
1. Use these maximum hanger spacings unless stated otherwise on the Drawings.
2. Rod hanger diameter is based upon maximum support span of water filled pipe. For shorter spans refer to hanger manufacturer’s published load ratings.
3. Rods may be reduced one size for double rod hangers supporting a single pipe. Minimum rod diameter is 3/8 inch.
4. Reduce hanger spacing for horizontal piping at a change of direction to 3/4 of the spacing specified above.

B. Size hanger rod for copper pipe the same as for steel pipe.

C. Size hanger rod for plastic pipe the same as for steel pipe. Space hangers as specified in the applicable piping specification or as shown on the piping Drawings

D. Install hangers to provide a minimum 1/2-inch space between the face of the support and the finished covering of the adjacent work with consideration for thermal movement.

E. Place a hanger within 12 inches of each horizontal elbow and on both sides of valves weighing 20 pounds or more unless written justification is provided to do otherwise.

F. Use hangers with 1-1/2 inches minimum vertical adjustment.

G. Support horizontal cast iron pipe adjacent to each hub with 5 feet maximum spacing between hangers.

H. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub. Piping thermal expansion and contraction must be considered to select proper supporting components.

I. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

J. Support riser piping independently of connected horizontal piping.

K. Do not support hot and cold piping on a common trapeze unless thermal effects are considered.

L. Support tubing at the following intervals.

TUBE SIZE (inches)	MAXIMUM SPACING (feet)	MINIMUM ROD DIAMETER (inches)
up through 5/8	6	3/8
7/8 through 1-1/8	8	3/8
1-3/8 through 2-1/8	10	3/8
2-5/8 through 5-1/8	10	1/2

END OF SECTION

SECTION 15160

PUMPS - GENERAL

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the general requirements for pumps.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the general requirements for pumps.
   1. Section 15050 - Basic Mechanical Requirements.
   2. Section 15170 - OEM Electric Motors.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 REFERENCES HYDRAULIC INSTITUTE STANDARDS (EDITION 14) DESIGN CRITERIA

A. Definitions: Refer to Hydraulic Institute Standards for definitions.

B. Requirements:
   1. Nonoverloading combination pump and motor are required.
   2. Pumps with an NPSH required equal to or less than the NPSH available at the minimum suction conditions while maintaining full-rated capacity are preferred.
   3. Grease for life is preferred over oil lubrication.
   4. Mechanical seals are preferred. The mechanical seals shall be balanced cartridge type for industrial pumps and single, inside unbalanced for HVAC pumps, if applicable. The manufacturer of the seals must approve of the sealing surfaces and materials of construction for the service. Seals shall be of a design that will not fret the pump shaft or sleeve.
   5. Pumps with a constant speed motor requiring a maximum diameter impeller to meet the rated pumping conditions are not acceptable. The impeller shall be such that at least a 10 percent increase in head at the rated capacity can be obtained by installing a larger-diameter impeller of the same pattern.
   6. Size pumps having single volute so that the impeller diameter furnished is less than 80 percent of the volute cut-water diameter. Size double-volute pumps so

that the impeller diameter furnished is no greater than 90 percent of the volute cut water.

7. Pumps having the rated capacity point to the right of the peak efficiency points on the head capacity curve for the impeller diameter proposed are not acceptable.
8. Pumps noted on the individual pump data sheets or schedule as operating in parallel shall have head capacity curves rising continuously to shutoff. The manufacturer shall submit evidence that one pump operating alone will not operate beyond its head capacity curve.
9. Pump efficiencies shall be as noted on the data sheets or schedule. Pumps or motors with efficiencies less than scheduled are not acceptable.
10. Pumps shall be of the back pullout design, if applicable.
11. Size impellers so that the nameplate horsepower of the supplied motor is not exceeded at any point on the curve.
12. Impellers shall have NPSH requirements so that stable, cavitation free operation at 120 percent or greater of best efficiency point is ensured.
13. Pump motor enclosures shall comply with the project design criteria.

1.4 WARRANTY

A. The complete pumping assembly shall be guaranteed for pressure, capacity, and power consumption at the specified design operation conditions, water NPSH, and satisfactory application in all respects to the operating conditions specified on the individual pump data sheet or schedule. Perform factory tests in accordance with Hydraulic Institute standards. Certification of test results is required.

B. A written warranty to cover the pumps and motors against defects in workmanship and material for a period of 5 years of operation under normal service.

C. Peak-to-Peak Vibration Limits (Mils):

Speed, RPM	Antifriction Bearing[1]	Sleeve Bearing[2]
1,800 and below	3.0	3.0

1.5 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipment:

1. Protect flange facings by securely fastened metal covers to prevent damage during shipment. Covers shall be a minimum of 1/4 inch thick and shall be

[1] Measured on bearing housing.
[2] Measured on the shaft.

installed with a full-face rubber gasket using a minimum of four full-diameter bolts. Tape the cover and flange for protection from water.

2. Protect mechanical seal assemblies from rusting and entry of moisture and dirt.
3. Electric etch each furnished coupling with tag item number of the purchased equipment for which it is intended.
4. For pumps with mechanical packing, prior to shipment, the packing used during running tests shall be removed. Two sets of new and unused packing shall be shipped with the pump properly identified, but not installed.
5. Clean metal lube oil filter elements prior to shipment. Replace nonmetallic filter elements prior to shipment and a spare set of nonmetallic filter elements shall be shipped with the unit. The equipment Vendor shall coordinate these requirements if the lube oil systems are furnished by subsuppliers.
6. Pumps shall not be doweled to the baseplate in manufacturer's shop prior to shipment.

1.6 SUBMITTALS

A. Provide the following submittals.

1. In addition to the pump curves, indicate separately the head, capacity, and overall efficiency.
2. Certified test curves shall include discharge head or pressure, Bhp, and efficiency plotted against capacity. For pumps, the curve shall include the maximum and minimum diameters or the impeller supplied, eye area of the impeller, identification number of the impeller, and pump serial number.
3. Cross-sectional or assembly-type drawings showing all parts and construction features shall be supplied for all equipment.
4. A list of any fits, clearances, and balancing data needed for maintenance, repair, and assembly.
5. Mechanical seals proposed.
6. Motor Specifications Including:
   a. Manufacturer and model.
   b. Enclosure.
   c. Bearings used; type and life expected.
   d. Service factor.
   e. Winding insulation class.
   f. Speed.
   g. Shaft size.
7. Coupling make and model (if applicable).

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pumps: Refer to individual pump specification section for acceptable pump manufacturers.

B. Mechanical Seals:
   1. Flowserve.
   2. Chesterton.
   3. Crane.

C. Packing (Only if Specified in Individual Pump Data Sheet):
   1. Garlock.
   2. Chesterton.
   3. Crane.

2.2 GENERAL

A. Motors:
   1. Supply motors accordance with Section 15170, OEM Electric Motors.

2.3 MATERIALS

A. Casings:
   1. Furnish casings with integral flanged suction and discharge nozzles. Flanges shall conform to ANSI standards. However, if the manufacturer's standard pattern offers a flanged thickness and diameter greater than that of the rating specified, the heavier flange may be furnished, but it shall be faced and drilled as specified.
   2. Flange bolt holes shall straddle the horizontal and vertical centerlines.
   3. Provide casing with suitable means to facilitate disassembly of gasketed joints, such as eye bolts, lugs, jack screws, etc.
   4. The stress used in design for any given materials shall not be in excess of the values given in Section VIII, Unfired Pressure Vessel of the ASME Boiler and Pressure Vessel Code, for the same material. For cast materials, the factor specified in the Code shall be applied.

B. Volutes:
   1. Pumps shall have cast iron construction on volute, backplates, seal housings, and bearing frames.
   2. Volutes shall have the discharge size one pipe size smaller than the suction size.
   3. Pumps with discharge 2 inches and below shall have NPS threads on suction and discharge.

C. Impellers:
   1. Impellers shall be of bronze construction, keyed with an impeller stainless steel key to the shaft and locked in place by threaded sleeves.
   2. Impellers shall be fully enclosed, trimmed to specified conditions, and dynamically balanced at the specified operating speed.
   3. Impellers shall have In accordance with ISO G6.3.

D. Shafts and Shaft Sleeves:
   1. Replaceable shaft sleeves to protect the shaft where it passes through the stuffing boxes are required on all packed pumps; shaft sleeves might not be supplied for pumps furnished with mechanical seals. Shaft sleeves shall extend beyond the outer face of the packing gland.
   2. Make the shaft sleeve diameter in increments of 1/8 inch above a 1-inch diameter. To provide for use of mechanical seals, the tolerance of the shaft diameter through the stuffing box shall not exceed nominal to 0.002 inch.
   3. Pump shaft or shaft sleeve runout at the impeller shall not exceed 0.002 inch.
   4. Dynamic shaft deflection under the worst conditions of load shall not exceed 0.002 inch maximum at the face of the stuffing box or mechanical seal.

E. Bearings, General:
   1. Select bearings in accordance with ANSI B3.11, Method of Evaluating Load Ratings for Ball and Roller Bearings.
   2. Equip oil-lubricated equipment with a 4-ounce minimum Trico Opto-Matic Model 30003 constant level oiler with wire guard Model 30013.
   3. Bearing housings shall be water cooled for equipment operating at temperatures above 350 degrees.
   4. When pressure oil lubrication is required, the manufacturer shall supply a complete system to circulate oil through all pumps and, if required, driver and gear bearings. The minimum system provided shall include positive displacement-type primary and auxiliary oil pumps, above-base reservoir, oil cooler, dual filters, relief valve, pressure gauges and switches, thermometers, valves, and piping. The components of the oil system shall be of steel construction, except stainless steel (18-8) piping shall be provided downstream of the lube oil filter to the pump and drive train bearings. Refer to individual pump data sheet for additional requirements.

F. Seals:
   1. Pumps covered by this Specification shall be equipped with mechanical seals unless otherwise noted on the individual pump data sheet or schedule.
   2. Mechanical seals shall be of a single, stationary, inside unbalanced for HVAC service or hydraulically balanced cartridge design for industrial service unless otherwise specified on the individual pump data sheet or schedule. Built-in or

integral-type mechanical seals are unacceptable, except for close-coupled pumps. Mechanical seals shall have static O-ring shaft seals.

3. Seal gland plates shall be of the same material as the pump case, except that carbon steel or more corrosion-resistant plates shall be furnished with cast iron, ductile iron, or bronze cases unless otherwise noted on the individual pump data sheet or schedule.
4. Gland plates retaining mechanical seals shall have at least four bolts.
5. The seal gland plate shall have a throttle bushing to restrict the flow to atmosphere in the event of a seal failure.
6. Nonmetallic cyclone separators are not acceptable for seal flush service.
7. Seal flush systems furnished by the pump vendor shall be provided with a visual means of determining that the flush liquid is flowing to the mechanical seal.
8. Single mechanical seals, when flushed, shall have the stuffing box or seal gland plate arranged so that the flush liquid is not directed at the seal mating faces.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Install pumps in accordance with the manufacturer's written installation instructions and as shown on the Drawings.

B. Support interconnecting piping independently to prevent stresses from being transmitted to casings.

C. Lubricate in accordance with manufacturer's instructions before operation.

D. Pumps that contain mechanical seals shall not be hydrotested.

3.2 STARTUP

A. Verify that piping systems have been flushed, cleaned, and filled.

B. Prime pumps, vent all air from the casings, and verify that rotations are correct. To avoid damage to mechanical seals, never start or run the pumps in dry conditions.

C. After several days of operation, remove disposable startup strainers.

D. Perform field mechanical balancing, if necessary, to meet specified vibration tolerances.

END OF SECTION

SECTION 15170

OEM ELECTRIC MOTORS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install electric motors which are provided as drivers for equipment that is normally assembled for off-the-shelf availability.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for OEM electric motors:
   1. Section 15050 - Basic Mechanical Requirements.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DESIGN CRITERIA

A. Provide driven equipment supplier's standard electric motors. Provide motors with the following design criteria:
   1. High-efficiency design.
   2. Ball and roller-type bearings with an AFBMA L-10 life of 40,000 hours.
   3. Minimum insulation class of F.
   4. Lowest possible motor speed.
   5. Maximum locked rotor code of six times FLA.
   6. Service factor of 1.15 in general based on ambient temperature of 40 degrees C, a service factor of 1.0 for inverter rated motors.
   7. Low starting current NEMA Type B.
   8. Overcome motor starting load inertia. Accelerate the load to rated speed under both rated and at 10 percent reduced voltage conditions during starting without excessive heating.
   9. Size motors for the altitude at which they are being installed.
   10. Rate motors to operate on an engine-generator set.
   11. If indicated on the data sheet, apply an epoxy dip on windings for outdoor application.

B. Provide motor enclosures and junction boxes suitable for the area electrical classification listed for the driven equipment.

C. Inverter-rate three-phase motors in adjustable frequency drive applications with 1,600V surge insulation per NEMA MG 1 and provide insulated bearings.

1.4 SUBMITTALS

A. Provide the following submittals:
1. Rating of each motor.
2. Motor manufacturer and model.
3. Motor efficiency at half load and at full load.
4. L-10 life of bearings provided.
5. Make and model of bearings.
6. Service factor and insulation class.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. OEM manufacturer's standard supplier.

B. When alternates are available, provide the following manufacturers:
1. Baldor.
2. General Electric.
3. Toshiba.
4. Lincoln.
5. Leeson.
6. Siemens.
7. T.B. Woods.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Install in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 15172

ADJUSTABLE FREQUENCY DRIVES

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install pulse-width modulated (PWM) adjustable frequency ac drives (AFDs) for controlling speed of ac squirrel-cage induction motors.

B. [Manufacturer's Responsibilities:
   1. Coordinate application engineering and startup support to ensure drives are properly selected.
   2. Drive problems before and after installation during warranty period at project site.
   3. Provide and warrant AFDs sent to driven equipment vendors for run testing. Provide technical assistance during testing along with shipping and coordination costs.]

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for AFDs:
   1. Section 15050 - Basic Mechanical Requirements.
   2. Section 16010 - Basic Electrical Requirements.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Allen-Bradley (AB).

B. Asea Brown Boveri (ABB).

C. Magnetek.

D. Siemens.

E. Square D.

2.2 GENERAL

A. Input Voltage: [480] Vac plus or minus 10 percent, three phase, 60 Hz plus or minus 2 percent.

B. Main Disconnect: circuit breaker interlocked with enclosure door, breaker rated for 65,000A fault duty symmetrical withstand.

C. Minimum 93 percent drive efficiency.

D. Overload Capability: 120 percent for 1 minute.

E. Overload Protection: thermal overload relays in all three phases.

F. Overcurrent Protection: current-limiting fuses.

G. Surge Protection: on input terminals, able to withstand 510V line-to-ground.

H. Operating Frequency Range: 3 to 67 Hz.

I. Active current limit to provide 110 percent torque for 1 minute.

J. AFD capable of operating when powered from normal power, engine generator power, solidly grounded power system, or resistance grounded power system.

K. AFD capable of starting and operating without motor connected.

L. Rate AFD for altitude where installed.

M. Provide terminal blocks for control and power interfaces.

N. Enclosure: NEMA 12 unless indicated otherwise.

2.3 COMMUNICATIONS AND CONTROLS

A. Full digital control of frequency and voltage with 7-segment LCD built-in key pad with programming, monitoring, alarms, adjustment, and control features including:
   1. Manual/Off/Auto selector with bumpless transfer.
   2. Local manual speed, start, stop, reset controls.

3. Local or remote speed reference selector for bumpless transfer via programmable acceleration/deceleration rates.
4. Adjustment of speed, rate of change, dc boost, current limit, frequency skip.
5. [Run pilot light.]
6. Remote start-stop control capability via contact.
7. Monitoring of current, frequency, voltage, and speed.
8. Drive diagnostics.

B. Interfaces and Cards:
1. RS232/RS485 and 4-20 mA interfaces.
2. Troubleshooting and diagnostic card.
3. Interfaces and interposing relays per AFD interface drawings.
4. Three programmable contacts for remote indication of events and alarms.
5. Failsafe dry contacts for fault, run, and auto indications.

C. Programming and Software:
1. Programming port for laptop running drive vendor configuration software.
2. If control signal is lost, keep speed at previous setting.
3. Flying restart after momentary 0.5 to 20 second power failure.

2.4 POWER QUALITY

A. Provide 5 percent AFD input line reactors or harmonic filters if TDD and THD exceed limits of IEEE 519.

2.5 DRIVEN LOAD CHARACTERISTICS

A. Motor Voltage Rating: 460, three phase.

B. Motor Service Factor: 1.0 for inverter rated and 1.15 for others.

C. Motor Temperature Rise: Class B, based on 40 degrees C ambient.

D. Motor Insulation: Class F.

E. Motor Torque Characteristic: NEMA Design B.

F. Load Type: variable torque.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.2 TESTING AND ADJUSTING

A. Test in accordance with manufacturer's recommendations.

B. Make and record settings in coordination with operating requirements from IDC.

C. For AFDs sent to driven equipment OEM facilities, provide testing, adjustment, and technical assistance for operation of overall system.

3.3 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative for the following services at job site or classroom as designated by Owner for minimum workdays listed below, travel time excluded:
   1. [1] workdays for programming.
   2. [1] workdays for [functional] [and] [performance] testing.
   3. [1] workdays for instruction of [2] personnel.

3.4 FIELD QUALITY CONTROL

A. Retest units failing to meet Specifications to satisfaction of IDC.

B. Furnish units that perform as specified if AFDs fail second test.

3.5 SUBMITTAL SCHEDULE

A. Provide the submittals listed in the Submittal Schedule:

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	5 WEEKS AFTER AWARD	AS INDICATED

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	5 WEEKS AFTER AWARD	AS INDICATED
15172-02	Catalog cut-sheets, other descriptive literature	X		
15172-03	Enclosure external and internal layout drawings with bill of material, dimensions and openings	X		
15172-04	Weights	X		
15172-05	Capacities and ratings	X		
15172-06	AFD single-line diagram	X		
15172-07	Speed range and output frequency range in Hertz	X		
15172-08	Maximum continuous output horsepower operating capability	X		
15172-09	Maximum short-term (60-second duration) horsepower without shutdown or damage to AFD	X		
15172-10	Maximum input current under rated load and in speed range for conductor sizing	X		
15172-11	Recommended sizes for line overcurrent protection	X		
15172-12	Fault duty withstand capability in symmetrical amperes	X		
15172-13	Efficiency under rated load at 60, 45, 30, and 15 Hz	X		
15172-14	Mounting, including seismic		X	
15172-15	Performance characteristics		X	
15172-16	Model numbers		X	

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	5 WEEKS AFTER AWARD	AS INDICATED
15172-17	Data sheets		X	
15172-18	Electrical input and output voltage ratings, load, and interface		X	
15172-19	Wiring, interconnection, and schematic diagrams		X	
15172-20	Control interface		X	
15172-21	Total Demand Distortion (TDD) and Total Harmonic Distortion (THD) at points of common coupling		X	
15172-22	Instruction and technical manuals		X	
15172-23	Spare parts list and pricing		X	
15172-24	Software, files, databases			4 weeks prior to start-up
15172-25	Factory testing results			Prior to shipment
15172-26	Field test results			1 week after test
15172-27	Operation and maintenance manuals			4 weeks prior to start-up
15172-29	Training			Coordinate with Owner
15172-29	AFD settings			4 weeks prior to start-up

END OF SECTION

SECTION 15190

MECHANICAL IDENTIFICATION

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. Identification requirements for tagging equipment, containers, valves, dampers, piping, tubing, and ductwork.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for identification of mechanical and process equipment, piping, and valves:
   1. Section 15050 - Basic Mechanical Requirements.

B. CAUTION: Use of this Section without including the above-listed items result in omission of basic requirements.

1.3 SUBMITTALS

A. Provide the following prior to having plates engraved, labels printed, and valve and damper tags stamped:
   1. A complete list of equipment, container, pipe, tubing and duct labels valve, and damper tags.
   2. A sample of each type of label showing sizing of letters and material.
   3. Submit a copy of the valve tag chart before installing.

PART 2 -- PRODUCTS

2.1 EQUIPMENT IDENTIFICATION PLATES

A. Materials: 3-inch by 5-inch engraved plastic, or stainless steel.

B. Marking: Include the tag number indicated on the Drawings and the associated reference name.

2.2 VALVE AND DAMPER IDENTIFICATION TAGS

A. General Description: numbered brass discs with stainless steel wire or chain for attachment to the valve.

B. Numbering:
   1. Manual Valves: Engrave with numbers corresponding to the identification code currently used within the building.
   2. Components and Devices: Engrave with numbers corresponding to the identification shown on the Drawings.

2.3 VALVE TAG CHART

A. Assemble a valve tag chart indicating valve tag number, location of valve, service, and normal operating position of valve (open or closed).

2.4 PIPING AND DUCTWORK IDENTIFICATION LABELS

A. Acceptable Manufacturers:
   1. H. Brady Company, Milwaukee, Wisconsin.
   2. Seton Nameplate Corporation, New Haven, Connecticut.
   3. Marking Services Incorporated, Milwaukee, Wisconsin.

B. General Description:
   1. Vinyl or vinyl cloth with permanent, pressure-sensitive adhesive.
   2. Provide labels and adhesives of long lasting materials, resistant to moisture, oils, solvents, and weathering.
   3. Label color, lettering color, and lettering height in conformance with ANSI A13.1 and OSHA requirements.
   4. Provide separate flow directional arrows that conform with the above criteria.

C. Piping Labels: Include the full-service identifier as specified in the label information column of Section 15059, Service Index.

D. Separate Chemical Gas and Bulk Chemical Piping Source and Destination Labels: Identify the source and destination with the numbers corresponding to the identification shown on the Drawings (e.g., VMB-23-G2 to ILD-01).

E. Process Exhaust Ductwork Labels - Identify the exhaust stream as follows:
   1. EF-1, 2 and EF-4 systems: Acid exhaust.

PART 3 -- EXECUTION

3.1 EQUIPMENT IDENTIFICATION PLATES

A. Installation:
   1. Install identification plates on equipment, including, but not limited to, pumps, air supply units, return air fans, exhaust fans, boilers, chillers, air compressors,

vacuum pumps, vacuum blowers, scrubbers, recirculation air handlers, and miscellaneous items of heating, ventilating, air conditioning, plumbing, and process equipment.

2. Locate plates in a clearly visible location.
3. Attach plates to equipment with stainless steel hardware or mastic to create a permanent bond.

3.2 VALVE AND DAMPER TAGS

A. Attach tags to valve handle or yoke with stainless steel wire or chain, or nylon ties.

B. Attach tags to damper handle or actuator with stainless steel wire or chain, or nylon ties.

3.3 PIPING AND DUCTWORK IDENTIFICATION LABELS

A. Utilize vinyl labels within the cleanroom environment.

B. Installation:
1. Attach labels to lower quarter of piping and ducts on horizontal runs. Labels are to be visible when viewed from below.
2. Install separate flow directional arrows with each label. Point flow indicator arrows away from labels.
3. Identify piping where it is not permanently concealed by the structure:
   a. At each valve.
   b. On both sides of wall, floor, and ceiling penetrations.
   c. At connections to equipment.
   d. At least every 30 feet along continuous runs of exposed piping and piping in ceiling spaces that are accessible through ceiling tiles.
4. Identify ductwork where it is not permanently concealed by the structure:
   a. On both sides of wall, floor, and ceiling penetrations.
   b. On each riser.
   c. At equipment connections.
   d. Every 50 feet maximum along duct runs.

END OF SECTION

SECTION 15240

MECHANICAL SOUND AND VIBRATION CONTROL

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements for noise and vibration control systems to be used for process, mechanical, electrical, and structural work.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for mechanical sound and vibration control.
   1. Section 15240.tbl - Vibration Isolation Schedule.
   2. Section 15830 - FRP Centrifugal Fans.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DESIGN CRITERIA

A. Do not install equipment piping, conduit, etc., in rigid contact with the structure unless it is required by this Specification. Structure includes slabs, beams, studs, walls, columns, lath, etc.

B. Prior to installation, bring to IDC's attention discrepancies between the Specifications and field conditions, changes required due to specific equipment selection, etc. Corrective work necessitated by discrepancies after installation shall be at the Contractor's expense.

1.4 COORDINATION

A. Coordinate the work under this Section with other mechanical, electrical, and structural work to accomplish the interfacing necessary to provide a complete and operating system in conformance with the intent of the Contract Documents.

1.5 SUBMITTALS

A. Provide the following within 3weeks of award of Contract:
   1. A general statement of materials and methods intended for use on this project. Provide specific information for items described under the Products section of

this Specification. Provide complete specifications, descriptive drawings, catalog cuts, and descriptive literature which includes make, model, dimensions, weight, and interface description with other work. Complete performance data is required that will indicate full compliance with Specifications as outlined herein.

2. Shop Drawings:
   a. Complete detailed shop drawings showing the intended locations and construction features of products specified. Submit shop drawings in a timely manner to allow review and revision without adversely affecting construction scheduling.
   b. Drawings showing equipment frame construction for each machine, including dimensions, structural member sizes, support point locations, etc.
   c. Drawings showing methods for suspension, support, guides, etc., for piping, ductwork, etc.
   d. Drawings showing methods for isolation of pipes, etc., piercing walls, slabs, beams, etc.
3. Product Data:
   a. Catalog cuts and data sheets on specific vibration isolators to be utilized showing compliance with the Specification.
   b. An itemized list showing items of equipment, piping, etc., to be isolated, the isolator type, and model number selected, isolator loading and deflection, and reference to specific drawing showing frame construction where applicable.
   c. Written approval of the frame design to be used, obtained from the equipment manufacturer.

B. Provide the following equipment balance reports as soon as they are available:
   1. Factory balance reports.
   2. Field balance reports.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Isolator Stability:
   1. Select springs with sufficient diameter to maintain stability of the equipment being supported. Provide a minimum horizontal to vertical stiffness ratio no less than 1:1.
   2. Select springs for a minimum additional travel to solid equal to 50 percent of the rated deflection.

B. Corrosion Protection for Outdoor Installations: Coat metal parts exposed to weather with hot-dip galvanizing (per ASTM A525), cadmium plating, or neoprene coating after fabrication.

2.2 EQUIPMENT BASES

A. General:
1. Coordination: Furnish equipment bases and isolators by the same manufacturer to ensure a coordinated system.
2. Painting of Bases: Prime coat with rust-inhibiting paint.
3. Seismic Provisions: Provide equipment base anchor bolts for attachment of seismic snubbers where specified.

B. Structural Base:
1. General:
a. Description: welded structural steel beams or channels with outboard isolator brackets and prelocated equipment anchor bolts. Provide additional steel as required by structural conditions.
b. Rigidity: Provide bases rigid enough to support the equipment without flexing and to resisit starting, operating and seismic forces without supplemental hold down devices. Provide cross members where necessary to support the equipment and to prevent twisting of the main members.
c. Base Depth: minimum of 10 percent of the long dimension of the base but not less than 6 inches. Maximum depth shall be 12 inches except where structural or alignment considerations dictate otherwise.

PART 3 -- EXECUTION

3.1 EQUIPMENT BASE

A. Install base in location shown on the drawings and as detailed. Provide all hardware as required. Seal all connections to building structural mounting bases.

END OF SECTION

SECTION 15250

MECHANICAL INSULATION

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. Mechanical insulation is required on all mechanical systems using energy to produce the desired temperature within a system, and the temperature difference between the system fluid and ambient is greater than 10 degrees unless system is specifically excluded.

B. Mechanical insulation is required on all systems capable of having condensation form on them.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for insulation of equipment, vessels, piping, and ductwork:
   1. Section 15050 - Basic Mechanical Requirements.
   2. Piping Insulation Schedule at the end of this Section.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DESIGN CRITERIA

A. Insulation for mechanical systems shall provide a continuous thermal and/or vapor barrier through walls and floors to its intended point of use.

B. Where state energy codes dictate requirements for insulation application and thickness, the minimum requirements are not superseded by this code.

C. Performance of thermal and vapor barriers shall not be degraded by mechanical support systems.

D. Insulation materials and adhesives shall have composite (insulation jacket adhesive) fire and smoke hazard ratings as tested by ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials, NFPA 255 Standard Method of Test of Surface Burning Characteristics of Building Materials, and UL 723 Standard for Safety Test for Surface Burning Characteristics of Building Materials., Do not exceed flame spread 25 and smoke developed 50 ratings.

E. Occupational Safety and Health Administration regulation compliance is required for installation of all insulating materials.

1.4 QUALITY ASSURANCE

A. The installation of specified materials is limited to trained mechanics experienced in the installation procedures for these materials.

B. The insulation contractor is required to have a minimum of 3 years' experience with insulation of mechanical insulation as a primary business.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe Insulation:
   1. See Pipe Insulation, Paragraph 2.2.

B. Duct Insulation:
   1. Owens-Corning, all-service duct wrap.
   2. Manville, Microlight duct wrap.
   3. Certain-Teed.

2.2 PIPE INSULATION

A. Fiberglass (FG):
   1. Fiberglass is not to be used inside the new laboratory.
   2. Type FG1 - Preformed Pipe Insulation, Jacketed:
      a. Description: sectional complying with ASTM C547, Standard Specification for Mineral Fiber Pipe Insulation.
      b. Thermal Conductivity: 0.23 at 75 degree F mean temperature.
      c. Jacket: factory-applied kraft-reinforced foil vapor barrier, all service jacket (ASJ) with self-sealing lap seal. Maximum ASJ surface temperature 150 degrees F.
      d. Density: 10 pcf
      e. Maximum Insulation Operating Temperature: 850 degrees F.
      f. Acceptable Manufacturers:
         1) Johns Manville-Micro-Lok AP-T Plus.
         2) Knauf Glass GmbH – 1,000 degrees SSL Pipe Insulation.
         3) Owens Corning Fiberglass Pipe Insulation.
   3. Type FG2 - Semirigid, Jacketed:
      a. Description: roll or board form complying with ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
      b. Thermal Conductivity: 0.27 at 75 degree F mean temperature.

c. Jacket: factory-applied kraft-reinforced foil vapor barrier, ASJ with self-sealing lap seal. Maximum ASJ surface temperature 150 degrees F.
d. Density: 2.8 to 3 pcf.
e. Maximum Operating Temperature: 850 degrees F.
f. Acceptable Manufacturers:
1) Johns Manville – Fabrication Board Type 3005.
2) Knauf Fiber Glass GmbH – Pipe and Tank Insulation ASJ.

4. Type FG3 - Semirigid, Jacketed, Low Temperature:
a. Description: roll form complying with ASTM C612.
b. Thermal Conductivity: 0.24 at 75 degree F mean temperature.
c. Jacket: factory-applied foil-reinforced scrim kraft, vapor barrier jacket (FSK) with self-sealing lap seal. Maximum FSK surface temperature 150 degrees F.
d. Density: 6 pcf.
e. Maximum Insulation Operating Temperature: 450 degrees F.
f. Acceptable Manufacturers:
1) Johns Manville – Spin Glas 817 FSK.
2) Knauf Fiber Glass GmbH – Insulation Board.
3) Owens Corning Type 705 Insulation.

5. Type FG4 - Flexible Blanket, Nonjacketed, High Temperature:
a. Description: roll form complying with ASTM C553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
b. Thermal Conductivity: 0.27 at 75 degree F mean temperature.
c. Nonjacketed,
d. Density: 2 pcf.
e. Maximum Operating Temperature: 1,000 degrees F.
f. Acceptable Manufacturers:
1) Johns Manville HTB 23.
2) Owens Corning – Fiber Glass TIW Type 1.

B. Thermal Insulating Wool, Type W, Flexible Blanket, Wire Mesh:
1. Description: roll form with stainless steel hexagonal wire netting, ASTM C553.
2. Thermal Conductivity: 0.25 at 75 degree F mean temperature.
3. Wire mesh.
4. Density: 8 pcf.
5. Maximum Operating Temperature: 1,200 degrees F.
6. Acceptable Manufacturer: CSR Bradford Fibermesh 650.

C. Cellular Glass - Type G - Rigid Preformed Pipe and Block:
1. Description: flat block or half-round incremental lengths of cellular glass complying with ASTM C552, Standard Specification for Cellular Glass Thermal Insulation, Type II, presized for nominal pipe sizes.

2. Thermal Conductivity: 0.345 at 75 degree F mean temperature.
3. Water Vapor Permeability: maximum 0.005 perm-inch.
4. Density: 6.7 to 9.2 pcf.
5. Maximum Operating Temperature: 800 degrees F.
6. Acceptable Manufacturer:
   a. Pittsburgh Corning Foamglas.
   b. Cell-U-Foam Ultra CUF.

D. Flexible Elastomeric Type E, Preformed Pipe and Sheet/Roll:
1. Flexible Eleastomeric is to be used inside new laboratory.
2. Description: Comply with ASTM C534, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form, Types I and II.
3. Thermal Conductivity: 0.30 at 75 degree F mean temperature.
4. Water Vapor Permeability: 0.2 perm-inch.
   a. Flame Spread/Smoke Developed Rating: 25/50 applicable to 3/4 inch thickness or less.
   b. Maximum Operating Temperature: 220 degrees F.
   c. Acceptable Manufacturers:
      1) Armacell: Armaflex SS (Self-Seal).
      2) Rubatex: Insul-LockII/Sheet 1800.

~~E. Hydrous Calcium Silicate, Type CS, Preformed Pipe or Block:~~
~~1. Description: rigid, white, asbestosfree complying with ASTM C533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation, Type 1.~~
~~2. Thermal Conductivity: 0.4 at 300 degree F mean temperature.~~
~~3. Density: 14 to 15 pcf.~~
~~4. Maximum Operating Temperature: 1,200 degrees F.~~
~~5. Acceptable Manufacturers:~~
~~a. Calsilite.~~
~~b. Johns Manville Thermo-12 Gold.~~

~~F. Open Cell Melamine - Foam, Type M, Flexible Open-Cell Melamine, Jacketed:~~
~~1. Description: prejacketed, preformed pipe or sheet insulation; fiberfree; low outgassing, antibacterial, flexible open-call melamine foam complying with ASTM C-1410, Standard Specification for Cellular Melamine Thermal and Sound Absorbing Insulation.~~
~~2. Thermal Conductivity: 0.26 at 75 degree F mean temperature.~~
~~3. Jacket: factory-applied hard, smooth, shiny gloss, rigid, high-impact PVC; 0.02 inch thick; white; 1-inch end overlap; with self-seal lap.~~
~~4. Density: 0.7 pcf.~~
~~5. Service Temperature: minus 150 degrees F to plus 400 degrees F; 0 degrees F to 140 degrees F for jacket.~~

6. Clean Zone Considerations: vacuum insulation at factory to remove dust prior to packaging.
7.5. Acceptable Manufacturer: Accessible Products Company Techlite SSL879.

G. Polyisocyanurate: Type PI Polyisocyanurate rigid cellular plastics.
1. Description: preformed rigid cellular polyisocyanurate plastic foam complying with ASTM C591, Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
2. Establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
3. Thermal Conductivitiy: 0.19 at 75 degree mean temperature.
a. Density: 2 pcf.
b. Maximum Operating Temperature: 190 degrees F.
c. Closed Cell Content: 90 percent.
d. Flame Spread/Smoke Developed Rating: 25/50 at 1 inch thickness or less, 25/90 at 1.5 inch through 6 inch thickness.
e. Acceptable Manufacturers:
1) Dow Chemical - Trymer 2000.
2) Hitherm, LLC HT-300.

H. Polystyrene - Type PS Rigid Polystyrene:
1. Description: rigid board, closed cell, cellular polystyrene thermal insulation board complying with ASTM C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
2. Establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
3. Thermal Conductivity: 0.24 at 75 degree mean temperature.
4. Density: 1.6 pcf minimum.
5. Maximum Operating Temperature: 165 degrees F.
6. Flame Spread/Smoke Developed Rating:
a. Flame Spread: 5.
b. Smoke Developed: 145.
7. Acceptable Manufacturers:
a. Apache Products Company EPS Insulation Board.
b. Dow Chemical Styrofoam.
c. Owens Corning Foamular.

I. Polymer Foam - Type F, Engineered Polymer Foam Insulation (EPFI)
1. Description: Extruded tubular, black pigmented, longitudinally preslit pipe insulation with press-sensitive factory-adhesive closure system (preglued), nonjacketed. EPFI is a flexible, polymer-based, low-density, closed-cell, chemically-inert pipe and sheet insulation.
2. Thermal Conductivity: 0.25 at 75 degree mean temperature.
3. Water Vapor Permeability: 0.

4. Density: 1.5 to 1.8 pcf.
5. Flame Spread/Smoke Developed Rating: 25/50, applicable up to 1 inch.
6. Maximum Operating Temperature: not to exceed 210 degrees F. Maximum service temperature on underground piping located above water table is 150 degrees F.
7. Acceptable Manufacturers: Imcolock and Imcosheet by Imcoa.

2.3 JACKETS

A. Type A - Vapor Barrier Jackets: kraft-reinforced foil vapor barrier with self-sealing lap, ASJ.

B. Type B - PVC:
1. Description: one piece, ultraviolet resistant, polyvinyl chloride (PVC).
2. Thickness: 0.02 cut and curled.
3. Flame Spread Rating: 25 or less.
4. Smoke Developed Rating: 50 or less.
5. Grade: weatherable.
6. Color: white.
7. Temperature Limits: zero to 140 degrees F.

C. Type C - Canvas: UL-listed, fire retardant treated, lagging adhesive, cotton fabric, 6-ounce-per-square-yard density, plain weave.

D.C. Type D - Aluminum: aluminum alloy 3003, 1100 or 3105 with H-14 temper with factory-applied moisture barrier meeting ASTM B209, Standard Specifications for Aluminum and Aluminum-Alloy Sheet and Plate as listed below:

Insulated Item	Thickness (Inch)	Finish
Piping	0.016	Smooth or embossed
Vessels and equipment shells 36 inch diameter and smaller	0.016	Smooth or embossed
Vessels and equipment above 36 inch diameter	0.032	Smooth, embossed, or corrugated
Vessels and equipment heads, vessel transitions, and stiffener rings	0.032	Smooth

E. Type E, Stainless Steel - Type 304 stainless steel as listed below:

~~Insulated Item~~	~~Thickness (Inch)~~	~~Finish~~
~~Piping~~	~~0.016~~	~~Smooth or embossed~~
~~Vessels and equipment shells 36 inch diameter and smaller~~	~~0.016~~	~~Smooth or embossed~~
~~Vessels and equipment above 36 inch diameter~~	~~0.020~~	~~Smooth, embossed, or corrugated~~
~~Vessels and equipment heads, vessel transitions, and stiffener rings~~	~~0.032~~	~~Smooth~~

~~F~~.D. Acceptable Manufacturers:

1. Johns Manville Zeston Ceel-Co PVC.
2. Childers.
3. Pittsburgh Corning.
4. Knauf Proto Fitting Covers.

2.4 ACCESSORIES

A. Insulation Bands:
   1. Galvanized Steel: 3/4 inch wide by 0.02 inch thick.
   2. Stainless Steel, 24 Inch Diameter or Less: 1/2 inch wide by 0.015 inch thick, Type 304.
   3. Stainless Steel, Larger Than 24 Inch Diameter: 3/4 inch wide by 0.02 inch thick, Type 304.
   4. Heavy-Duty Stainless Steel: wing-type or crimp seals.

B. Insulating Cement: ASTM C195, Standard Specification for Mineral Fiber Thermal Insulating Cement.

C. Finishing Cement: ASTM C449, Standard Specification for Miner Fiber Hydraulic – Setting Thermal Insulation and Finishing Cement.

D. Flashing Compound: high-temperature asphalt emulsion type suitable for flashing.

E. Glass Fabric: 10-by-10 open mesh, asphalt treated, 9 ounces per square yard.

F. Wire: ties and wire, 18-gauge stainless steel, Type 304, soft annealed, or 20-gauge galvanized steel as indicated.

G. Breather Springs: flat, spiral wound, Type 302 stainless steel.

H. Sheet Metal Screws: 1/2 inch long, No. 8, hex or pan head, stainless steel, self-tapping.

I. Expansion/Contraction Joints: loose mineral fiber blanket or resilient fiberglass blanket.

J. S Clips: Fabricate from 1-inch-wide by 0.032-inch Type 304 stainless steel.

K. Insulation Tape: 3/4 inch wide, glass filament reinforced, pressure sensitive.

L. Expansion/Contraction Joint Tape: 4-inch-wide foil kraft tape or material matching insulation.

M. Weatherproof Mastic: asphalt emulsion type.

N. Adhesives: compatible with insulation.

O. Insulated Fittings: two-piece preformed/molded pipefitting material matching insulation.

P. Insulated Block/Pipe Supports: molded insulated pipe and block support.

Q. Vapor Barrier Coating: emulsion-based mastic coating.

R. Acceptable Manufacturers:
1. Childers.
2. Dow Corning.
3. Johns Manville.
4. ICA Inc. HamFab Products.
5. Knauf.
6. Pittsburgh Corning.
7. RPR Products.
8. 3M.

2.5 DUCT INSULATION

A. Flexible Fiberglass Blanket:
1. Reinforced foil/kraft vapor retarder facing (FSK) meeting ASTM C553 Type 1, Class B-2 flexible blanket with a 2-inch stapling and taping flange.
2. Minimum thickness 1 1/2 inches nominal with R-5 thermal resistance.

B. Flexible Elastomeric Type E, Preformed Pipe and Sheet/Roll:
1. Flexible Eleastomeric is to be used inside new laboratory.

2. Description: Comply with ASTM C534, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form, Types I and II.
3. Thermal Conductivity: 0.30 at 75 degree F mean temperature.
4. Water Vapor Permeability: 0.2 perm-inch.
   a. Flame Spread/Smoke Developed Rating: 25/50 applicable to 3/4 inch thickness or less.
   b. Maximum Operating Temperature: 220 degrees F.
   c. Acceptable Manufacturers:
      1) Armacell: Armaflex SS (Self-Seal).
      2) Rubatex: Insul-LockII/Sheet 1800.

PART 3 -- EXECUTION

3.1 PREPARATION

A. All systems to be insulated must pass all applicable tests and inspections prior to coverings.

B. All surfaces are to have a clean application surface free of dust, construction debris, and condensation.

C. All insulating materials are to be clean, dry, and free of dents or abrasions.

D. Install and inspect systems requiring heat tracing.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions, including types of insulating cements, caulks, lagging adhesives, and weatherproofing mastics if different from those specified.

B. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.

C. Continue insulation with vapor barrier through penetrations, such as wall openings, floor openings, pipe hangers, and pipe sleeves unless otherwise noted.

D. Provide insert between support shield and piping on piping 1-1/2 inches (38mm) diameter or larger. Fabricate of heavy-density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:
   1. To 2-1/2-Inch Pipe Size: 10 inches long.
   2. 3-inch to 6-Inch Pipe Size: 12 inches long.

3. 8-inch to 10-Inch Pipe Size: 16 inches long.
4. 12 Inches and Over: 22 inches long.

E. Provide removable insulation sections on all devices that require access for maintenance of equipment or removal, such as unions, strainer end plates, access panels, etc. Do not insulate flexible pipe couplings.

F. Finished appearance of all insulation shall be smooth and continuous. Joints shall be lapped and the integrity of the vapor seals maintained in strict accordance with the manufacturer's instructions. Do not use staples and screws to secure components of system that have a vapor barrier.

3.3 EXTERIOR PIPE INSULATION

A. Cover straight portions of insulated piping for exterior service with 0.016-inch aluminum or 0.01-inch stainless metal jacketing with all joints lapped 2 inches and arranged to shed water. Secure jacketing with metal bands installed on 9-inch centers.

B. Weatherproof fittings with prefabricated metal covers with weatherproof seams. Secure metal covers with bands and adhesive caulk.

C. Install a watertight metal flashing ring where pipe insulation terminates.

3.4 EXTERNAL DUCT INSULATION - FIBERGLASS

A. Secure insulation to ductwork using wires and adhesive.

B. Install without sag on the underside of ductwork using adhesive or mechanical fasteners where necessary. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

C. Lap joints and seams of external insulation a minimum of 3 inches overlap and staple 3 inches on center. Wire where required. Utilize adhesive. Where insulation type meets, lap external insulation a minimum of 6 inches overlap and seal the vapor barrier jacket.

D. Seal insulation with vapor barrier adhesive or tape matching jacket type to maintain the vapor barrier.

3.5 EXTERNAL DUCT INSULATION – ELASTOMERIC

A. Secure insulation on ductwork using full coverage of Armaflex 520 or 520 BLV Adhesive. Apply adhesive per manufacturer’s installation instructions.

~~3.5~~3.6 EXTERIOR DUCT INSULATION

A. Insulate exterior duct using rigid fiberglass board, applied foil face out, using insulation adhesive and mechanical fasteners.

B. Seal all seams and foil punctures with UL-listed, pressure-sensitive foil tape.

C. Exterior Jackets:
   1. Aluminum jacket, 0.016-inch-thick sheet, smooth embossed finish with longitudinal slip joints and 2-inch minimum lap joints.
   2. PVC jackets, UV-resistant polyvinyl chloride covering with joints secured and sealed with PVC welding adhesive.
   3. All seams and joints located and assembled to shed water.

~~3.6 INTERNAL DUCT LINER~~

~~A. General: Apply liner in accordance with the SMACNA Duct Liner Application Standard.~~

~~B. Application: Apply internal insulation to flat sheet metal with continuous coverage of adhesive. Use adhesive on all butted and exposed edges. Install clip pins at 15 inches on center and no more than 2 inches maximum from any cut or exposed edge. Use of nail-type fasteners is prohibited.~~

~~C. Dimensions: Duct dimensions shown are net inside clear dimension. Increase the size of sheet metal to allow for liner thickness.~~

~~D. Plenums: Provide 1-inch mesh hardware cloth facing over attenuated plenum floors.~~

~~E. Nosing Strips: Provide nosing strips at each joint in the duct liner where air velocities exceed 1,500 fpm, at cut edges in lined plenums, and where noted or otherwise specified.~~

~~F. Provide perforated sheet metal cover over access walkways through lined plenums.~~

~~G. External duct insulation is not required over internally lined duct unless otherwise noted.~~

~~H. Interrupt internal liners in the vicinity of electric duct heaters and fire dampers.~~

Piping Insulation Schedule[jpk1]

	Pipe Size Inches (mm)	Thickness Inches (mm)

	Pipe Size Inches (mm)	Thickness Inches (mm)
Outside Cleanroom: Fiberglass insulation		
Domestic hot up to 200°F	Up to 2 2-1/2 to 4 Over 4	1 1-1/2 2
Cold water	All sizes	1
Roof drain bodies	All sizes	1/2
Roof drainage within 10 feet (3 meters) of the exterior	All sizes	1/2
Plumbing vents within 10 feet (3 meters) of the exterior	All sizes	1/2
Heating water supply and return	All sizes	1-1/2
Chilled water supply and return	Up to 4 To 36 Over	1-1/2 2 1-1/2
Condenser water supply and return	Up to 4 Over 4	1 1-1/2
~~Heat recovery water~~	~~All sizes~~	~~1~~
Piping exposed to freezing	All sizes	1-1/2
~~Hydrous calcium silicate - engine exhaust piping~~	~~All sizes~~	~~4~~
Elastomeric foam		
~~Refrigerant suction~~	~~All sizes~~	~~1~~
~~Refrigerant hot gas~~	~~All sizes~~	~~3/4~~
Humidifier piping	All sizes	3/4
Domestic hot water		1/2
Cold water		½
Tempered hot water (inside)	All sizes	½
Tempered hot water return (inside)	All sizes	½
Tempered hot water (outdoors)	All sizes	1

	Pipe Size Inches (mm)	Thickness Inches (mm)
Tempered hot water return (outdoors)	All sizes	1
Condensate (inside)	All sizes	½
Acid Waste (inside)	All sizes	1/2
Condensate (outdoors)	All sizes	1

~~Equipment Insulation Schedule~~

	~~Thickness Inches (mm)~~
~~Flexible fiberglass blanket~~	
~~Water softeners~~	~~1~~
~~Heat exchangers/converters~~	~~1-1/2~~
~~Air separators~~	~~1~~
~~Chilled water pump bodies~~	~~1-1/2~~
~~Rigid fiberglass board - domestic hot water storage tanks~~	~~2~~
~~Elastomeric foam~~	
~~Chiller cold surfaces (not factory insulated)~~	~~1~~
~~Chilled water-supplied equipment (not factory insulated)~~	~~1~~
~~Calcium silicate - flue gas breeching~~	~~4~~

Ductwork Insulation Schedule

	Thickness Inches (mm)	Finish
Outside Cleanroom: Flexible fiberglass		
Exhaust ducts ~~within 10 feet (3 meters) of exterior terminations~~on roof	~~1~~ 1 1/2	FSK
~~Exhaust ducts exposed to outdoor air ventilation equipment casings~~	~~1~~	~~FSK~~
Supply ducts ~~(cooling systems)~~on roof	1-1/2	FSK

	Thickness Inches (mm)	Finish
~~Return ducts in unconditioned spaces~~	~~1-1/2~~	~~FSK~~
~~Rigid fiberglass~~Inside Cleanroom: Elastomeric foam		
~~Combustion air ducts~~Supply ducts	~~2~~ 1	~~AP~~ AP
~~Outside air intake ducts~~	~~2~~	~~FSK~~
~~Plenums (cooling systems)~~	~~2~~	~~FSK~~
~~Return and relief ducts in mechanical rooms~~	~~1-1/2~~	~~FSK~~
~~Exterior duct~~	~~2~~	~~FSK/aluminum~~
~~Duct liner, where indicated~~	~~1~~	~~Linacoustic, Permacote, or mat faced~~

~~3.7 EXCLUSIONS~~

~~A. Heat recovery piping installed within conditioned spaces within 10 degrees of internal fluid temperature.~~

~~B. Air conditioning supply and return ducts installed within the spaces they serve.~~

~~C. Cleanroom recirculating supply and return ducts installed within return air plenums.~~

END OF SECTION

SECTION 15290

DUCTWORK INSULATION

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install ductwork thermal insulation and internal sound attenuation insulation.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the specific requirements for ductwork insulation:
   1. Section 15050 - Basic Mechanical Requirements.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 QUALITY ASSURANCE

A. Provide insulation with composite (insulation-jacket-adhesive) fire and smoke hazard ratings not exceeding a flame spread of 25 and smoke developed of 50, as tested by Procedure ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials, NFPA 255 Standard Method of Test of Surface Burning Characteristics of Building Materials, and UL 723 UL Standard for Safety Test for Surface Burning Characteristics of Building Materials.

B. Installer qualifications: firm with a minimum of 3 years' experience in ductwork insulation application.

C. Manufacturer Qualifications: firm with a minimum of 10 years' experience in ductwork insulation manufacturing.

1.4 SUBMITTALS

A. Provide the following submittals:
   1. Product data sheets for all insulation, liners, and adhesives.
   2. Manufacturer’s instructions for installation.

PART 2 -- PRODUCTS

2.1 EXTERNAL DUCT INSULATION

A. Materials:
1. Type A:
a. Flexible glass-fiber insulation, thickness as scheduled, 3/4-pcf density, with UL-labeled foil vapor barrier.
b. Thermal conductivity no greater than 0.31 Btu-inch per hour- ft^2 degrees F at 75 degrees F.
c. Acceptable Manufacturers:
1) CertainTeed Corp: Duct Wrap Insulation, Type 75.
2) Johns Manville: R-Series Microlite.
3) Knauf Fiber Glass: Knauf Duct Wrap.
4) Owens Corning: Fiberglas All Service Duct Wrap.

2.2 OUTDOOR JACKET

A. Acceptable Manufacturer: Childers.

B. Materials, Type - Aluminum Sheet, Aluminum Alloy 3003-H-4 or 5005-H-14 with Factory-Applied Moisture Barrier as Listed Below:

Insulated Item	Thickness (Inches)	Finish
Ductwork width or depth smaller than 36 inches	0.016	Smooth or stucco
Ductwork width or depth 36 inches or larger	0.032	Smooth or stucco

2.3 ACCESSORIES

A. Adhesives: water based; Miracle PF 102.

B. Lagging Adhesive: fire resistive.

C. Tie Wires: galvanized, 20 gauge.

D. Joint Tape: foil scrim kraft (FSK) tape.

E. Impale Anchors: galvanized steel, 13-gauge nail, self-adhesive pad, 30-gauge galvanized steel washers.

PART 3 -- EXECUTION

3.1 FIELD PREPARATION

A. Install external insulation materials after ductwork has been cleaned, sealed, and has passed pressurization tests.

B. Clean surfaces to encourage adherence of adhesives.

3.2 INSTALLATION

A. General: Install materials in accordance with the manufacturer's instructions.

B. External Duct Insulation, Indoor:
   1. Application:
      a. Secure insulation to ductwork using wires and adhesive. Insulation may also be secured with mechanical fasteners, such as impale anchors.
      b. Install without sag on the underside of ductwork using adhesive or mechanical fasteners where necessary. Bend over nail tips after installation of washers to facilitate sealing of vapor barrier and to preclude injury. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
      c. Seal insulation with glue to maintain the vapor barrier. Pay particular attention to penetrations by mechanical fasteners, joints and seams and to ends and edges.

C. External Duct Insulation, Outdoor:
   1. Application:
      a. Secure insulation to ductwork using wires and adhesive. Insulation may also be secured with mechanical fasteners, such as impale anchors.
      b. Install without sag on the underside of ductwork using adhesive or mechanical fasteners where necessary. Bend over nail tips after installation of washers to facilitate sealing of vapor barrier and to preclude injury. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
      c. Seal insulation with tape matching insulation jacket.
      d. Install aluminum outer jacket to enclose the duct insulation.
   2. Jacket Installation:
      a. Cover duct tops and sides with continuous sheet if possible, but top shall be seamless.
      b. Cross break top sheet or provide slope to allow water drainage. Low points on ducts that allow standing water are not acceptable.
         1) Lap end seams 2 inches minimum and overlap in the direction of water flow to shed water.

2) Form 3/4-inch-high standing seam closure at edges; install seam closure strip with mastic and rivet at 12 inches on center.
3) Apply mastic at overlapped end seams and install gasketed screws at 6 inches on center.
4) Extend side jacket panels to allow 1-inch rain drip lip at bottom duct closure jacket, seal with mastic, and install gasketed screws at 6 inches on center along bottom of side panel.
5) Maintain complete integrity of closure system to shed rainwater.

3.3 SCHEDULE

DUCTWORK INSULATION SCHEDULE

Location	Insulation Type	Insulation Thickness (Inches)	Notes
Outside of the Clean Zone			
AHU-1 supply air duct outside building envelope	B	1	1
AHU-1 supply air duct inside building			
EF-1,2 ductwork on roof	B	1.5	1
EF-3,4 ductwork	None		

Notes:

1. Provide weather cover on all exterior ductwork as specified above.

END OF SECTION

SECTION 15409

POTABLE WATER SYSTEMS STERILIZATION

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements for sterilizing the potable water piping systems before they are placed into service.

1.2 RELATED SPECIFICATIONS

A. Use this Section in conjunction with the following other specification and related Contract Documents to establish the total requirements for potable water system sterilization:
   1. Section 15050 - Basic Mechanical Requirements.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 SUBMITTALS

A. See the Submittal Schedule at the end of this Section.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Sterilize pipelines intended to carry potable water before they are placed into service. Procedures shall conform to AWWA C651-92 and as specified below.

B. The water supply for flushing or sterilizing shall be protected with an approved reduced-pressure-type backflow preventer.

C. Before sterilizing, flush all foreign matter from the pipeline. Provide hoses, temporary pipes, ditches, etc., as required to dispose of flushing water without damage to adjacent properties. Flushing velocities shall be at least 2.5 fps. For pipes 24 inches and larger, clean pipeline in place from the inside by brushing and sweeping, then flush the line at a lower velocity.

2.2 STERILIZATION MIXTURE

A. Sterilization Mixture: chlorine-water solution having a free chlorine residual of 40 to 50 ppm. Prepare the sterilizing mixture by injecting one or more of the following:
   1. Liquid chlorine gas-water mixture.
   2. Dry chlorine gas.
   3. Calcium hypochlorite and water mixture. Comparable commercial products include HTH, Perchloron, and Pittchlor.
   4. Sodium hypochlorite and water mixture. Comparable commercial products include Chlorox and Purex.

Product	Quantity	Water
Calcium hypochlorite (65 to 70 percent Cl)	1 pound	7.50 gallons
Sodium hypochlorite (5.25 percent Cl)	1 gallon	4.25 gallons

PART 3 -- EXECUTION

3.1 STERILIZATION MIXTURE

A. Liquid Chlorine Gas-Water Mixture: Inject mixture by means of an approved solution feed chlorinating device.

B. Dry Chlorine Gas: Feed gas through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe being treated. Chlorinating devices for feeding solutions of chlorine gas or the gas itself must provide a means of preventing the backflow of water into the chlorine cylinder.

C. Calcium Hypochlorite and Water Mixture: Mix the dry powder with water to make a thick paste, then dilute to approximately a 1 percent solution (10,000-ppm chlorine).

D. Sodium-Hypochlorite and Water Mixture: Dilute the liquid with water to obtain a 1 percent solution.

3.2 INJECTION

A. Point of Application:
   1. Inject the chlorine mixture into the pipeline to be treated at the beginning of the line through a suitable tap in the top of the pipe. Water from the existing system or other approved source shall be controlled so as to flow slowly into the newly installed piping during the application of chlorine. The rate of chlorine mixture flow shall be in proportion to the rate of water entering the

pipe so that the combined mixture will contain 40 to 50 ppm of free available chlorine.

2. Do not place concentrated quantities of commercial sterilizers in the line before it is filled with water.

B. Retention Period:

1. Retain treated water in the pipeline long enough to destroy all nonspore-forming bacteria. Maintain proper flushing and the specified solution strength for at least 24 hours. At the end of the retention period, the sterilizing mixture shall have a strength of at least 10 ppm of chlorine.
2. Operate all valves, hydrants, and other appurtenances during sterilization to ensure that the sterilizing mixture is dispersed into all parts of the line, including dead ends, new services, and similar areas that otherwise may not receive the sterilizing solution.

C. Flushing: After chlorination, flush with water from the permanent source of supply until the water through the line is equal chemically and bacteriologically to the permanent source.

D. Disposal of Sterilizing Water: Dispose of sterilizing water in an approved manner. Do not allow sterilizing water into waterways or sanitary sewers without adequately diluting or treating with a neutralizing chemical that reduces the chlorine concentrations to a safe level and without a permit from the AHJ.

E. Bacteriological Testing:

1. After final flushing and before the new water main is connected to the distribution system, two consecutive sets of acceptable samples must be collected. Sets shall include samples from every 1,200 feet of new water main, at the end of the main, and from each branch.
2. Collect samples from a smooth unthreaded 1/2-inch hose bibb into sterile bottles treated with sodium thiosulfate. Sampling shall be in accordance with AWWA Standard Methods for Examination of Water and Wastewater.
3. All samples shall be tested for bacteriological quantity by the state health department.
4. If the initial disinfection fails to produce satisfactory bacteriological results, reflush and disinfect the system and resample. A satisfactory test report must be received prior to making a permanent connection to the active distribution system.

Provide the submittals listed in the following Submittal Schedule.

Submittal Schedule

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	2 WEEKS PRIOR TO BEGINNING INSTALLATION	PRIOR TO SUBSTANTIAL COMPLETION
15409-001	Provide state health department bacteriological test reports showing the absence of coliform organisms for all water samples.			And prior to connecting to city water supply

END OF SECTION

SECTION 15440

PLUMBING FIXTURES

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install:
   1. Fixture trim.
   2. Plumbing fixtures.
   3. Safety equipment.
   4. Drainage products.
   5. Plumbing specialties.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the referenced plumbing fixtures:
   1. Section 07900 - Joint Sealers.
   2. Section 15050 - Basic Mechanical Requirements.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 SUBMITTALS

A. See the Submittal Schedule at the end of this Section.

1.4 REGULATORY REQUIREMENTS

A. Comply with the Americans with Disabilities Act (ADA) and state and local handicap laws.

B. Comply with the latest edition of the following:
   1. IPC and local jurisdiction.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Fixture Trim:

1. Supply Stops and Traps:
    a. American Standard.
    b. McGuire.
2. Flush Valves: Sloan.
3. Water Closet Seats:
    a. Beamis.
    b. Church.
    c. Olsonite.

B. Plumbing Fixtures:
1. Water Closets, Urinals and Lavatories:
    a. Acorn.
    b. American Standard.
    c. Kohler
    d. Sloan.
2. Faucet Fittings:
    a. Sinks:
        1) Chicago.
        2) Kohler
        3) T&S Brass.
    b. Lavatories:
        1) Chicago.
        2) Kohler
        3) Sloan.
        4) T&S Brass.
3. Shower Trim:
    a. Acorn.
    b. Powers.
    c. Symmons.
4. Shower Stalls:
    a. Aqua Glass.
    b. Fixture Manufacturers.
5. Stainless Steel Sinks:
    a. Elkay.
    b. Just.
    c. Kohler
6. Mop Sinks and shower bases:
    a. Acorn.
    b. Stern Williams.
7. Drinking Fountains/Electric Water Coolers:
    a. Elkay.
    b. Haws.
    c. Western.

C. Emergency Showers and Eyewashes:
   1. Haws.
   2. Guardian.
   3. Western.

D. Drainage Products:
   1. Smith.
   2. Wade.
   3. Zurn.

E. Plumbing Specialties:
   1. Hose Bibbs:
      a. Acorn.
      b. Chicago.
   2. Wall Hydrants:
      a. Smith.
      b. Wade.
      c. Zurn.
   3. Shock Arresters (PDI-Certified):
      a. Smith.
      b. Wade.
   4. Trap Primers:
      a. Precision Plumbing Products.
      b. Smith.
      c. Wade.
   5. Pressure/Temperature Relief Valves:
      a. Conbraco.
      b. Watts.
   6. Pressure Regulators:
      a. Cash Acme.
      b. Conbraco.
      c. Watts.
   7. Pressure Gauges:
      a. Ashcroft.
      b. Marsh.
      c. Marshalltown.
   8. Pressure-Reducing Valve:
      a. Cash-Acme.
      b. Conbraco.
      c. Watts.
   9. Tempering Valves:
      a. Conbraco.
      b. Powers.

10. Thermometers:
    a. Ashcroft.
    b. Marshalltown.
    c. Weiss.
11. Supply/Drain Box:
    a. Acorn.
    b. Bradley.

2.2 GENERAL

A. Fixture Trim: Provide plumbing fixture trim where applicable on all fixtures.

B. Plumbing Fixtures: Products are indicated by a fixture number as shown on the Drawings.

C. Drainage Products: Products are indicated by a fixture number as shown on the Drawings.

D. Plumbing Specialties: Products are indicated by a fixture number as shown on the Drawings.

2.3 MATERIALS

A. Fixture Trim:
    1. Supply Stops: McGuire rigid, heavy-pattern, all-metal supplies with heavy cast brass, loose key, 1/2-inch IPS by 3/8-inch OD tubing angle stops to wall with canopy flanges; all chrome plate finish. Provide stops with stuffing box.
    2. Traps: McGuire chrome-plated, 17-gauge, semicast P traps with compression ring cast brass waste and vent connections and cleanout; 1-1/4 inches for lavatories and drinking fountains, 1-1/2 inches for sinks.
    3. Flush Valves for Water Closets and Urinals: Sloan Royal Continental, low flush; quiet action with screwdriver stop and vacuum breaker.

B. Plumbing Fixtures:

    1. LV-1, Lavatory (Wall-Hung Type):
        a. Fixture: American Standard Lucerne, Model 0355.012 20 inches by 18 inches, vitreous china, for floor-mounted concealed arm carrier, three-hole punched on 4-inch centers for faucet
        b. Faucet: T&S Brass B-0871 with faucet foot control.
        c. Trim: 3/8-inch supply stops with loose key, 17-gauge chrome-plated cast brass P trap, McGuire ProWrap for trap, tailpiece, and hot and cold water supply piping.

d. Strainer: McGuire 155A chrome-plated grid strainer with tailpiece.
e. Carrier: J. R. Smith 700 series concealed arm.

2. SK-1, Sink (Counter, Stainless Steel, Single Compartment):
   a. Fixture: Just, Model SLX-2222-A-GR, 22 inches by 22 inches by 10-1/2 inches deep, 18 gauge, Type 304 stainless steel, three-hole punch, self-rimming, undercoated, ledge-type.
   b. Faucet: Plastinetics Inc. 1000-YN (PPY) all plastic fixture.
   c. Trim: 1-1/2-inch OD, 17-gauge chrome-plated cast tailpiece, chrome-plated 17-gauge cast brass P trap with cleanout, and 1/2-inch wall supply stops with loose key.
   d. Strainer: Just J-35, stainless steel crumb-type.
3. Faucet Foot-Valve
   a. Stream Industries Model FFV-2000 – high density polyethylene inner core and connection points, to be used with laboratory sinks furnished by owner.

C. Safety Equipment:
1. EW-1, Emergency Eyewash (Freestanding):
   a. Model: Haws 7720.
   b. Eyewash: ABS plastic receptor, dual PVC-covered antisurge spray heads with dust cover.
   c. Valve: stay-open chrome-plated brass ball valve with automatic stream control.
   d. Support: galvanized steel pedestal with 9-inch-diameter floor flange.
2. ES-1, Emergency Shower (Freestanding):
   a. Model: Haws 8100.
   b. Shower: ABS plastic deluge.
   c. Valve: stay-open chrome-plated brass ball valve.
   d. Support: 1-1/4-inch galvanized pipe standard with 9-inch-diameter floor flange.

D. Drainage Products:
1. FD-1, Floor Drain (Finished Areas):
   a. Model: J. R. Smith 2005T-U-B-square with trap primer
   b. Materials: cast iron body, adjustable nickel bronze strainer.
   c. Modifications: vandalproof screws.
2. WCO, Wall Cleanout:
   a. Model: J. R. Smith 4472.
   b. Material: stainless cover and screw.
3. FCO, Floor Cleanout (Finished Areas):
   a. Model: J. R. Smith 4103S.
4. FCO, Floor Cleanout (Unfinished Areas):
   a. Model: J. R. Smith 4243S.

b. Material: taper thread, bronze plug with round adjustable scoriated secured cast iron top.

5. CTG, Cleanout to Grade:
   a. Model: J. R. Smith 4263.
   b. Material: taper thread, bronze plug, heavy-duty scoriated cast iron top.
6. TP-1, Trap Priming Valves: Precision Plumbing Products, Model P-1 and Model DU-4, distribution unit.
7. TP-2, Trap Priming Valve: J. R. Smith Figure 2699.
8. TP-3, Automatic Trap Priming System: Precision Plumbing Products, Model MP-500.

PART 3 -- EXECUTION

3.1 FIELD PREPARATION

A. Install fixtures and accessories in accordance with the plumbing laws, rules, and regulations of the state and of the city, whichever represent the higher standards.

B. Drawings do not attempt to show exact details of all fixtures, and no extra payment will be allowed for obstruction by work of other trades or local obstructions to the work under this Contract which require offsets. Where diagrams have been made to show fixture locations, the Contractor is cautioned that these diagrams must not be used for obtaining material quantities. Changes in location of fixtures, advisable in the opinion of the Contractor, shall be submitted to IDC for review before proceeding with the work. Measurements and dimensions shall be verified at the site. Equipment shall be adjusted and left in a condition satisfactory to IDC.

C. Preparation of the structural components of the building required for fixtures and material regarding the work shall be done by the particular affected trade and shall be done to the satisfaction of IDC.

3.2 INSTALLATION

A. Fixture Trim: Provide plumbing fixture trim where applicable on fixtures.

B. Plumbing Fixtures, Mounting Heights: fixtures standard rough-in catalogued heights unless shown otherwise on the Drawings.
   1. Exposed fixture connections and piping shall be polished chrome plated.
   2. Fixtures in contact with finish walls shall be caulked with waterproof, white, nonhardening sealant that will not crack, shrink, or change color with age. See Section 07900, Joint Sealers.

C. Exact fixture location and mounting arrangements shall be as indicated on toilet room elevations and details as shown on the architectural drawings.

D. Unless noted otherwise and as a minimum, fixtures shall be supported as indicated in Plumbing and Drainage Institute (PDI) Code Guide 302.

E. Safety Equipment:
   1. System Shutoff Valves:
      a. Shutoff valves shall give a visual indication of position (open or closed).
      b. Shutoff valves shall be lockable valves and locked in the open position.
   2. Each safety shower, eyewash, combination safety shower/eyewash shall have a red safety signoff tag. After completing the requirements listed below, the installing contractor and the Owner shall sign the red safety signoff tag. The requirements are as follows:
      a. Visually check safety shower/eyewash piping for leaks.
      b. Verify that upon operation, stay-open valves remain open.
      c. Showerheads to be between 82 inches and 96 inches above standing surface.
      d. Showerhead spray pattern, when valve is full open, shall be a minimum 20 inches in diameter at 60 inches above standing surface.
      e. The water arcs from the eyewash spray heads must cross. Test with an eyewash gauge, Haws, Model 9015.
      f. Minimum flow rates for safety showers shall be 20 gpm.
      g. Minimum flow rate for eyewash units shall be 0.5 gpm.

F. Drainage Products:
   1. Floor Drains: Set top flush with floor. Provide membrane clamps where required.
   2. Cleanouts: where shown or required for purposes intended. Set cover flush with finished floor.

G. Plumbing Specialties:
   1. Hose Bibbs and Wall Hydrants: Mount at 24 inches above finished floor or grade unless otherwise noted on the Drawings.
   2. Shock Arresters: Install PDI-certified and rated shock arresters, sized and located in accordance with PDI standard WH-201 and as shown on the Drawings. Shock arresters shall have access panels or to be otherwise accessible.
   3. Priming Valves:
      a. Floor drain traps primed with priming valves, 1/2-inch copper pipe to floor drain.

b. Two traps maximum primed from one priming valve or as recommended by manufacturer. Locate in mechanical spaces or janitor's rooms and as indicated on the Drawings.
c. Provide shutoff valve ahead of priming valves.

4. Thermometers and Pressure Gauges:
   a. Arrange devices to facilitate use and observation.
   b. Install in an orientation that will allow clear observation from ground level.
   c. Provide pressure gauges with block valves.
   d. Install thermometers in thermowells.

H. Penetrations of exterior walls shall be caulked with waterproof sealant per Section 07900, Joint Sealers.

I. Adjust water flows in domestic water systems for reasonable water flows at each plumbing fixture, terminal device, and recirculation loop. Flush valve fixtures shall be adjusted for proper flush cycle time and water quantity.

3.3 FIELD QUALITY CONTROL

A. Safety shower and eyewash units shall be tested. Water flow shall be tested at both the showerhead and eyewash/face ring.
   1. The shower flow may be tested with a tube-type water guide (Haws, Model 9010) and a 5-gallon bucket. The bucket should fill in 15 seconds or less with a required minimum 20-gpm flow.
   2. The eyewash flow can be tested in a similar manner using a 1-gallon container.

B. Alarm operation shall be verified both locally and system wide. Notify security prior to test if alarm is connected system wide.

C. A visual inspection for physical damage, blocked access, cleanliness, and missing items shall be performed.

D. Log, date, and initial the inspection upon passing flow tests.

E. Notify the Owner and IDC of shower testing 48 hours prior to the scheduled test. The Owner and IDC reserve the right to witness safety shower testing.

Provide the submittals listed in the following Submittal Schedule.

Submittal Schedule

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	2 WEEKS PRIOR TO BEGINNING INSTALLATION	PRIOR TO SUBSTANTIAL COMPLETION
15440-001	Catalog information and rough-in dimensions for plumbing fixtures, products, and specialties.		X	
15440-002	Completed and signed safety shower and eye wash inspection log.			X

END OF SECTION

SECTION 15488

HEAT TRACING SYSTEM - ELECTRIC

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements for electric heat tracing for the following uses:
   1. Freeze protection of HVAC and process piping.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for electrical heat tracing:
   1. Section 15050 - Basic Mechanical Requirements.
   2. Section 15270 - Equipment and Piping Insulation.
   3. Section 16011 - Basic Electrical Construction Materials and Methods.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

C. In the event of conflict regarding electric heat tracing system requirements between this Section and another section, the provisions of this Section govern.

1.3 SYSTEM DESCRIPTION

A. Provide a complete UL-listed system of heating cable, components, and controls to:
   1. Prevent HVAC and process pipelines from freezing.

1.4 DESIGN CRITERIA

A. Environmental Conditions - Design the heat tracing systems to the following ambient conditions:

Location	Summer	Winter
Indoor	75 degree F dry bulb, 50 percent RH	72 degrees F dry bulb
Outdoor	88 degree F dry bulb; 71 degree F wet bulb	-10 degree F dry bulb

B. Freeze Protection System:
   1. Design Voltage: As indicated on drawings.
   2. Circuit Breaker Size and Loading: 20A or 30A not loaded to more that 80 percent (16A or 24A maximum).
   3. Thermal Rating - Design system based on:
      a. Linear heating element installation with no spiral wrap of pipe.
      b. Pipe and equipment insulation as specified in Section 15270, Equipment and Piping Insulation.
      c. Pipe materials as shown on the process and instrumentation diagrams (P&IDs).
      d. Allowance of 10 percent safety factor for calculated heat loss.
   4. Element Length:
      a. Select based on pipe lengths indicated on Drawings and not to exceed listed manufacturer's recommendations for the design voltage.
      b. Add additional length to allow for valves, devices, flanges, and pipe support.
      c. Coordinate with the maximum loading allowed on the electrical circuit breaker
   5. Electrical Requirements:
      a. Comply with Section 16011 Basic Electrical Construction Materials and Methods.
      b. Install splices and other electrical connections in junction boxes mounted external to the insulation.
      c. Provide necessary electrical and control devices and appurtenances for a complete and operational system, consistent with the design criteria.

1.5 MANUFACTURER'S SERVICES

A. Include the following minimum service requirements in the Bid. Exclude travel time.
   1. 1 man-days for training of Owner's personnel for startup, operation, and maintenance.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Briskheat.

B. Chemelex/Raychem.

C. Chromalox.

D. Dekoron.

E. Thermon.

2.2 HEATING ELEMENTS

A. Low Temperature, Self-Regulating:
1. Description: two copper bus wires embedded in parallel in a self-regulating polymer core with variable power output responding to temperatures along length, suitable for direct use on plastic pipe and for self-crossing of the element without hot spots.
2. Jacket: radiation cross-linked polyethylene, dielectric rated at 300 Vac at 105 degrees C with outer braid of tinned copper and outer jacket of fluoropolymer.
3. Operating Voltage: As indicated on drawings. single phase, 60Hz.
4. Labeling: Continuously stencil outer jacket with manufacturer's name, catalog number, nominal supply voltage, and nominal output in watts per foot.
5. Voltage Rating: 1,600-Vac rms for 1-minute duration between parallel conductors and metallic braid.
6. Output Rating: as listed on the data sheets, watts per foot at 50 degrees F.
7. Continuous Exposure Temperature:
   a. Power On: 150 degrees F.
   b. Power Off: 185 degrees F.
8. Minimum Installation Temperature: minus 40 degrees F.
9. Minimum Bending Radius: 1-1/4 inches.
10. T Rating: T6, 185 degrees F.
11. FM Hazard Class: ordinary hazard
12. Monitoring Wire: tinned-copper braid or additional wire inside braid.

2.3 CONTROL SYSTEMS

A. Microprocessor Heat Tracing Control and Monitoring System
1. Description: complete panel face-mounted, microprocessor-based control and monitoring module with temperature sensors and control panel as indicated on Drawings.
2. Monitoring and Control Capacity: ten circuits as indicated on Drawings.
3. Supply Voltage: as indicated on Drawings.
4. Power Consumption: 40 watts.
5. Operating Temperature Range: zero to 160 degrees F.
6. Relative Humidity Range: zero to 90 percent.
7. Data Retention: nonvolatile EEPROM not requiring battery backup.

8. Security: key-lock access required to change parameters; not for routine surveillance or alarm acknowledgment.
9. Input Sensor: three-wire, 100-ohm platinum RTD for each circuit.
10. Output:
    a. Control: replaceable 30-ampere, 120-Vac or 240-Vac SPST mechanical relays.
    b. Alarm: 10-ampere, 120/240-Vac SPDT common mechanical relay.
11. Approvals: CSA, FM.
12. Temperature Range: zero to 500 degrees F.
13. Control Dead Band: 3 degrees F.
14. Alarm Monitors: ground fault alarm for each circuit for ground leakage of 50 mA or more.
15. Chassis: formed aluminum.
16. Control Functions:
    a. On/off control.
    b. Digital temperature display.
    c. Alarms for high temperature, low temperature, and damaged sensor.
    d. Minimum and maximum temperature in given time period.
    e. Data entry through nine-key tactile feel mechanical switch key pad.
17. Enclosure: formed aluminum.
18. Control Panel: NEMA 1 for indoor locations of ordinary hazard class and NEMA 3R or 4 for outdoor locations of ordinary hazard class, with hinged and key-locked door.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Verify that preparation work required before execution of work specified in this Section has been completed and is acceptable.

B. Notify IDC in writing describing conditions that are not acceptable for execution of work specified in this Section.

3.2 FIELD PREPARATION

A. Test piping systems and accept prior to start of heat tracing.

B. For thermoplastic piping, cover piping with aluminized tape prior to application of the thermal element.

3.3 INSTALLATION

A. Install electric heat tracing system in accordance with manufacturer's written instructions and NEC Article 427.

B. Apply heating cable linearly on pipe and secure to pipe using straps, cable ties, or polyester tape.

C. Contain splices and other electrical connections in junction boxes mounted external to the insulation.

D. Test heat tracing using a 1,000-Vdc megger to verify minimum insulation resistance is 10 to 1,000 megohms, regardless of length, but do not exceed manufacturers recommendations.

E. Apply insulation per Section 15270, Equipment and Piping Insulation.

F. Apply electric-traced signs to the outside of the thermal insulation.

3.4 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each tracing circuit assisted by the manufacturer's representative as follows:
   1. Verify power is available to each circuit and control panel.
   2. Simulate each function specified for control panels. Perform under actual or approved simulated operating conditions.
   3. Provide written report and certification that systems function per design intent.

END OF SECTION

SECTION 15725

AIR-HANDLING UNITS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section includes the work necessary to furnish and install, complete, the air handlers located and serving areas outside of the Clean Zone.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the referenced air-handling units:
   1. Section 15050 - Basic Mechanical Requirements.
   2. Section 15170 - OEM Electric Motors.
   3. Section 15172 - Adjustable Frequency Drives.
   4. Section 15240 - Mechanical Sound and Vibration Control.
   5. Section 15751 - Steam Humidifiers.
   6. Section 15761 - Air Coils.
   7. Section 15861 - Air Filters, HVAC.
   8. The air handler data sheets located in the attached appendix.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DESIGN CRITERIA

A. Provide equipment suitable for indoor or outdoor installation, as listed in the data sheets.

B. Heating and cooling equipment shall have minimum operating efficiencies defined as coefficient of performance and energy efficiency ratio specified in ASHRAE 90.

C. Provide insulation complying with NFPA 90A for flame spread and smoke generation.

D. Rate, test, and certify fans in accordance with AMCA standards.

E. Rate, test, and certify coils in accordance with ARI standards.

F. Ship units fully assembled unless unit exceeds maximum dimensions for shipping. Ship split units in maximum allowable sizes.

1.4 SUBMITTALS

A. Provide the following within 1 week of award of Contract:
   1. Shop drawings, including complete detailed drawings showing arrangement and construction of the air handlers and details for the isolation of the fans, unit pressure drop profile with static pressure listed for each drain connection.
   2. Electrical interfaces, voltage, load.

1.5 EXTRA STOCK

A. Provide the following filter sets, as scheduled, for each air handler:

Filter	Quantity of Complete Sets
Prefilter	two
Final	one
Absolute	one

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. CleanPak.

2.2 ADJUSTABLE FREQUENCY DRIVES

A. As scheduled on the data sheet, provide drives in accordance with the requirements of Section 15172, Adjustable Frequency Drives.

B. Variable frequency drive factory mounted and wired. VFD mounted in a ventilated compartment integral to the air handling unit.

2.3 MOTORS

A. Provide motors in accordance with the requirements of Section 15170, OEM Electric Motors.

B. Select motors at 1.2 times the design conditions operating brake horsepower.

2.4 FILTERS

A. Provide filters and holding frames as scheduled in the data sheet.

B. Provide filters and frames in accordance with the requirements of Section 15861, Air Filters, HVAC.

2.5 COILS

A. Provide coils as scheduled in the data sheet.

B. Provide coils in accordance with the requirements of Section 15761, Air Coils.

C. Provide intermediate drain pans at maximum 36-inch intervals for coils where condensation may occur.

2.6 HUMIDIFIER

A. Provide humidifier dispersion array in accordance with the requirements of Section 15751, Steam Humidifiers.

2.7 ACOUSTICAL PERFORMANCE

A. Provide units which do not exceed the sound power levels based upon dB reference 10(-12) watts as scheduled.

2.8 VIBRATION PERFORMANCE

A. Conduct balancing tests with fan operating at a resistance equal to design external static pressure. For testing, mount the fan on an isolated suspension test stand that weighs no more than 15 percent of the assembled fan weight and provides an isolation deflection of 4 inches when loaded.

Rotational Speed	Vibration Amplitude Peak to Peak
250 rpm	5.0 mils
500 rpm	4.0 mils
750 rpm	3.0 mils
1,000 rpm	2.0mils
1,500 rpm	1.5mils
1,750 rpm	1.0 mil

B. At the completion of the factory fan balance procedures, measure and log vibration amplitudes of the exterior casing or housing of the fan assembly along the same three axes, to be used for future reference in verifying fan vibration limits.

2.9 CASING

A. Interior surface of all panels to be smooth with no exposed bolts or screws. Standing seam construction using minimum 16 gauge material and bolt connections on all panels. Roof panels shall use standing seam construction with cap strips for a 100 percent weather seal. Roof panels to be bowed ¼-inch per foot to ensure rain run off. Roof system design for 30 lb/ft snow load. Provide 1.5-inch rain gutter at each door.

B. All wall and roof panels to be minimum to be 4-inches thick with acoustical/thermal insulation. Maximum deflection shall not exceed 1/200 of any span in any direction at 8-inch static pressure applied load. Casing shall meet AMCA Class "C" plenum requirements. All panels assembled with minimum 0.25-inch diameter stainless steel bolts on maximum 10 inch centers. Seal all panel joints and seams with polyurethane sealant which meets ASTM C920, Type S, Grade NS, Class 25. Interior liner shall be minimum 22 gauge solid galvanized coated with polyurethane primer and Polyester-Hibrid semigloss top coat.

C. Structural steel unit base with intermediate supports as required to adequately support the entire unit. Base system to be minimum 6-inch channel. Floor covered with minimum 16 gauge galvanized and painted steel fully welded to base rail. All seams to be sealed with polyurethane sealant which meets ASTM C920, Type S, Grade NS, Class 25.

D. Full height access doors, 2-inches thick, double wall, insulated, thermal break type. Minimum 16 gauge inner and outer liner, minimum 2-inch thick 1.5 pcf density insulation. Doors and door frames to be one piece extruded aluminum with knife edge gasket seal. Gasket to be closed cell replaceable neoprene seal. Door handles to be ceramic material. Door hinges, latches and all hardware to be T304 stainless steel. All doors to open against system pressure. Provide 8-inch view window in fan plenum access door.

E. Wall, ceiling and floor panels to be insulated with AP/Armaflex sheet, 2 inches thick, 0.27 BTU-in/hr-ft^2-F at 75 degrees F mean temperature, 25/50 flame spread and smoke developed index. Polyurethane foam and fiberglass insulation is prohibited.

F. All panels coated with polyurethane primer and polyester-Hybrid semigloss top coat. Paint baked on at 450 degrees F.

G. Interior Lights: Fluorescent with glass and heavy-gauge wire safety cage, switched by a single switch located outside the respective access door.

H. Provide drain pan in coil, and humidifier sections. Construct drain pans of double-wall 304 stainless steel with two way sloping.

2.10 FAN

A. SWSI centrifugal, airfoil blade, plenum type direct drive design. Air foil blades fabricated from heavy gauge extruded aluminum. Blades continuously welded to back plate and inlet shroud. Fan wheel rated and tested to meet service requirements, statically and dynamically balanced. Size fans with maximum rpm not to exceed 80 percent of their first critical speed.

2.11 DAMPERS

A. Outside Air Damper: double gasketed with airfoil blades for positive weather-tight closure and built into a frame that is contained inside the inlet section. Orient blades horizontally with maximum blade length 46 inches.

END OF SECTION

SECTION 15725.APP

AIR HANDLING UNITS APPENDIX

AHU Tag	Title	Revision Number	Date
AHU-1	Air Handling Unit		

Drawing Number	Title	Revision Number	Date

AIR HANDLER DATA SHEET

Tag: AHU-1 Name: Air Handling Unit

Location: Roof Type:

Area Served: Quantity: 1

Fan		
Airflow:	7,500	SCFM
TSP:	6.0	In. WC

Motor		
HP:	15	Min.
Speed:	3600	RPM
Voltage:	480	
Freq.:	60	Hz
Phase:	3	ϕ
Controller:	VFD	

Filters

	Efficiency	Type [1]	Depth	Access	Velocity	Pressure Drop (in. WG)		Notes
	%		(in.)		(fpm)	Clean	Dirty	
Prefilter	30	PME	4	Side	500	0.32	0.9	
Main	NA							
Final	90	DPR	12	Side	500	0.68	1.2	
Absolute	NA							
Gas Phase	NA							

1. See Section 15861 for Type definitions.
2. All filters to be UL Class 1.[jpk1]

Accessories

Vibration Isolation:

Humidifier: Per Section 15751

Octave Band Sound Power Levels (decibels re:$10e^{-12}$)

Location	Octave Band							
	63	125	250	500	1000	2000	4000	8000
Inlet:								
Outlet:								
Casing Radiation:							[jpk2]	

Coils

Coil	Type	Face Velocity [1]	Rows [1]	Fins per inch [1]	Airstream				Pres. Drop [1]	Capacity		Fluid Stream			Pres. Drop [1]	Notes
					EAT (deg. F)		LAT (deg. F)			Total	Sensible	EWT	LWT	Flow		
		(fpm)			DB	WB	DB	WB	(in. WC)	(MBH)	(MBH)	(deg. F)	(deg. F)	(gpm)	(ft. WC)	
Preheat	(2)	450		12	-10		60		0.4	580		180	150	40	10	
Reheat	NA															
Cooling	(3)	450		12	88	71	55	54	0.5	425		45	55	85	10	

1. Values listed are maximum values.
2. Face and bypass
3. Serpentine

SECTION 15761

AIR COILS, HYDRONIC

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install, complete, the duct and plenum- hydronic heating and cooling coils. This Section also specifies the requirements for coils provided with air handling units.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specification and related Contract Documents to establish the total requirements for the referenced air coils.
   1. Section 15725 - Air Handling Units.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 SUBMITTALS

A. Submit in conjunction with AHU's specified in Section 15725, Air Handling Units:
   1. Complete ARI-certified performance data at design conditions, including:
      a. Cfm.
      b. Air pressure drop.
      c. Air inlet temperature.
      d. Discharge air temperature.
      e. Water inlet temperature.
      f. Water outlet temperature.
      g. Fluid flow.
      h. Fluid pressure drop.
      i. Connection size.
   2. Computer output data showing capacity reserve available for selected coil.
   3. Complete coil dimensional data and installation requirements.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - HYDRONIC COILS

A. Aerofin.

B. Colmac.

C. Heatcraft.

D. Marlo.

E. Trane.

F. Wing

G. Mestek

2.2 WATER HEATING COILS

A. Tubes:
1. Material: seamless continuous copper, without flow turbulating devices.
2. Pressure/Temperature Rating:
   a. Copper: 100 psig at 400 degrees F.
   b. Red Brass: 200 psig at 400 degrees F.

B. Fins: 0.008-inch-thick plate-type aluminum, mechanically bonded to fins and headers.

C. Casings: galvanized steel with flanged duct connections.

D. Boron free components: Fabricate all components from Boron-free materials including, but not limited to, tubes, fins, brazing and soolder.

E. Tests:
1. Proof Test: 1.5 times maximum working pressure or minimum 300 psig.
2. Leakage Test: 200 psig underwater.

2.3 WATER COOLING COILS

A. Tubes:
1. Material: seamless continuous copper, without flow turbulating devices.
2. Pressure/Temperature Rating:
   a. Copper: 100 psig at 400 degrees F.
   b. Red Brass: 200 psig at 400 degrees F.

B. Fins: 0.008-inch-thick plate-type aluminum, mechanically bonded to fins and headers.

C. Casings: stainless steel with stainless steel center tube supports for coils over 42 inches, air bypass seals, and flanged duct connections.

D. Headers:
   1. Water Coils: gray cast iron or copper with tapped and plugged vent and drain connections.

E. Boron free components: Fabricate all components from Boron-free materials including, but not limited to, tubes, fins, brazing and solder.

F. Tests:
   1. Proof Test: 1.5 times maximum working pressure or minimum 300 psig.
   2. Leakage Test: 200 psig underwater.

2.4 VERTICAL TUBE FACE-AND-BYPASS COIL

A. Acceptable Manufacturer: Wing (Mestek).

B. General Description: vertical tube integral face-and-bypass steam heating coil, complying with ARI Standard 410, consisting of a built-in series of heating elements and bypasses with integral interlocked dampers, to maintain discharge air temperature by damper modulation alone with full heating water applied.

C. Dampers: 16-gauge stainless steel, arranged to completely enclose and isolate the heating elements when no temperature rise is required.

D. Casing: 14-gauge stainless steel with rigid framework.

E. Heating Elements: seamless straight, vertical 5/8-inch OD copper tubes mechanically bonded to rectangular aluminum fins, maximum 12 fins per inch. Secure each tube individually to the steam and return headers by brazing, with provision for individual tube expansion and contraction without galling. Factory test tube assemblies at 200 psi steam and 500 psi hydrostatic pressure.

F. Damper Operator: electric, side mounted. Fail to heat position.

G. Boron free components: Fabricate all components from Boron-free materials including, but not limited to, tubes, fins, brazing and solder.

H. Performance:
   1. Maintain the temperature at any point in a plane parallel to the face of the coil 3 feet downstream from the leaving side within 5 degrees F of the average air discharge airstream temperature, regardless of variations in entering air temperature.
   2. The volume of air passing through the coil shall not vary more than plus or minus 5 percent, within the full damper position range.

END OF SECTION

SECTION 15811

METAL HVAC DUCTWORK AND ACCESSORIES

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the work necessary to furnish and install, complete, metal HVAC ductwork systems with pressure classifications ranging from negative 3 inches WC to positive 10 inches WC.

B. The SMACNA publication HVAC Duct Construction Standard - Metal and Flexible generally governs the material gauges and the fabrication and installation techniques for systems specified in this Section. SMACNA criteria are superseded by the requirements of this Section.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the referenced metal HVAC ductwork and accessories.
1. Section 07900 - Joint Sealers.
2. Section 15050 - Basic Mechanical Requirements.
3. Section 15240 - Mechanical Sound and Vibration Control.
4. Section 15290 - Ductwork Insulation.
5. Section 15811.tbl - HVAC Ductwork Schedule.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

C. In the event of conflict regarding metal HVAC ductwork and accessory requirements between this Section and another section, the provisions of this Section govern.

1.3 DESIGN STANDARDS

A. Where required to provide design, based upon criteria imposed by this Section, use the following SMACNA publications as a minimum:
1. HVAC Duct Construction Standards - Metal and Flexible.
2. Seismic Restraint Manual, Guidelines for Mechanical Systems.

B. NFPA Publications:

1. 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.4 SYSTEM DESCRIPTIONS

A. Definitions:
1. Duct: a tube or channel, including fittings, through which a gas moves.
2. Ductwork: a system of interconnected ducts and duct accessories, including, but not limited to, isolation and balancing dampers, smoke and/or fire dampers, access doors, turning vanes, flexible connections, air extractors, hangers and supports, and other miscellaneous items required for a completely operable and adjustable system.

1.5 DESIGN CRITERIA

A. Supports, Anchorage, and Restraints:
1. General:
a. When supports, anchorages, and seismic restraints for equipment and supports and seismic restraints for ductwork are not shown on the Drawings, provide for their design.
b. Seismic restraints and anchorages shall resist seismic forces as specified in the latest edition of the Uniform Building Code for the seismic zone specified for the project.
c. Provide duct supports independent of other utilities.
d. Seismic restraints shall not introduce stresses in the ductwork caused by thermal expansion or contraction.
e. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
2. Suspended Ductwork: Provide seismic restraints in accordance with the latest edition of the SMACNA Seismic Restraint Manual - Guidelines for Mechanical Systems.
3. Engineered Support Systems - The following support systems shall be designed, detailed, and bear the seal of a professional engineer registered in the state of Vermont:
a. Supports and seismic restraints for suspended equipment.
b. Support frames for ductwork and equipment that provide support from below.
c. Equipment and support frame anchorage to supporting slab or structure.

1.6 QUALIFICATIONS

A. Fabricate and install sheet metal work using qualified, experienced mechanics as specified herein.

1.7 COORDINATION

A. The Drawings do not attempt to show exact details of all ductwork. No extra payment will be allowed for obstruction by work of other trades or local obstructions to the work which require offsets. Where diagrams have been made to show duct connections, the diagrams must not be used for obtaining material quantities.

B. Submit changes in location of equipment or ductwork, advisable in the opinion of the Contractor, for review before proceeding with the work. Verify measurements and dimensions at the site.

C. Duct sizes shown on the Drawings represent the nominal free area required for that service. Where changes in duct dimensions are necessary to coordinate the installation, the Contractor may change to an equivalent duct area with different dimensions as determined using a Trane Ductulator or Carrier or ASHRAE equivalence charts.

D. Coordination with Existing Conditions and Other Trades:
   1. Coordinate the installation of ductwork with existing conditions and the work of other trades to allow the installation of ductwork and the proper operation of dampers, operators, and duct access doors.
   2. Relocate existing thread rod, strut material, miscellaneous supports, conduit, or piping under 1 inch diameter where it obstructs the passage of the ductwork at no additional cost to the Owner. Coordinate the work with other trades.

1.8 SUBMITTALS

A. Provide the following, submittals:
   1. Shop drawings of suspended and roof mounted ductworkshowing all joint locations and indicating all specify fitting types.
   2. Shop drawings for support frames, equipment and ductwork supports, and associated anchorage and seismic restraints indicating point loads and seismic restraint locations, along with IDC's calculations and details keyed to the layouts.
   3. Product data for duct accessories.
   4. Product data for duct materials.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. Ductwork Materials:
   1. Galvanized Steel (GS): hot-dipped GS sheet, lock-forming grade, conforming to ASTM A924 and A653, having G90 zinc coating in conformance with ASTM A90, unless heavier galvanizing is specified.
   2. Stainless Steel (SS): Type 304 or 316 SS sheet, as scheduled, with No. 2B finish conforming to ASTM A167 and A480; matching type structural members conforming to ASTM A666; Type 316 SS fasteners.

B. Sealants and Tapes:
   1. Duct Sealer - Acceptable Manufacturers:
      a. United Duct Sealer.
      b. Duro-Dyne HPS Sealant.
      c. Vulkem (one part polyurethane) Sealant.
      d. 3M Fastbond Duct Sealer 900.
   2. Tape and Adhesive/Activator System:
      a. Acceptable Manufacturer: Hardcast.
      b. Description:
         1) Hardcast Type DT tape and FTA-20 (indoors) or RTA-50 (outdoors) adhesive.
         2) Do not use Hardcast within cleanrooms or in locations where it is exposed to air that is to be recirculated back to cleanrooms. Use NASHUA No. 324A tape under this circumstance.
   3. Duct Tape - Acceptable Manufacturers: NASHUA No. 357 silver cloth tape.
   4. Shrink Band (Round Ducts Only) - Acceptable Manufacturer: Raychem Flexcad.
   5. Silicon Sealant (SS Ductwork Only) - Acceptable Manufacturers:
      a. Clear GE Construction 1200.
      b. Dow 999A.

2.2 ROUND AND FLAT OVAL SPIRAL LOCK-SEAM HVAC DUCTWORK

A. Acceptable Duct Manufacturers:
   1. United Sheet Metal Company "UniSeal" with uniform fittings.
   2. Semco.
   3. Local manufacturers with equal quality and dimension standards, as approved by the Owner. (Submit sample for approval.)

B. Materials: Except as indicated in alternative material, construct round and flat oval HVAC ductwork, along with all components and accessories from materials specified above, as scheduled in Section 15811.tbl, HVAC Ductwork Schedule, unless otherwise noted on the Drawings.

C. Fabrication:
1. General:
a. Fabricate ducts using spiral lock-seam construction technique out of sheet material equaling or exceeding the minimum gauge shown in the SMACNA round duct gauge selection tables and SMACNA flat oval duct construction table for the duct pressure classifications specified.
2. Fittings:
a. General: machine formed, shop fabricated with continuous corrosion-resistant welded seams.
b. Branch Takeoffs: Duct fittings must be a completely separate fitting and not tapped directly into spiral ducts. Saddle fittings are prohibited. Provide branch takeoffs as shown on the Drawings. Where branch takeoffs are not shown, provide 45 degree laterals or conical tees.
c. Branch Takeoffs, Rectangular to Round:
1) 3 Inches WC and Greater Pressure Class: manufactured bell-mouth fittings.
2) 2 Inches WC and Lower Pressure Class: conical bell-mouth fittings for supply; boot fitting for return and exhaust.
d. Transitions, Elbows:
1) Utilize transitions of concentric type or eccentric type to maintain elevations indicated with not more than 15 degree angle variation on sloped portion.
2) Provide 90 degree elbows of five-piece segmented design with centerline radius equal to one and a half of duct diameter minimum.
3) Provide 60 degree and 45 degree elbows of three-piece segmented design with centerline radius equal to one and a half of duct diameter minimum.
4) Elbows 8 inches diameter and smaller may be of the stamped variety with a bead rolled on each end.
5) Contractor fabricated transitions and elbows are prohibited except where standard fabricated fittings cannot be used and only after review of each specific case and approval by the Owner.
e. Joints - Circumferential:
1) Provide couplings with centering beads.
2) Flanged joints may be used for connections to equipment where longitudinal seam ductwork is provided, where flat oval ductwork requires reinforcing, and at other locations where couplings are inappropriate.
3) Crimped-end joints are prohibited.

2.3 RECTANGULAR HVAC DUCTWORK

A. Materials: Construct rectangular HVAC ductwork and all components and accessories from materials specified above as scheduled in Section 15811.tbl, HVAC Ductwork Schedule, except as noted on Drawings.

B. Fabrication:
   1. General: Fabricate ductwork from sheet material equaling or exceeding minimum wall thickness and reinforcing as scheduled in the SMACNA rectangular duct construction schedules to comply with duct pressure classifications specified. Cross break or bead all duct widths over 12 inches and horizontal surfaces to prevent ballooning or breathing.
   2. Fittings:
      a. General: Fabricate fittings for lowest air pressure drop.
      b. Radius Elbows: Fabricate with centerline radius equal to or greater than one and a half times the duct dimension in the plane of the turn.
      c. Mitered Elbows: Provide with turning vanes as specified under ductwork accessories.
      d. Branch Takeoffs, Rectangular to Rectangular:
         1) 3 Inches WC and Greater Pressure Class: Use parallel flow branches where possible. Where branch taps must be made, use 45 degree entry with L = 1/4, 4 inches minimum.
         2) 2 Inches WC and Lower Pressure Class:
            a) Use parallel flow branches where possible. Where branch taps must be made, use 45 degree entry with L = 1/4w, 4 inches minimum.
      e. Joints:
         1) Longitudinal: Pittsburgh lock flooded with mastic prior to assembly. Snaplock is unacceptable.
         2) Transverse: Use formed flange design, TDC on all rectangular ductworkwith dimension 12-inches and greater. Use S and Drive cleat system for smaller sizes. Demountable systems such as Ductmate or Nexus are not allowed. Seal corners prior to assembly.

C. Materials:

2.4 DUCT ACCESSORIES

A. General: Fabricate duct accessories from the same material as the ductwork in which the accessory will be installed, unless specified otherwise.

B. Manual Single-Blade Balancing Dampers (2 Inches WC Construction):

1. Fabricate in accordance with SMACNA standards, except as detailed on the Drawings and as specified.
2. Provide dampers of length suitable to shut off branch ducts without causing damper flutter.
3. Cross-break dampers and stiffen edges with two edge brakes for rigidity. Provide additional stiffening angles, as required.
4. Provide continuous rods and outside end bearings, or provide inside end bearings for dampers installed in internally lined ducts. Mark the ends of damper rods with a saw-cut to indicate blade position.
5. Maximum single-blade balancing damper size is 12 by 12 inches. Provide manual opposed-blade balancing dampers in ducts wider than 12 inches. Section damper blades over 48 inches wide horizontally.
6. Provide specified locking quadrants for ductwork serving nonclean areas. Provide specified dial regulators for ductwork serving cleanrooms.

C. Regulators and Quadrants:
   1. Acceptable Manufacturers:
      a. Ventfabrics Inc. (Ventlok).
      b. Duro-Dyne Specline/Quadline.
   2. Exposed Uninsulated Ductwork in Finished Spaces: Hi-Vel Ventlok Figure 640 dial regulator with 609 end bearing.

D. Turning Vanes:
   1. Acceptable Manufacturers:
      a. Elgen All-Tight.
      b. Duro-Dyne Vane Rail.
   2. Description: hat channel or embossed vane side rails with shop-fabricated, double-blade turning vanes of the same material as the ductwork.

E. Flexible Connectors:
   1. Outdoor Applications:
      a. Description: Hypalon-coated, fire-retardant woven glass fabric, minimum 24-ounce-per-square-yard density, UL listed, crimped into metal edging strip, with 2-inch minimum clearance between equipment and ductwork, unless otherwise indicated.
      b. Products:
         1) Ventfabrics: Ventlon.
         2) Duro-Dyne: Durolon metal fab or super metal fab.

c.

2.5 DUCT HANGERS AND SUPPORTS

A. General:
1. Duct hanger and support material gauges shall comply with details on the Drawings. Where details are not provided, comply with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
2. Suspension material may be threaded rod, metal strap, structural shapes, or strut material; however, the use of strap is limited to inaccessible areas or those accessed through a ceiling. The use of wire as suspension material is prohibited.

B. Upper Attachments:
1. Concrete Construction:
a. Expanding concrete anchors as specified in another division of work may be used.
b. The use of powder-actuated fasteners is prohibited.
2. Steel Construction:
a. Acceptable Manufacturers:
1) Grinnell.
2) B-line Inc.
b. Support ductwork from structure or supplementary steel, utilizing beam clamps designed for the intended service. Support from metal decks above is prohibited. Provide supplementary steel as detailed and as required.

C. Trapezes: Utilize structural steel shapes or strut material. Separate dissimilar ducts and support materials with 1/16-inch rubber sheet.

D. Support Frames: structural steel shapes or strut frames for support of ductwork, accessories, and HVAC system components with nuts, bolts, fittings, etc., compatible with the frame material as detailed on the drawings. .

PART 3 -- EXECUTION

3.1 FABRICATION AND INSTALLATION

A. General:
1. Duct sizes shown on the Drawings are inside duct dimensions and represent the netfree dimensions of the duct.
2. Install the entire duct system with a minimum number of bends and transitions.

3. Except where Hardcast or Raychem are applied, seal all nonwelded joints with a specified chemical-resistant mastic sealant while joining.
4. Install additional reinforcement to preclude ballooning or breathing of ducts.

B. Purchased Components: Install ductwork components, such as Duct-Mate, Hardcast, etc., and accessories in accordance with the manufacturers' written instructions.

C. Joints:
1. Assemble round and oval sections using couplings with duct sealer mastic applied to inside and outside of section. After applying mastic, push sections together with 1-inch minimum overlap. Apply a coat of duct sealer mastic over joint and coupling.
2. At the Contractor's option, sections may be assembled with all joints brazed or welded.
3. Hardcast or Raychem shrinkwrap may be used in lieu of mastic and tape system with Owner’s prior approval.

D. Branch Takeoffs:
1. Takeoffs to terminal units shall be the same free area as terminal unit inlet or as shown, whichever is larger.
2. Connect rigidly to terminal unit inlet without flexible duct.

E. Balancing Dampers:
1. Install where shown and where required. Install quadrants or regulators as specified, leaving all dampers locked wide open.
2. Add or remove balancing dampers at the direction of the Owner based on recommendations by the air balancing firm for the necessary control of air in ducted systems.

F. Turning Vanes: Install in all 90 degree miter elbows.

G. Ducts Through Walls and Floors:
1. Caulk nonfire-rated openings with Minnesota Mining and Manufacturing (3M) Company, 3M butyl sealer.
2. Seal openings through fire-rated partitions with fire sealants as specified in Section 07900, Joint Sealers.
3. Attach sheet metal collar tightly and neatly to duct to cover exposed openings.

H. Rectangular Ducts Exposed to Weather:
1. Provide ducts greater than 30 inches in width with 1-1/2-inch standing seams at each joint.

I. Connections to Equipment:
1. Install flanges to match those of connecting factory-fabricated equipment.

2. Make transitions in ductwork from rectangular to round or to accommodate the sizes of factory-fabricated equipment, e.g., coils and dampers using tapered ducts, not by safing.

J. Vibration Isolators and Seismic Restraints:
1. Vibration isolation shall be in accordance with Section 15240, Mechanical Sound and Vibration Control, and as detailed on the Drawings.
2. When details regarding seismic restraints are not present, install seismic restraints to comply with the applicable building code for the seismic zone at the site with materials and installation in accordance with SMACNA Seismic Restraint Manual.

3.2 DUCT HANGERS AND SUPPORTS

A. General Support Locations:
1. Install hangers close to transverse joints of main ducts and branches, clinch collar branch connections, and the first branch elbows after nested splits.
2. Locate hangers of ducts penetrating walls or partitions as though the walls will contribute no support to the duct.
3. Install hangers in pairs on exact opposite sides of duct. Install duct supports from floors and walls when necessary.
4. Provide a set of hangers at the midpoint of small- and medium-sized horizontal
5. Provide at least one set of hangers for short duct branches 3 feet or less in length.
6. Provide one or more sets of hangers for equipment in duct runs, such as heating coils, air terminal units, mixing boxes, etc.,.

B. Specific Support Locations - Locate Duct Hangers:
1. Approximately 2 to 24 inches from flexible connections of fans.
2. Approximately 2 to 12 inches from the ends of all branch ducts.
3. Approximately 2 inches to half the duct width, plus 2 inches from the vertical centerline of the lower elbow of short vertical offsets made with vaned square elbows. The width refers to the dimension of the elbow in the plane of the turn. The heavier the duct, the closer the hanger should be to the centerline of the elbow.
4. Approximately 2 inches to half the duct width, plus 2 inches from the vertical centerline of the bottom and top elbows of vaned square elbow offsets over 8 feet high. Diameters of hanger rods of heavy offsets must be increased proportionately. The heavier the duct, the closer the hanger should be to the centerline of the elbow.
5. Approximately 6 to 12 inches from transverse joints of ducts whose lengths are the same as specified hanger intervals.

6. Approximately 6 to 12 inches from one side of walls or partitions penetrated by ducts.

C. Support Spacing - Maximum Permitted Hanger Spacing:
   1. Ducts with areas up to 4 square feet may have their hangers spaced up to 8 feet apart.
   2. Ducts with areas from 4 to 10 square feet may have their hangers spaced not more than 6 feet apart.

D. Support Method:
   1. Support low ductwork from floors or other steel structures acceptable to the Owner using struts or structural steel shapes or bars. Where possible, maintain 6 inches clear between the bottom of the duct and the supporting structure.
   2. Support ductwork suspended from overhead using trapeze supports for rectangular ducts or straps for round ducts with the hanger strap wound completely around the duct. Use threaded rod for support from above.
   3. Use of sheet metal screws for attaching support straps to ducts is prohibited.
   4. Trim support material to minimum length after elevation is adjusted.

3.3 ADJUSTING AND CLEANING

A. Cleaning of General Service Ductwork: Remove debris from general-purpose ductwork and accessories, then blow ductwork clean with air movement provided by the system fan or blower. Blow supply ductwork clean before final branch connections are made to terminal units or before terminal grilles, registers, or diffusers are installed.

B. Cleaning of Supply Air Ductwork:
   1. Ductwork, accessories, and hardware shall be visibly free of oil, grease, paint, chips, fibers, dust, dirt, etc., prior to installation.
   2. Conduct a visual inspection of 100 percent of the ductwork interior surface. Inspect surfaces for visible contamination using a 100-watt lamp at a distance of 1 to 2 feet. Magnification or similar aids (except for normally worn eyeglasses) may not be used. Reclean contaminated areas.
   3. After installation, the general cleaning sequence for ductwork serving the cleanrooms is:
      a. Visually inspect the ductwork as specified above.
      b. Remove particles using a HEPA-filtered vacuum cleaner with a brush attachment.
      c. Solvent wipe surfaces using the following products:
         1) The acceptable cleaning agents for metal surfaces are a 50-50 mixture of isopropyl alcohol (IPA) and ultrapure or RO

deionized water. Distilled water may be used if ultrapure or RO deionized water is not available.

2) Acceptable low-shedding wipe materials are:
   a) Texwipe cloths, Texwipe Company, Hillsdale, New Jersey.
   b) Nylon Tricot 1068 cloths, Laminaire Company, Rahway, New Jersey.
   c) Owner-approved equal.

d. Remove residual particles using a HEPA-filtered vacuum cleaner and a nonshedding wand attachment.

e. Visually inspect surfaces as specified above.

C. General Cleaning: Clean up and remove refuse material, crates, and rubbish arising from work of this Section from the premises.

3.4 SCHEDULE

A. Fabricate portions of systems listed in Section 15811.tbl, HVAC Ductwork Schedule from sheet metal with gauge and reinforcement in accordance with SMACNA duct construction tables.

END OF SECTION

SECTION 15811.TBL

HVAC DUCTWORK SCHEDULE

System	Duct Material	Pressure Class Inches WC	SMACNA Seal Class	Minimum Gauge	Applicable Standard	Pressure Test Required	Remarks
AHU-1 SA ductwork	GS	3	A	Code	--	No	
EF-3 EA ductwork	GS	2	A	Code	--	No	

END OF SECTION

SECTION 15812

INDUSTRIAL DUCTWORK AND ACCESSORIES

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the work necessary to furnish and install, complete, metal industrial ductwork systems with pressure classifications ranging from negative 30 inches WG to positive 30 inches WG.

B. The SMACNA publications entitled Round Industrial Duct Construction Standards and Rectangular Duct Construction Standards generally governs the material gauges and the fabrication and installation techniques for systems specified in this Section of work. SMACNA criteria are superseded by the requirements of this Section.

C. Ductwork systems specified under this Section include:
   1. EF-1,2 exhaust ductwork system.
   2. EF-4 exhaust ductwork system.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the referenced ductwork and accessories:
   1. Section 15050 - Basic Mechanical Requirements.
   2. Section 15240 - Mechanical Sound and Vibration Control.
   3. Section 15812.tbl - Industrial Ductwork Schedule.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DESIGN STANDARDS

A. Where required to design, based upon criteria imposed in this Section, use the following publications, at a minimum:

B. SMACNA Publications:
   1. Accepted Industry Practice for Industrial Duct Construction.
   2. Round Industrial Duct Construction Standards.
   3. Rectangular Industrial Duct Construction Standards.
   4. Seismic Restraint Manual Guidelines for Mechanical Systems.

C. NFPA Publications:
1. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.4 SYSTEM DESCRIPTION

A. Definitions:
1. Duct: a tube or channel, including fittings, through which a gas moves.
2. Ductwork: a system of interconnected ducts and duct accessories, including, but not limited to, isolation and balancing dampers, access doors, turning vanes, flexible connections, hangers and supports, and other miscellaneous items required for a completely operable and adjustable system.

B. Description: The extent of work on each of the following systems specified under this Section is shown on the Drawings.
1. EF-1,2,4 Ductwork Systems:
a. Ductwork and duct accessories from the termination inlet or process equipment connection to the fan discharge stack.

1.5 DESIGN CRITERIA

A. EF-1, 2 Exhaust System Duty:
1. Anticipate the following contaminants in various mixes in the exhaust air stream being handled by this duct system:

Exhaust Airstream Contaminants	
Acids	
Sulfuric acid	
Nitric acid	
Hydrofluoric acid	[0.3]
Hydrochloric acid	
Perchloric acid	

2. Temperature range from -20 to 100 degrees F.

B. Supports, Anchorage, and Restraints:
1. General:

a. When supports, anchorages, and seismic restraints for equipment and supports and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the Contractor is responsible for their design.
b. Include a minimum live load of 10 percent volume filled with water for systems shown with water washdown system installed, as shown on the Drawings.
c. Seismic restraints and anchorages shall resist seismic forces as specified in the latest edition of the Uniform Building Code (UBC)[jpk1] for the seismic zone specified for the project.
d. Seismic restraints shall not introduce stresses in the ductwork caused by thermal expansion or contraction.
e. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
f. Support frames that provide support for ductwork and equipment from below.
g. Equipment and support frame anchorage to supporting slab or structure.

1.6 QUALIFICATIONS

A. General: Fabricate and install sheet metal ductwork using qualified, experienced mechanics as specified herein.

B. Factory-coated Stainless Steel Ductwork:
1. Manufacturer's Qualifications: firms regularly and satisfactorily engaged for 3 years in the manufacture and coating of fluoropolymer-coated stainless steel ductwork products of types, materials, and sizes required.
2. Installer Qualifications: firm with at least 3 years of successful installation experience on projects with metal ductwork, specifically industrial exhaust systems.

1.7 QUALITY ASSURANCE

A. SMACNA Standards: Comply with SMACNA's Round Industrial Duct Construction Standards and Rectangular Industrial Duct Construction Standards for fabrication and installation of metal ductwork.

B. ASHRAE Standards: Comply with ASHRAE Handbook Equipment Volume, Chapter 1 Duct Construction, for fabrication and installation of metal ductwork.

C. NFPA Compliance: Comply with NFPA 90A Standard for the Installation of Air-Conditioning and Ventilation Systems, and with NFPA 91 Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids.

D. Field Reference Manual: Retain at the project field office a copy of "SMACNA Round Industrial Duct Construction Standards".

1.8 COORDINATION

A. The Drawings do not attempt to show exact details of all ductwork. No extra payment will be allowed for obstruction by work of other trades or local obstructions to the work which require offsets. Where diagrams have been made to show duct connections, the diagrams must not be used for obtaining material quantities.

B. Submit changes in location of equipment or ductwork, advisable in the opinion of the Contractor, for review before proceeding with the work. Verify all measurements and dimensions at the site.

C. Duct sizes shown on the Drawings represent the nominal free area required for that service. Where changes in duct dimensions are necessary to coordinate the installation, the Contractor may change to an equivalent duct area with different dimensions as determined using a Trane ductulator or Carrier or ASHRAE equivalence charts.

D. Coordination with Existing Conditions and Other Trades:
   1. Coordinate the installation of ductwork with existing conditions and the work of other trades to allow the installation of work and the proper operation of dampers, operators, duct access doors, and operation and removal of blast-gate dampers. Correct any deficiency in operation at no additional cost to the Owner.
   2. Relocate existing thread rod, strut material, miscellaneous supports, conduit or piping under 1-inch diameter where it obstructs the passage of the ductwork, at no additional cost to the Owner. Coordinate the work with other trades.

1.9 SUBMITTALS

A. Provide the following submittals:
   1. Shop drawings of suspended ductwork indicating point loads and seismic restraint locations, along with applicable details keyed to layouts.
   2. Shop drawings for support frames, equipment and ductwork supports, and associated anchorage and seismic restraints indicating point loads and seismic restraint locations, along with IDC's calculations and details, keyed to the layouts.
   3. Product data for purchased products, accessories, sealants, coatings, and corrosion-resistant materials.

B. Certificate of test approval by Owner's representative on all systems within 1 week of test date.

C. Maintenance Data: maintenance and parts lists for ductwork system. Include this data, shop drawings, and record drawings in the maintenance manual.

1.10 DELIVERY, STORAGE, AND HANDLING OF COATED DUCTWORK

A. Protect coated ductwork and fittings from damage during shipping, storage, and handling using wood or cardboard flange covers over shrink-wrapped duct seal, applied to ends of ductwork to prevent end damage and prevent dirt and moisture from entering ducts and fittings. Separately package each piece without internal nesting of duct pieces.

B. Inspect shipments upon delivery. Note damages and discrepancies on bill of lading and notify manufacturer within 24 hours.

C. Store coated ductwork on cardboard, Styrofoam, or similar material, out of traffic areas. Where possible, store ductwork indoors and protect from dirt and debris. Where necessary to store outdoors, store above grade and enclose with waterproof wrapping to protect from dirt and debris.

D. If coating is scratched, contact manufacturer for repair instructions. Repair or replace ductwork as determined by the manufacturer.

PART 2 -- PRODUCTS

2.1 INDUSTRIAL DUCT ACCESSORIES

A. Flexible Connectors:
   1. Acceptable Manufacturers:
      a. Proco Products Inc., Series 500.
      b. Holz.
   2. Description:
      a. Nonmetallic flexible connector, corrosion resistant, consisting of an integrally flanged frame with external bolted backup bars, and reinforced elastomer, 9-inch face-to-face dimension.
      b. Select materials for chemicals being conducted for use outdoors in sunlight in a corrosive environment, including bolts and nuts.

2.2 INDUSTRIAL FLEXIBLE DUCTWORK

A. Chemically Resistant Exhaust (Type CR):
   1. Acceptable Manufacturer: Gen-Line Series 900 (blue) by Darcy Rubber Corporation.

2. Description: wire-wound air duct fabricated with smooth, reinforced PVC air passageway, rated for 5-inch Hg vacuum. Provide stainless steel band clamp at equipment connection. Exposed wire is prohibited.

B. Solvent Resistant Exhaust (Type SR):
   1. Acceptable Manufacturers:
      a. Flexible Technology, Flexflyte TFE.
   2. Spring steel wire spiral-wound air duct fabricated with 4-mil-thick inner Teflon liner bonded to two piles of neoprene-coated fiberglass for temperatures below 200 degrees F or silicon-coated fiberglass for temperatures above 200 degrees F.

2.3 DUCT HANGERS AND SUPPORTS

A. General:
   1. Duct hanger and support material gauges shall comply with details on the Drawings. Where details are not provided, comply with SMACNA Industrial Duct Construction Standards.
   2. Suspension material may be threaded rod, metal strap, structural shapes, or strut material; however, the use of strap is limited to inaccessible areas or those accessed through a ceiling. The use of wire as suspension material is prohibited.

B. Upper Attachments:
   1. Concrete Construction:
      a. Expanding concrete anchors as specified in another division of work may be used.
   2. Steel Construction:
      a. Acceptable Manufacturers:
         1) Fee and Mason Manufacturing Company.
         2) Grinnell.
         3) B-Line Inc.
      b. Support ductwork from structure or supplementary steel, utilizing beam clamps designed for the intended service. Support from metal decks above is prohibited. Provide supplementary steel as detailed and as required.

C. Trapezes: Utilize structural steel shapes or strut material. Separate dissimilar duct and support materials with 1/16-inch rubber sheet.

D. Support Frames: structural steel shapes or strut frames for support of ductwork, accessories, and HVAC system components with nuts, bolts, fittings, etc., compatible with the frame material.

2.4 FLUOROPOLYMER-COATED STAINLESS STEEL DUCT SYSTEM

A. Acceptable Manufacturers:
   1. Fab-Tech Inc., Perma Shield Pipe.
   2. GDS Manufacturing, Kem-Tuff brand.

B. Fluoropolymer-Coated Stainless Steel Ductwork:
   1. General: Factory-fabricated system approved by Factory Mutual as fume/smoke exhaust duct without sprinklers when tested in accordance with ASTM E-84, with flame-spread rating of less than 25 and smoke-developed rating of less than 50.
   2. Base Metal:
      a. Material: 316L stainless steel with 2B exterior finish fabricated with gauges and reinforcing in accordance with the SMACNA Industrial Duct Construction Standards to meet designated system class and pressure class.
      b. Longitudinal seams: fusion-welded using no filler rod.
      c. Transverse seams: continuously welded.
      d. Seam finishing: ground/polish smooth.
   3. Coating System:
      a. Acceptable Manufacturers:
         1) ETFE Fluoropolymer 532-6005 primer, 532-6012 top coat by E.I. DuPont DeNemours and Company, Wilmington, Delaware.
         2) HALAR-ECTFE Flouropolymer by Ausimont, USA, Inc., Morristown, NJ.
      b. Description:
         1) Electrostatically applied thermoplastic resin powder coating system. Ductwork interior applications shall 10 to 12 mils thick to provide complete and spark free coverage.
         2) Prepare base metal surfaces and apply coating in accordance with coating manufacturer's requirements to ensure proper and complete adhesion of coating to base metal.
      c. Accessories: Prep and coat duct accessories, such as dampers and blast gates, in the same manner as the duct in which they are to be installed.
      d. Testing: Wet test the entire coated surface inside and out (where applicable) and edges, using a dc spark tester used at 250 volts per mil to detect flaws. Repair flaws and retest until all flaws are repaired.
   4. Fabrication:
      a. Fittings:
         1) Elbows: minimum centerline radius of 1-1/2 times the duct diameter whenever possible.
         2) Transitions: Limit taper angle to 30 degrees for contracting and to 20 degrees for expanding transitions.

3) Branch takeoff connections: Unless specifically detailed otherwise, provide 45 degree laterals and 45 degree elbows.
4) 90 degree branch takeoffs: shoe-tap-type tees.

b. Flanged Joints:
1) Coating only on inside: Use companion flange (Van Stone) duct joints consisting of rolled or pressed steel angle rings, and GoreTex or envelope-style gaskets.
2) Flange ring materials:
a) Clean Spaces and Corrosive Environments: 304 stainless steel.
b) Indoors in Mechanical Spaces: mild steel (or 304 stainless steel).
c) Outdoors: hot dip galvanized steel (or 304 stainless steel).

c. Slip Joints: Make small diameter field joints using Raychem TWDB heat shrink wrap on slip joints on sizes 10 inches and smaller diameter. Install slip joints only when absolutely necessary. Apply heat shrink bands around the perimeter of the joint after properly aligning.

d. Dampers: Heavy-duty industrial back draft, blast gate, and butterfly dampers provided by the selected duct system manufacturer, unless otherwise shown on the Drawings.

C. Miscellaneous Materials:
1. General: Provide miscellaneous materials and products of the types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements, including proper connection of ductwork and equipment.
2. Nuts and Bolts:
a. Outdoors: stainless steel.
3. Gasket Material:
a. Acceptable Manufacturer: W.L. Gore and Associates Inc., Elkton, Maryland.
b. Description: form in place, fully expanded 100 percent PTFE gasket material, size as recommended by the manufacturer.
4. Drains:
a. Prior to coating, weld stainless steel couplings to the bottom of main and branch ducts that are trapped, and/or where shown on the Drawings, to allow removal of condensed liquids.
b. Predetermine locations of duct drains prior to manufacturer's fabrication.
5. Pitot Ports:
a. Bulkhead fittings configured to prevent exposure of metal, located on the side or top of the duct. Bottom locations are prohibited.
b. Predetermine locations of pitot ports prior to manufacturer's fabrication. At minimum, provide pitot ports in each major main duct, at each fan

and scrubber inlet and outlet, in each branch take off, and where shown on Drawings.

6. Manual balance dampers:
   a. Floating ring connectors, handle with locking mechanism, PTFE edge seal, molded 25 percent glass filled PTFE blade holders, liquid tight axle seals.
7. Fan isolation dampers:
   a. Stainless steel body with welded connector flanges, gear drive actuator with 5 degree damper axle lock, liquid tight shaft seals, 1.38-inch steel axles, 0.25 inch stainless steel blade, welded blade stop with viton seal. 120V actuator motor designed for outdoor duty and sized for the fan static pressure as scheduled on the drawings. Damper end switches to prove damper 90 percent open and 90 percent closed.
8. Duct Support Materials: Unless otherwise noted, provide steel materials with finish to match flange rings.

2.5 POLYPROPYLENE DUCT SYSTEM

A. Material: Group 1 Class 1, Grade 0 Polypropylene Homopolymer material per ASTM-D4101, Federal specification L-p-39413. Material to be heat stableized, U.V. stabilized and contain a flame retardant additive, and pigmented to RAL 7037. Combustion behavior shall be as follows:
   1. BI Flame Retardant per DIN 4102, 28% oxygen index per ASTM 2863, >380 C Ignition Temperature per ASTM 1929, Y=0 Class per U.L. 94.

B. Ductwork: Welded seam and joint construction of flat 1/8” sheet material. Bolted or slip collar joints designed for 100-percent seal.

C. Fittings: Mitered elbows formed and welded of similar construction to ductwork. Elbow centerline radius 1.5 timed diameter. Branch fittings to be wye or boot tee style.

D. Static loading: Reinforce ductwork and fittings as required for minus 3 inches internal pressure at minus 20 degrees F.

PART 3 -- EXECUTION

3.1 PREPARATION

A. Demolition or Connection to Existing Fume Exhaust System: Follow Owner guidelines and industry regulatory practices in the removal or modification of existing ductwork.

3.2 FABRICATION AND INSTALLATION

A. General:
   1. Duct Sizes: Sizes shown on the Drawings are inside duct dimensions and represent the netfree dimensions of the duct.
   2. Changes of Direction: Install the entire duct system with a minimum number of bends and transitions.
   3. Additional Reinforcing: Install additional reinforcement to preclude ballooning, breathing, or collapse of ductwork.
   4. Accessibility:
      a. Position ductwork to allow easy access for maintenance and repair of adjacent equipment to all new and existing components and to allow adequate space for tube removal or other repairs.
      b. Install ducts so they do not obstruct passageways or interfere with equipment access or operation.

B. Purchased Components: Install purchased ductwork components in accordance with the manufacturer's written instructions. Seal connections as specified above.

C. Joints and Seams:
   1. Assemble sections using the method specified in Part 2 and the sealant scheduled.
   2. Seal all nonwelded joints with the specified gaskets and sealant while joining.
   3. Install longitudinal seams on top of ducts.

D. Branch Takeoffs: Takeoffs to equipment shall be the same free area as the equipment outlet or the size shown, whichever is larger.

E. Dampers:
   1. Install where shown and where required to allow the system to be balanced. Install quadrants or regulators as specified, leaving dampers locked wide open
   2. Install butterfly damper sections with the damper rod in the horizontal position to preclude condensate leakage at the rod penetration. Seal damper shafts and bearings after system balancing.
   3. Mark damper rod ends with saw cuts to indicate damper blade positions.

F. Flexible Connectors: Make connections to fans and other rotating equipment using flexible connectors with 1-inch minimum clearance between casing and ductwork, with the equipment operating.

G. Drain Couplings: Install plugged drain couplings at system low points and as shown on the Drawings.

H. Locate drain couplings and pitot probe ports in an accessible locations, which have been coordinated between all trades of construction.

I. Connections to Equipment:
   1. Install continuous welded flanges to match connection points on equipment and accessories.
   2. Make transitions in ductwork from rectangular to round or to accommodate the sizes of factory-fabricated equipment, e.g., coils and dampers, using tapered ducts, not by safing.

J. Duct Access Doors: Provide duct access doors for concealed devices requiring inspection, cleaning, and maintenance.

K. Vibration Isolators and Seismic Restraints:
   1. Install vibration isolators where specified in accordance with Section 15240, Mechanical Sound and Vibration Control, and as detailed on the Drawings.
   2. When details regarding seismic restraints are not present, install seismic restraints to comply with the applicable building code for the seismic zone at the site with materials and installation in accordance with the applicable SMACNA publication listed in Part 1 of this Section.

3.3 INSTALLATION, INDUSTRIAL FLEXIBLE DUCTWORK

A. Installation:
   1. Make connections at ends using a stainless steel draw band strap. Install the strap to be retained by the rolled bead on the duct collar.
   2. Reducing the free area of the duct by crimping is prohibited. Avoid bends in excess of 90 degrees.
   3. Trim excess flex duct to the minimum required length.
   4. Install and support duct to prevent any condensation from collecting in the flexible ductwork.

3.4 DUCT HANGERS AND SUPPORTS

A. General Support Locations:
   1. Install duct support frames as detailed and where shown on the plans.

3.5 INSTALLATION, FLUOROPOLYMER-COATED DUCTWORK

A. Inspection:
   1. Examine areas and conditions under which coated ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
   2. Prior to assembling, examine components to determine that coatings have not been damaged.

3. Repair of Scratches: Contact the manufacturer for repair instructions. Coat all scratches, chips, and other damage to the coating with a field-applied coating patch to cover an area 2 inches on each side of the damaged area. Clean and prepare the affected area as described in the manufacturer's instructions. Spare test repairs prior to installation.
4. Holes and dents: Replace parts with holes or dents.

B. Installation:
1. Assemble and install coated stainless steel ductwork using extreme care not to scratch surface of coatings, and in accordance with recognized industry practices which will achieve airtight and liquid tight systems.
2. Do not penetrate the coating for any reason. No fastening devices, such as Tek screws, rivets, etc., are to be used on any part of a coated ductwork application. Test holes and slots for monitoring must be predetermined before fabrication and coating. Discuss air balance options with air balance contractor.
3. Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal space between construction openings and ductwork with sheet metal flanges of the same material and gauge as the duct. Overlap the opening on all sides by at least 1-1/2 inches.

3.6 FIELD QUALITY CONTROL

A. Testing, General:
1. Prior to connection to equipment and before applying insulation, perform a dynamic pressure test on ductwork systems using a high-pressure blower with a calibrated orifice and manometer. Provide all necessary blowers, gauges, connections, and similar items required to perform the tests.
2. Repair all leaks and retest until stipulated results are achieved.
3. Advise the Owner 48 hours in advance of each test. Failure to so notify will require that the test be rescheduled.

B. Testing Requirements: Test systems at the same pressure as the duct pressure classification, except positive. Maximum air loss shall not exceed 0.5 percent of rated flow.

3.7 ADJUSTING AND CLEANING

A. Cleaning of Ductwork: Remove debris from ductwork and accessories, then blow ductwork clean with air movement provided by the system fan or blower. Blow ductwork clean before making final connections to equipment.

3.8 SCHEDULE

A. Fabricate portions of systems listed in Section 15812.tbl, Industrial Ductwork Schedule from sheet metal with gauge and reinforcement in accordance with SMACNA duct construction tables.

END OF SECTION

SECTION 15812.TBL

INDUSTRIAL DUCTWORK SCHEDULE

System	Duct Material	Pressure Class Inch WG	System Class	Gasket Material	Sealant Material	Pressure Test Required	Flexible Duct Type	Remarks
EF-4,5 system	304 SS	Minus 6	1	Goretex®	Butyl	No	CR	Note 1
EF-7 system	Polypropylene	Minus 3	1	Welded	Welded	No	CR	

Notes:

1. Fluoropolymer-coated interior.

3. Slope entire exhaust system to drain or as shown on Drawings. When duct slope is opposite air flow direction install eccentric reducers so that bottom of duct is straight for drainage.

4. Provide flanged joints to allow for periodic disassembly and cleaning.

END OF SECTION

SECTION 15830

FRP CENTRIFUGAL FANS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install the following fans:
   1. FRP centrifugal fans.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for FRP fans:
   1. Section 15050 – Basic Mechanical Requirements.
   2. Section 15170 - OEM Electric Motors.
   3. Section 15240 - Mechanical Sound and Vibration Control.
   4. The FRP centrifugal fan data sheets located in the attached appendix.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

C. In the event of conflict regarding FRP centrifugal fans requirements between this Section and another section, the provisions of this Section govern.

1.3 DESIGN CRITERIA

A. Construct fans in accordance with ASTM D4167, Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.

B. Test and certify fan performance in accordance with AMCA Standard 210, laboratory methods of testing fans for aerodynamic performance rating and comply with the requirements of AMCA 211, certified ratings program - air performance. Provide fans with the AMCA certified ratings seal for air performance.

C. Fan Bearings:
   1. Select bearings in accordance with standards set forth by the Antifriction Bearing Manufacturer's Association (AFBMA) published rating data.
   2. Mount bearings out of the airstream on structural steel supports and/or bases. Provide grease-lubricated bearings.
   3. Provide self-aligning bearings designed for average life based on AFBMA rating designations.

1.4 SUBMITTALS

A. Provide the following within 3 weeks of Contract award:
   1. Final shop drawings, specifications, descriptive drawings, catalog cuts, maintenance manuals, descriptive literature, including make, model, dimensions, weight of equipment, field wiring diagrams, and electrical schematics.
   2. Corrected or supplemental technical data to the information furnished with the Bid.
   3. Provide certificate of compliance papers with each fan at shipment by the fan manufacturer's quality control inspector, including:
      a. Certified sound power test data.
      b. Resin cure and hardness tests.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The following criteria apply to fans specified in this Section where applicable:
   1. Belt and Shaft Guards: Provide OSHA approved guards where required for compliance.
   2. Motors:
      a. As specified in Section 15170, OEM Electric Motors.
      b. Selection: Provide motors with 20 percent or greater horsepower than the required brake horse power at the design operating conditions.
   3. Belt Drives:
      a. Select V-belt drives of cast iron or forged steel. Provide fan and motor sheaves and V-belts rated for 150 percent of motor horsepower.
      b. Provide matched sets of multiple-drive belts where motor horsepower is 1 hp or larger.
      c. Provide belt guards, easily removed by one person.
      d. Provide tachometer access holes large enough to accept standard tachometer drive shaft.
      e. Equip fan with fixed or adjustable-pitch sheave for operation at the designed rpm, as scheduled in the data sheets.
   4. Shaft Couplers: Provide flange-type couplers with horsepower ratings of 150 percent of the motor horsepower.
   5. Vibration Isolation: Provide vibration isolation mounts in accordance with the requirements of Section 15240, Mechanical Sound and Vibration Control
   6. Access Doors: Provide access doors on the fan housings for inspection of internal components.

2.2 CENTRIFUGAL FANS - CLASS I THROUGH IV

A. Acceptable Manufacturers:
   1. Hartzell Fan Inc.
   2. Harrington Industrial Plastics Inc.
   3. New York Blower Co.
   4. Ceilcoat Air Pollution Co.

B. Centrifugal Fans: Centrifugal spiral-shaped fan scroll with straight and parallel sides and inlet and outlet flanges of molded vinyl ester resin with Class I flame spread of 25 or less. Protect internal surfaces with a minimum 10-mil layer of chemical- and flame-resistant resin.
   1. Include a single molded inlet bell ground smooth and coated with vinylester resin selected for the intended service.
   2. Provide internal shaft and hardware of 304 stainless steel with a 10-mil coating of vinyl ester resin.
   3. Bearings: pillow block ball bearings selected for L-10 life of 100,000 hours. Provide bearing support constructed of structural channels or heavy-formed angles of sufficient size and strength rated for static and dynamic load. Mount the bearing out of airstream.
   4. Base: constructed of welded structural steel, finished with epoxy paint.
   5. Shaft Seals: Install shaft seals of FRP and neoprene to fill the shaft hole in the fan housing.
   6. Shafts: Construct shafts with polished 304 stainless steel, coated with fiberglass in the air stream ground and balanced prior to assembly. Size shafts so that their first critical speed will be at least 1.2 times the maximum operating speed.
   7. Drive and Sheave: Provide cast iron, adjustable-pitch or fixed pitch motor sheaves, as specified in the data sheets.
   8. Drain: Provide 1-1/2-inch low-point drain in fan scroll, constructed from a threaded PVC pipe coupling bonded to the housing scroll, and fitted with a PVC plug.
   9. Fan Housing: Constructed of FRP of suitable thickness and reinforcement required by the fan class rating and service environment.
   10. Wheel: true backward-inclined type, one piece, resin transfer molded, solid fiberglass construction with a stainless steel core insert for shaft attachment, factory balanced, and protected with a 10-mil coating of vinyl ester resin.
   11. Finish: Construct the fan internal surfaces in contact with the air stream for a smooth surface finish.

2.3 VENTURI STACK AND FAN SYSTEM

A. Acceptable Manufacturers: M.K. Plastics Corporation.

B. Venturi Stack:

1. Induced draft venturi fabricated from corrosion resistant fiberglass polymer (FRP) construction. Resin to be polyester or vinyl ester, properly cured containing no fillers. Material flame spread rating of 25 or less.
2. Discharge velocity of stack shall be 3000 fpm or greater in accordance with ANSI Z9.5.
3. Integral curb cap provided to fit venturi stack.
4. Venturi stack and wash ring water line to be fabricated with a 2-inch R-12 double wall insulation system.
5. Provide integral FRP wash ring for water cleaning of perchlorate deposits on the venturei interior.

C. Fan Housing

1. Fan housing manufactured with UV inhibited and reinforced fiberglass.
2. Flanged outlet for bolted duct connection.
3. Fan inlet provided with PVC screen.

D. Fan Impeller

1. Solid molded FRP construction, electronically balanced both statically and dynamically per AMCA 204 Standard.

E. Fan Motor and Drive

1. TEFC and premium efficiency motor with 1.15 service factor.
2. AISI – 1045 carbon steel shaft mounted out of the airstream.
3. Regreaseable spherical pillow block bearings with a L-10 life at 100,000 hours.

F. Washdown Controls

1. NEMA 4 control panel complete with wash timer, wash cycle start button, control circuitry, interface terminal strip and three way water solenoid valve.
2. Wash cycle time variable from 30 to 60 minutes.

PART 2 -- EXECUTION

3.1 GENERAL

A. Install fans as shown and detailed on Drawings and in accordance with manufacturer's instructions. Provide hardware as required for a complete installation.

B. EF-8: Mount fan and venture stack as shown on the drawings. Provide guy wire restraint system complete with roof anchorage. Mount venturi stack roof curb solidly to roof structure, prepared for roofing by others. Mount fan on roof curb with spring isolators with ¾-inch deflection. Mount washdown control panel in the ceiling space

above the served hood, with remote washdown start button mounted as indicated by the laboratory staff. Provide all interconnecting wiring and washdown water piping between washdown control components and venturi stack connections as required for a fully functioning washdown system.

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END OF SECTION

SECTION 15831

CENTRIFUGAL FANS

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install the following fans:
   1. Centrifugal Fans.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for centrifugal fans:
   1. Section 15050 - Basic Mechanical Requirements.
   2. Section 15170 - OEM Electric Motors.
   3. Section 15240 - Mechanical Sound and Vibration Control.
   4. Section 15811 - Metal HVAC Ductwork and Accessories.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DESIGN CRITERIA

A. Provide belt driven or direct drive fans as indicated in the data sheets.

B. Test and certify fan performance in accordance with AMCA Standard 210, Laboratory methods of testing fans for aerodynamic performance rating and comply with the requirements of AMCA 211, certified ratings program, air performance. Provide fans with the AMCA certified ratings seal for air performance.

C. Fan Bearings:
   1. Select bearings in accordance with standards set forth by the Antifriction Bearing Manufacturer's Association published rating data.
   2. Mount bearings out of the airstream on structural steel supports and/or bases. Provide sealed-type bearings.
   3. Provide self-aligning bearings designed for average life based on AFBMA rating designations.

1.4 SUBMITTALS

A. Provide the following submittals:
   1. Full-load and part-load fan performance curves showing brake horsepower requirements versus air quantity handled for the operating conditions listed in the data sheets.
   2. Provide sound ratings based on tests in accordance with AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans, in decibels referenced 10-12 watts. Include sound power data for the fans proposed for this project running at for the operating conditions listed in the data sheets. Provide sound ratings in the format outlined in AMCA Standard 301, methods for calculating fan sound ratings from laboratory test data. Provide data for an eight-octave band analysis. Include inlet, outlet and radiated sound data.
   3. Final shop drawings, specifications, descriptive drawings, catalog cuts, maintenance manuals, descriptive literature, including make, model, dimensions, weight of equipment, field wiring diagrams, and electrical schematics.
   4. Corrected or supplemental technical data to the information furnished with the Bid.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The following criteria apply to all fans specified in this Section where applicable:
   1. Belt and Shaft Guards: Provide OSHA approved guards where required for compliance.
   2. Motors:
      a. As specified in Section 15170, OEM Electric Motors.
      b. Selection: Provide motors with at least 120 percent horsepower than the required brake horsepower.
   3. Belt Drives:
      a. Select V-belt drives of cast iron or forged steel.
      b. Provide fan and motor sheaves and V-belts rated for 150 percent of motor horsepower. Provide motor and fan sheaves with one redundant belt.
      c. Provide matched, multiple belts on all units 1 hp and over.
      d. Equip fan with fixed or adjustable-pitch sheave for operation at the designed rpm, as shown in the data sheets.
      e. Provide belt guards easily removed by one person.
      f. Provide tachometer access holes large enough to accept standard tachometer drive shaft.

4. Vibration Isolation: Provide vibration isolation mounts in accordance with the requirements of Section 15240, Mechanical Sound and Vibration Control.
5. Access Doors: Provide access doors on the fan housings for inspection of internal components.

2.2 CENTRIFUGAL FANS - CLASS I THROUGH IV

A. Acceptable Manufacturers:
1. Barry Blower.
2. Howden Fan Co.
3. Industrial Air Products.
4. New York Blower Co.
5. Twin City Fan & Blower Co.

B. Centrifugal Fans, General:
1. Centrifugal spiral-shaped fan scroll welded to straight and parallel sides with welded inlet and outlet flanges. Include a single spun inlet bell ground smooth and treated or coated as specified for the intended service.
2. Bearings: pillow block ball bearings selected for L-10 50,000 hour life. Provide bearing support constructed of structural channels or heavy-formed angles of sufficient size and strength rated for static and dynamic load. Mount the bearing out of airstream.
3. Shaft Seals: Install shaft seals to fill the shaft hole in the fan housing. Provide seal materials suitable for intended service.
4. Shafts: Construct shafts with AISI C-1018, 1040, or 1045 hot-rolled steel, ground, polished, and ring gauged. Size shafts so that its first critical speed will be at least 1.35 times the maximum operating speed. Provide 0.0003 inch or less per foot of shaft length for lateral static deflection.
5. Drive and Sheave: Provide variable-pitch or fixed pitch motor sheaves as specified in the data sheets.
6. Drain: Provide 1-1/2-inch low-point drain in fan scroll, constructed from a threaded pipe coupling welded to the housing scroll, and fitted with a PVC plug.
7. Fan Housing: constructed of steel of suitable thickness and reinforcement required by the fan class rating and service environment.

PART 3 -- EXECUTION

3.1 ISOLATION

A. Isolate sheet metal duct connections from fans in accordance with Section 15811, Metal HVAC Ductwork and Accessories.

B. Install fan mounts using spring isolators as specified in Section 15240, Mechanical Sound and Vibration Control.

3.2 INSTALLATION

A. Locate units where shown on the Drawings and provide access space for motor, drive, bearing service, and fan shaft removal.

B. Perform lubrication, drive belt setup, and additional manufacturer's installation requirements prior to startup.

C. Anchor fans as required by seismic zone specified for the project.

END OF SECTION

SECTION 15861

AIR FILTERS, HVAC

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install, complete air filters for HVAC application with frames, mounting hardware, and accessories as indicated or specified.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for air filters for HVAC application:
   1. Section 15050 - Basic Mechanical Requirements.
   2. Section 15725 - Air Handling Units.
   3. Section 15811 - Metal HVAC Ductwork and Accessories.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DESIGN CRITERIA

A. Unless otherwise specified herein, provide filters that meet the requirements of NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems.

B. Test efficiencies according to the latest edition of ASHRAE 52.1 Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

C. Provide filters, frames, and accessories for components to be mounted in air handlers as specified in Section 15725, Air Handling Units.

D. Provide filters, frames, and accessories as indicated on the data sheets included at the end of this section to be mounted in ductwork constructed according to Section 15811, Metal HVAC Ductwork and Accessories.

1.4 SUBMITTALS

A. Provide the following submittals:

1. Complete certified performance data at design conditions, including cfm and air pressure drop.
2. Product literature and a schedule with quantity and sizes.
3. Product installation details.

PART 2 -- PRODUCTS

2.1 PLEATED MEDIUM-EFFICIENCY (PME) FILTER

A. Acceptable Manufacturers:
   1. Camfil Farr: 30/30 Series.

B. Description: pleated, disposable, extended area filters, with universal Type 8 holding frame or side-access housing as scheduled.

C. Filter Media: high-density glass microfiber laminated to all glass woven mesh backing meeting UL Class 1 requirements or nonwoven cotton and synthetic fabric media meeting UL Class 2 requirements, as scheduled.

D. Media Support Grid: welded wire grid bonded to filter media to prevent the media from oscillating or pulling away.

E. Enclosing Frame: nonflammable board meeting UL Class 1 requirements or rigid paperboard meeting UL Class 2 requirements, as scheduled, with diagonal support members bonded to the air entering and exiting side of each pleat to ensure pleat stability. Bond the inside periphery to the filter pack to eliminate air bypass.

F. Boron free materials: All components of construction for media, holding grid and holding frame shall be fabricated and assembled using entirely boron free materials.

G. Efficiency: 25 to 30 percent when rated in accordance with ASHRAE Test Standard 52.1.

H. Performance:
   1. Provide filters capable of maintaining rated efficiencies under the following conditions:

Filter Thickness	Rated Face Velocity	Initial Pressure Drop (Inch WC)
2 inches	500 fpm	0.32
4 inches	500 fpm	0.0.28

2. Provide filters capable of operating up to a final (changeout) resistance of 0.9 inch WC without damaging the filter.

2.2 DEEP-PLEATED RIGID (DPR) FILTERS

A. Acceptable Manufacturers:
1. Camfil Farr: Riga-Flo.

B. Description: deep pleated, totally rigid, disposable, extended area filters with universal Type 8 holding frame or side-access housing as scheduled.

C. Filter Media: high-density glass microfibers reinforced with a backing to form a lofted filter blanket meeting UL Class 1 requirements or Class 2 requirements as scheduled.

D. Media Support Grid: welded wire grid bonded to filter media or aluminum separators to prevent the media from oscillating or pulling away.

E. Contour Stabilizers: galvanized steel mounted on both the air entering and exiting sides of the media.

F. Enclosing Frame: galvanized steel with the media pack mechanically and chemically bonded to the inside periphery to prevent air bypass. Provide galvanized steel diagonal support braces on the air entering and exiting sides of the filter.

G. Boron free materials: All components of construction for media, holding grid and holding frame shall be fabricated and assembled using entirely boron free materials.

H. Efficiency: Provide filters with an average efficiency as scheduled based on ASHRAE Test Standard 52.1.

I. Performance:
1. Provide filters capable of maintaining rated efficiencies under the following conditions:

Average Efficiency	Filter Thickness	Rated Velocity	Initial Pressure Drop (Inch WC)
40 to 45	6 inches 12 inches	500 fpm 500 fpm	0.30 0.25
60 to 65	6 inches 12 inches	375 fpm 500 fpm	0.32 0.45

Average Efficiency	Filter Thickness	Rated Velocity	Initial Pressure Drop (Inch WC)
80 to 85	6 inches 12 inches	300 fpm 500 fpm	0.41 0.56
90 to 95	6 inches 12 inches	300 fpm 500 fpm	0.56 0.68

2. Provide filters capable of operating up to a final (changeout) resistance of 1.2 inches WC without damaging the filter.

2.3 ULTRA LOW PARTICAL ARRESTENCE (ULPA)

A. Standard capacity air filters with water resistant polytetraflouroethylene media formed into a durable filter pack and sealed into an anodized extruded aluminum frame.

B. Media shall be one continuous pleating of water resistant polytetraflouroethylene media formed into a durable filter pack. Please shall be uniformly spaced to allow uniform airflow. Media pack shall be bonded to the enclosing from using an ultra low out-gassing polyurethane sealant.

C. Anodized aluminum enclosing frame shall be bonded to the media pack. Polyurethane gasket shall form a positive seal upon installation.

D. Filter shall have a minimum tested efficiency of 99.9995 percent when evaluated at Most Penetrating Particle Sizes (MPPS) at 100 fpm. Initial resistance to airflow shall not exceed 0.48-inch wc on a filter pack depth of 0.37 inch on a filter pack depth of 2.7 inches. Filter frame designed for gel seal to housing.

E. Ducted ceiling module of 0.063-inch thick aluminum welded construction and leak tested to 3.0 inches wc. Guillotine style damper for airflow balancing, flush mounted face grille for unit service and integral tabs for overhead suspension hangers. Duct collar on end or side, as shown on the Drawings. Seal designed to accept gel seal filters of 99.9995 percent efficiency at 0.3 micron most penetrating particle size.

2.4 FILTER GAUGES

A. Manometer Type:
1. Acceptable Manufacturer: Dwyer Mark II.
2. Description: inclined-vertical draft gauges with glass level vials, front zero adjustment, fill plugs, and pointer flags.

3. Accessories: static pressure tips, aluminum tubing, zeroing means, and extra oil.
4. Range: Select gauges with the minimum ranges to span the maximum filter final pressured drop recommended by the manufacturer.

B. Dial Type:
1. Acceptable Manufacturer: Dwyer 2000 Series Magnahelic.
2. Description: diaphragm-actuated, direct-reading gauge with pointer zero adjustment and adjustable signal flag.
3. Accessories: mounting panel with screws, static pressure tips, aluminum tubing, and vent valves.
4. Ranges: Select gauges with the minimum ranges to span the maximum filter final pressure drop recommended by the manufacturer.

END OF SECTION

SECTION 15900

DIRECT DIGITAL CONTROL SYSTEM -COMMERICAL

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements to furnish and install a fully integrated Direct Digital Control System (DDC) consisting of direct digital controllers (DDCs), operator interface terminals and field devices. The DDC system will provide both monitoring and control for HVAC equipment. Provide engineering, installation, calibration, software programming, and checkout necessary for a complete and fully operational system as specified. Items of work included are as follows:

1. Provide necessary hardware and software to meet the specified functional requirements.
2. Prepare individual hardware layouts, interconnection drawings and control loop configuration data from project design data. The Contractor shall be fully responsible for creating drawings as required and necessary to build the panels and assure proper field installation.
3. Implement the detailed design for all system input/output points, distributed control and system data bases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.
4. Design equipment cabinets, panels, and the data communication network cables including all associated hardware.
5. Provide and install field devices such as temperature and pressure sensors, damper actuators and control valves unless they are specifically listed as provided and/or installed by others.
6. Provide and install interface panels, interlock wiring and control devices as necessary to assure a complete and properly operating control system including interposing relays, auxiliary contacts, transformers, pilot lights, switches, etc. Coordinate provision and installation of these items with other contractors and equipment suppliers as necessary.
7. Provide and install cabinets, panels, and data communication network cables including all associated hardware.
8. Provide and install interconnecting cables between supplied cabinets, controllers, and field devices.
9. Provide and install all interconnecting cables between operator terminals and peripheral devices (such as printers, etc.) supplied under this section.

10. Provide and install an interposing relay to provide an alarm output to the security system vendor. Coordinate the programming and installation of this alarm contact with the security system vendor.
11. Provide complete submittals for all items supplied and receive approval from The Owner before purchasing.
12. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, start-up and commissioning.
13. Provide a comprehensive operator and technician-training program as described herein.
14. Provide as-built documentation, software, DDC control logic and all associated support documentation on approved media that accurately represents the final system.

B. The Contractor shall have the responsibility as the expert in the proper application of his control components and DDC system. The final design, installation and operation of the control system are the responsibility of the Contractor. The Contractor shall make additions and/or modifications to the design, at no additional cost, as necessary to meet the control intent as shown on the sequence of operations and/or other design documents. He shall work with the Owner and obtain approval for necessary revisions.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 15060—Pipe and Pipe Fittings - General:
1. Control valves.
2. Pressure and temperature sensor wells and sockets.
3. Terminal unit controls.

1.3 PRODUCTS NOT FURNISHED OR INSTALLED BUT INTEGRATED WITH THE WORK OF THIS SECTION

A. Section 15725, Air Handling Units.

B. Section 15172, Adjustable Frequency Drives.

1.4 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the Direct Digital Control System and referenced associated items:
1. The Contract.
2. Division 1 sections included in the project specification.
3. Section 13851 - Fire Alarm and Smoke Detection Systems.
4. Section 15060 - Pipe and Pipe Fittings – General.

5. Section 15172 -Adjustable Frequency Drives.
1. Section 15725 - Air Handling Units.
6. Section 16120 - Wire and Cable.
7. Section 16131 - Conduit.
8. Section 16132 - Surface Raceways.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.5 SYSTEM DESCRIPTION

A. The DDC shall be as shown and consist of a high-speed, peer-to-peer network of DDC controllers and an operator workstation. The operator workstation shall be a personal computer (PC) with a color monitor, mouse and keyboard. The PC will allow a user to interface with the network via dynamic color graphics. Each mechanical system, building floor plan, and control device will be depicted by point-and-click graphics. A modem will be provided for remote access to the network and for paging the operators when an alarm occurs. The system shall provide control and monitoring of the systems and functions specified herein and as shown on the design documents. These include, but are not limited to the types listed below.
1. Air handlers.
2. Exhaust fans.
3. Pumps.

B. The system shall include all necessary master control panels, submaster control panels and slave modules as required to make up a complete system.

1.6 CODES AND STANDARDS

A. Work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to receipt of bids of the following codes:
1. National Electric Code (NEC).
2. International Building Code (IBC).
3. International Mechanical Code (IMC).

1.7 SYSTEM PERFORMANCE

A. Performance Standards - The system shall conform to the following:
1. Graphic Display: The system shall display a graphic with 20 dynamic points with all current data within 10 seconds.

2. Graphic Refresh: The system shall update a graphic with 20 dynamic points with all current data within 8 seconds.
3. Object Command: The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds.
4. Object Scan: All changes of state and change of analog values will be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will have been current within the previous 6 seconds.
5. Alarm Response Time: The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.
6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Performance: DDC s shall be able to execute PID control loops at a selectable frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
8. Multiple Alarm Annunciation: Workstations on the network must receive alarms within 5 seconds of each other.
9. Stand-alone Control: Configure device controllers to provide reliable and stable stand-alone control in the event of communication failure. Connect I/O points for a device integral to its controller and use default values or other method for values normally read over the network.
10. Reporting Accuracy - The system shall report all values with an end-to-end accuracy as listed or better than those listed below:

Measured Variable	Reported Accuracy
Space Temperature	±1ºF (±0.5ºC)
Ducted Air	±1ºF (±0.5ºC)
Outside Air	±2ºF (±1.0ºC)
Dew Point	±3ºF (±1.5ºC)
Water Temperature	±1ºF (±0.5ºC)
Delta-T	±0.25ºF (±0.15ºC)
Relative Humidity	±5% RH
Air Pressure (ducts)	±25 Pa (±0.1 in. WC
Air Pressure (space)	±3 Pa (±0.01 in. WC)

11. Stability of Control - Control loops shall maintain measured variable at set point within the tolerances listed below:

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±0.2 in. WC (±50 Pa) ±0.01 in. WC (±3 Pa)	0-6 in. WC (0-1.5 kPa) 0.1 to 0.1 in. WC (25 to 25 Pa)
Airflow	±10% of full scale	
Space Temperature	±2.0ºF (±1.0ºC)	
Duct Temperature	±3ºF (±1.5ºC)	
Humidity	±5% RH	
Fluid Pressure	±1.5 psi (±10 kPa) ±1.0 in. WC (±250 Pa)	1-150 psi (MPa) 0-50 in. WC (0-12.5 kPa) differential

1.8 QUALITY ASSURANCE

A. Like items of equipment provided in this Section shall be the end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and service. Components shall have been thoroughly tested and proven in actual use.

B. The Contractor shall have a formal and documented quality assurance (QA) program. This QA program shall monitor the quality and conformance of each hardware and software module provided.

C. Provide technical bulletin subscription for notification of hardware/software problem reports.

1.9 REFERENCES

A. Demonstrate expertise and capabilities to perform the work specified in this Section by providing a minimum of three references for similar work performed. Include company name, contact person name, phone number, number of tags, and version of software.

1.10 COORDINATION

A. Coordinate work with the Owner, IDC, and other contractors. The Owner shall incur no additional costs or schedule delays due to coordination problems.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Package equipment shipped to the Owner's site for protection from shipping damage and weather.

B. Provide or arrange for onsite storage accommodations. Security from theft and protection from weather and the environment shall be the responsibility of the Contractor.

C. The Contractor shall be responsible for expediting delivery of materials from vendors to meet the construction schedule.

D. Furnish or arrange for suitable material handling equipment to place equipment in the specified locations in the Owner's facility.

1.12 SUBMITTALS

A. See the Submittal Schedule at the end of this Section.

1.13 PROJECT RECORD DOCUMENTATION

A. Project Record Documents - Upon completion of installation, submit three copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and shall include:
   1. Project Record Drawings: These shall be as-built versions of the submittal shop drawings. One set of magnetic media including CAD, .DWG, or .DXF drawing files also shall be provided.
   2. Testing and Commissioning Reports and Checklists: Completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of Part 3, Control System Demonstration and Acceptance.
   3. Operation and Maintenance (O&M) Manual - This shall include as-built versions of the submittal product data. In addition to the information required for submittals, the O&M manual shall include:
      a. Names, addresses, and 24-hour telephone numbers of contractors installing equipment and the control systems and service representatives of each.
      b. Operators Manual with procedures for operating the control systems, including logging on/off, alarm handling, producing point reports,

trending data, overriding computer control, and changing set points and other variables.

c. One set of programming manuals with a description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.

d. Engineering, installation, and maintenance manuals that explain how to design and install new points, panels, and other hardware; preventive maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.

e. A listing and documentation of all custom software created using the programming language, including the set points, tuning parameters, and object database. One set of magnetic/optical media containing files of the software and database also shall be provided.

f. One set of magnetic/optical media containing files of color graphic screens created for the project.

g. A list of recommended spare parts with part numbers and suppliers.

h. Complete original issue documentation, installation, and maintenance information for third-party hardware provided, including computer equipment and sensors.

i. Complete original issue diskettes for all software provided, including operating systems, programming language, operator workstation software, and graphics software.

j. Licenses, guarantees, and warranty documents for all equipment and systems.

k. Recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.

B. Training Manuals: The Contractor shall provide a course outline and training manuals for all training classes at least six weeks prior to the first class. The engineer may modify any or all of the training course outline and training materials to meet the needs of the Owner. Review and approval by IDC shall be completed at least three weeks prior to the first class.

1.14 WARRANTY

A. Warrant all work as follows:

1. Labor and materials for the control system specified shall be warranted free from defects for a period of 12 months after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner. The Contractor shall respond to the Owner's request for warranty service within 24 hours during normal business hours.

2. All work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.
3. At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily the Owner will sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty.
4. Operator workstation software, project-specific software, graphic software, database software, and firmware updates that resolve known software deficiencies as identified by the Contractor shall be provided at no charge during the warranty period. Upgrades or functional enhancements associated with the above-mentioned items also can be provided during the warranty period for an additional charge to the Owner by purchasing an in-warranty service agreement from the contractor. Written authorization by the Owner must, however, be granted prior to the installation of any of the above-mentioned items.
5. Exception: The Contractor will not be required to warrant reused devices, except for those that have been rebuilt and/or repaired. The Contractor shall warrant installation labor and materials, however, and shall obtain Owner's acceptance.

PART 2 -- PRODUCTS

2.1 MATERIAL

A. Products used in this project installation shall be new and currently under manufacture and shall have been applied in similar installations for a minimum of 2 years. This installation shall not be used as a test site for new products unless explicitly approved by IDC in writing. Spare parts shall be available for at least 5 years after completion of this Contract.

2.2 OPERATOR INTERFACE

A. Operator Interface: Furnish one PC-based workstation. This workstation shall be able to access all information in the system. This workstation shall reside on the same high-speed network as the building controllers.

B. Hardware: Each operator workstation and custom programming workstation shall consist of the following:
1. Personal Computer: The CPU shall be a minimum of an Intel Pentium III and operate at a minimum of 1 GHz. A minimum of 128 megabytes of RAM, one

1.44 megabyte 3.5 inch diskette drive, and a 20 GB hard disk with shall be provided. A two-button mouse also will be provided. Furnish required serial, parallel, and network communication ports and all cables for proper system operation. The PC shall have a minimum of a 17-inch monitor with a resolution of 1024 by 768 and 24 bit color.

2. Modems: Furnish one auto-dial telephone modem per workstation and associated cables for communication to remote buildings and workstations. The modem shall transmit at a minimum of 56 K baud and communicate over voice-grade telephone lines.

C. System Software:

1. Operating System: Furnish a Windows XP Professional or higher version operating system.
2. System Graphics: The operator workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while online. An operator with the proper password level shall be able to add, delete, or change dynamic objects on a graphic. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the object.
3. Custom Graphics: Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in industry standard formats such as BMP, JPG, and TIFF. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Designer or AutoCAD.
4. Graphics Library: Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.

D. System Applications: Each workstation shall provide operator interface and off-line storage of system information. Provide the following applications at each workstation:

1. Automatic System Database Save and Restore: Each workstation shall store on the hard disk a copy of the current database of each Building Controller. This database shall be updated whenever a change is made in any system

panel. The storage of these data shall be automatic and not require operator intervention. In the event of a database loss in a building management panel, the first workstation to detect the loss shall automatically restore the database for that panel. The operator may disable this capability.

2. Manual Database Save and Restore: A system operator with the proper password clearance shall be able to save the database from any system panel. The operator also shall be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
3. System Configuration: The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection.
4. Online Help: Provide a context-sensitive, online help system to assist the operator in operating and editing the system. Online help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
5. Security: Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application, editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto logoff time period shall be user-adjustable. System security data shall be stored in an encrypted format.
6. System Diagnostics: The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
7. Alarm Processing: Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, alarm limit differentials, states, and reactions for each object in the system.
8. Alarm Messages: Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying upon acronyms or other mnemonics.
9. Alarm Reactions: The operator shall be able to determine (by object) what, if any, actions are to be taken during an alarm. Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation, or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day.

10. Trend Logs: The operator shall be able to define a custom trend log for any data object in the system. This definition shall include interval, start time, and stop time. Trend data shall be sampled and stored on the building controller panel, be achievable on the hard disk, and be retrievable for use in spreadsheets and standard database programs.
11. Alarm and Event Log: The operator shall be able to view all system alarms and change of states from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.
12. Object and Property Status and Control: Provide a method for the operator to view, and edit if applicable, the status of any object and property in the system. The status shall be available by menu, on graphics, or through custom programs.
13. Clock Synchronization: The real-time clocks in all building control panels and workstations shall be automatically synchronized. The system shall automatically adjust for daylight savings and standard time, if applicable.
14. Reports and Logs: Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be able to be archived on the hard disk for historical reporting. Provide the ability for the operator to obtain real-time logs of all objects by type or status (e.g., alarm, lockout, normal). Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications, including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer and shall be set to be printed either on operator command or at a specific time each day.
15. Standard Reports: The following standard system reports shall be provided for this project. Provide ability for the Owner to readily customize these reports for this project.
    a. All Objects: All system (or subsystem) objects and their current values.
    b. Alarm Summary: All current alarms (except those in alarm lockout).
    c. Disabled Objects: All objects that are disabled.
    d. Alarm Lockout Objects: All objects in alarm lockout (whether manual or automatic).
    e. Alarm Lockout Objects in Alarm: All objects in alarm lockout that are currently in alarm.
    f. f. Logs:
        1) Alarm history.
        2) System messages.
        3) System events.
        4) Trends.

16. Custom Reports: Provide the capability for the operator to easily define any system data into a daily, weekly, monthly, or annual report. These reports shall be time and date stamped and shall contain a report title and the name of the facility.

E. Workstation Applications Editors: Each PC workstation shall support editing of system applications. Provide editors for each application at the PC workstation. The applications shall be downloaded and executed at one or more of the controller panels.
   1. Controller: Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
   2. Scheduling: An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and month. This shall consist of a monthly calendar for each schedule. Exception schedules and holidays shall be shown clearly on the calendar. Provide a method for allowing several related objects to follow a schedule. The start and stop times for each object shall be adjustable from this master schedule. Schedules shall be easy to copy to other objects and/or dates.
   3. Custom Application Programming: Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. The programming language shall have the following features.
      a. The language shall be English language oriented, be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and allow for free-form programming (i.e., not column-oriented or fill in the blanks). Alternatively, the programming language can be graphically based using function blocks as long as blocks are available that directly provide the functions listed below and that custom or compound function blocks can be created.
      b. A full-screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate word processing features such as cut/paste and find/replace.
      c. The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.
      d. The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and observe any intermediate values and/or results. The debugger also shall provide error messages for syntax and execution errors.

e. The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

f. The programming language shall support floating-point arithmetic and square root. The following mathematical functions also shall be provided: absolute value and minimum/maximum value from a list of values.

g. The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program. Values from all of the above variables shall be readable by the language so that they can be used in a program for such purposes as IF/THEN comparisons, calculations, etc.

h. The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.

2.3 CONTROLLER SOFTWARE

A. Furnish the following applications software for building and energy management. Software applications shall reside and operate in the system controllers. Editing of applications shall occur at the operator workstation.

B. System Security:
1. User access shall be secured using individual security passwords and user names.
2. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
3. User Log On/Log Off attempts shall be recorded.
4. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.

C. Scheduling - Provide the capability to schedule each object or group of objects in the system. Each schedule shall consist of the following:
1. Weekly Schedule: Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop, and night economizer. Each schedule may consist of up to 10 events. When a group of objects are scheduled together, provide the capability to adjust the start and stop times for each member.
2. Exception Schedules: Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up

to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.

3. Holiday Schedules: Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

D. System Coordination: Provide a standard application for the proper coordination of equipment. This application shall provide the operator with a method of grouping together equipment based on function and location. This group may then be used for scheduling and other applications.

E. Binary Alarms: Each binary object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.

F. Analog Alarms: Each analog object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.

G. Alarm Reporting: The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate workstations based on time and other conditions. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display graphics.

H. Remote Communication: The system shall have the ability to dial out in the event of an alarm using a modem or other communication device.

I. Sequencing: Provide application software based upon the sequences of operation specified to properly sequence chillers, boilers, and pumps.

J. PID Control: A PID (proportional-integral-derivative) algorithm with direct or reverse action and antiwindup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, set point, and PID gains shall be user-selectable.

K. Staggered Start: This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user-selectable.

L. Anti-Short Cycling: Binary output objects shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.

M. On/Off Control with Differential: Provide an algorithm that allows a binary output to be cycled based on a controlled variable and set point. The algorithm shall be direct-acting or reverse-acting and incorporate an adjustable differential.

N. Run-Time Totalization: Provide software to totalize run-times for all binary input objects. A high runtime alarm shall be assigned, if required, by the operator.

2.4 BUILDING AND DEVICE CONTROLLERS

A. General: Provide an adequate number of building and device controllers' to meet the following requirements.
   1. The building automation system shall be composed of one or more independent, standalone, microprocessor-based building controllers to manage the global strategies described in the system software section.
   2. The building controller shall have sufficient memory to support its operating system, database, and programming requirements.
   3. Data shall be shared between networked controllers.
   4. The operating system of the building controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
   5. Controllers that perform scheduling shall have a real-time clock.
   6. The building controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
      a. Assume a predetermined failure mode.
      b. Generate an alarm notification.

B. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
   1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 40 degrees C to 65 degrees C (40 degrees F to 150 degrees F).
   2. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0 degrees C to 50 degrees C (32 degrees F to 120 degrees F).

C. Keypad: A local keypad and display shall be provided for each controller. The keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display. If the manufacturer does not provide this keypad and display, provide a portable operator terminal.

D. Serviceability: Provide diagnostic LEDs for power, communication, and processor. Wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

E. Memory: The building controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

F. Immunity to Power and Noise: Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

2.5 INPUT/OUTPUT INTERFACE

A. Hardwired inputs and outputs may tie into the system through building or device controllers.

B. Input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. Iinput and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to the controller.

C. Binary inputs shall allow the monitoring of On/Off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.

D. Pulse Accumulation Input Objects: This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.

E. Analog inputs shall allow the monitoring of low-voltage (0 to 10 Vdc), current (4 to 20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with, and field configurable to, commonly available sensing devices.

F. Binary outputs shall provide for On/Off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers shall have three-position (On/Off/Auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.

G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 Vdc or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on building or custom application controllers shall have status lights and a two position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual

override. Analog outputs shall not exhibit a drift of greater than 0.4 percent of range per year.

H. Tri-State Outputs: Provide tri-state outputs (two coordinated binary outputs) for control of three point floating type electronic actuators without feedback. Use of three point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct-mounted heating coils, zone dampers, radiation, etc.). Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

I. Input/Output points shall be the universal type, i.e., controller input or output may be designated (in software) as either a binary or analog type point with appropriate properties. Application specific controllers are exempted from this requirement.

J. System Object Capacity: The system size shall be expandable to at least twice the number of input/output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.6 POWER SUPPLIES AND LINE FILTERING

A. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80 percent of rated capacity.
   1. Dc power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0 percent line and load combined, with 100-microsecond response time for 50 percent load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand a 150 percent current overload for at least three seconds without trip-out or failure.
      a. Unit shall operate between 0 degrees C and 50 degrees C (32 degrees F and 120 degrees F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
      b. Line voltage units shall be UL recognized and CSA approved.

B. Power line filtering:
   1. Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:
      a. Dielectric strength of 1,000 volts minimum.
      b. Response time of 10 nanoseconds or less.

c. Transverse mode noise attenuation of 65 dB or greater.
d. Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.

2.7 AUXILIARY CONTROL DEVICES

A. Electric damper/valve actuators.
1. The actuator shall have mechanical or electronic stall protection to prevent damage to the actuator throughout the rotation of the actuator.
2. Where shown, for power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing. Alternatively, an uninterruptible power supply (UPS) may be provided.
3. Proportional actuators shall accept a 0 to 10 Vdc or 0 to 20 mA control signal and provide a 2 to 10 Vdc or 4 to 20 mA operating range.
4. 24 Vac/Vdc actuators shall operate on Class 2 wiring
5. Nonspring-return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return actuators with more than 7 N·m (60 in.-lb) torque capacity shall have a manual crank for this purpose.
6. Limit switches shall be provided where required as shown on design documents.

B. Control Valves:
1. Control valves shall be two-way or three-way type for two-position or modulating service as shown.
2. Close-off (differential) Pressure Rating - Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
a. Water Valves:
1) Two-way: 150 percent of total system (pump) head.
2) Three-way: 300 percent of pressure differential between ports A and B at design flow or 100 percent of total system (pump) head.
b. Steam Valves: 150 percent of operating (inlet) pressure.
3. Water Valves:
a. Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
b. Sizing Criteria:
1) Two-Position Service: Line size.
2) Two-way Modulating Service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50 percent of the pressure difference between supply and return mains, or 5 psi, whichever is greater.
3) Three-way Modulating Service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 35 kPa (5 psi) maximum.

4) Valves 1/2 inch through 2 inches shall be bronze body or cast brass ANSI Class 250, spring-loaded, PTFE packing, quick opening for two-position service. Two way valves to have replaceable composition disc or stainless steel ball.
5) Valves 2-1/2 inch and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing.

c. Water valves shall fail normally open or closed, as scheduled on plans, or as follows:
1) Water zone valves—normally open preferred.
2) Heating coils in air handlers—normally open.
3) Chilled water control valves—normally closed.
4) Other applications—as scheduled or as required by sequences of operation.

C. Binary Temperature Devices:
1. Low-voltage space thermostat shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 13 deg C to 30 deg C (55 deg F to 85 deg F) set point range, 1 deg C (2 deg F) maximum differential, and vented ABS plastic cover.
2. Line-voltage space thermostat shall be bimetal-actuated, open contact type, or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint adjustment, 13 deg C to 30 deg C (55 deg F to 85 deg F) setpoint range, 1 deg C (2 deg F) maximum differential, and vented ABS plastic cover.
3. Low-Limit Thermostats: Low-limit air stream thermostats shall be UL listed, vapor pressure type, with an element of 6 m (20 ft) minimum length. Element shall respond to the lowest temperature sensed by any 30 cm (1 ft) section. The low-limit thermostat shall be manual reset only.

D. Temperature Sensors:
1. Temperature sensors shall be Resistance Temperature Device (RTD).
2. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1m2 (10 ft2) of duct cross section.
3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.
4. Space sensors shall be equipped with set point adjustment, override switch, display, and/or communication port.
5. Provide matched temperature sensors for differential temperature measurement.

E. Humidity Sensors:
1. Duct and room sensors shall have a sensing range of 20 percent to 80 percent.

2. Duct sensors shall be provided with a sampling chamber.
3. Outdoor air humidity sensors shall have a sensing range of 20 percent to 95 percent RH. They shall be suitable for ambient conditions of 40 degrees C to 75 degrees C (40 degrees F to 170 degrees F).
4. Humidity sensor's drift shall not exceed 1 percent of full scale per year.

F. Relays:
1. Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus/minus 200 percent (minimum) from set point shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

G. Current Transmitters:
1. Ac current transmitters shall be the self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale, with internal zero and span adjustment and plus or minus 1 percent full-scale accuracy at 500 ohm maximum burden.
2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA Recognized.
3. Unit shall be split-core type for clamp-on installation on existing wiring.

H. Current Sensors:
1. N.O. or N.C. solid state switch for applications up to 240Vac/dc
2. Current sensors shall be the self-powered, solid or split-core current case type with built-in mounting feet. With isolated solid-state outputs, 1-6 A, 6-40A, and 40 to 200A input ranges.
3. Current Sensors shall have UL, CUL and CE approval.
4. Unit shall be split-core type for clamp-on installation on existing wiring.

I. Current Transformers:
1. Ac current transformers shall be UL/CSA Recognized and completely encased (except for terminals) in approved plastic material.
2. Transformers shall be available in various current ratios and shall be selected for plus or minus 1 percent accuracy at 5 A full-scale output.
3. Transformers shall be fixed-core or split-core type for installation on new or existing wiring, respectively.

J. Voltage Transformers:

1. Ac voltage transformers shall be UL/CSA Recognized, 600 Vac rated, complete with built-in fuse protection.
2. Transformers shall be suitable for ambient temperatures of 4 degrees C to 5 degrees C (40 degrees F to 130 degrees F) and shall provide plus or minus 0.5 percent accuracy at 24 Vac and a 5 VA load.
3. Windings (except for terminals) shall be completely enclosed with metal or plastic material.

K. Pressure Transducers:
1. Transducer shall have linear output signal. Zero and span shall be field adjustable.
2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50 percent greater than calibrated span without damage.
3. Water pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and block and bleed valves.
4. Water differential pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and five-valve manifold.

L. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as shown.

M. Photohelic pressure indicators:
1. Magnehelic gauge combined with a DPDT relay pressure switch to signal low and high gas pressure. Knob controls to adjust dual pressure set points.

N. Audible/Visual Strobe:
1. ABS construction with polycarbonate red lens, sound output 101 dB(A) at 1 meter, volume control 0 to -20 dB adjustment, flash energy 0.7 Joules, flash frequency 60 per minute.

O. Local Control Panels:
1. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and sub-panels.
2. Interconnections between internal and face mounted devices shall be pre-wired with color coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/interlock drawings, with adequate

clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.

3. Provide ON/OFF power switches with over current protection for control power sources to each local panel.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment locations. Discrepancies, conflicts, or omissions shall be reported to IDC for resolution before rough-in work is started.

B. Inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to IDC for resolution before rough-in work is started.

C. Examine the Drawings and specifications for other parts of the work. If head room or space conditions appear inadequate, or if discrepancies occur between the plans and the Contractor's work and the plans and the work of others, report these discrepancies to IDC and obtain written instructions for changes necessary to accommodate the Contractor's work with the work of others. Changes in the work covered by this specification made necessary by the failure or neglect of the Contractor to report such discrepancies shall be made by, and at the expense of, the Contractor.

3.2 PROTECTION

A. Protect work and material from damage by his/her work or employees and shall be liable for damage thus caused.

B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. Protect material that is not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

A. Site:

1. Where work will be installed in close proximity to, or will interfere with, work of other trades, assist in working out space conditions to make a satisfactory adjustment. If the Contractor installs their work before coordinating with other trades, so as to cause interference with work of other trades, the Contractor

shall make the necessary changes in their work to correct the condition without extra charge.

2. Coordinate and schedule work with other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

B. Life Safety:

1. Duct smoke detectors required for air handler shutdown are supplied by others. Interlock smoke detectors to air handlers for shutdown as described in Sequences of Operation.

C. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this Section. These controls shall be integrated into the system and coordinated by the Contractor as follows:

1. Each supplier of a controls product is responsible for the configuration, programming, startup, and testing of that product to meet the sequences of operation described in this section.
2. Coordinate and resolve any incompatibility issues that arise between the control products provided under this Section and those provided under other sections or divisions of this specification.
3. The Contractor is responsible for providing controls described in the Contract Documents regardless of where within the Contract Documents these controls are described.
4. The Contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the Contract Documents.

3.4 GENERAL WORKMANSHIP

A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).

D. Verify integrity of wiring to ensure continuity and freedom from shorts and grounds.

E. Equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 FIELD QUALITY CONTROL

A. Work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification.

B. Continually monitor the field installation for code compliance and quality of workmanship.

C. Contractor shall have work inspected by local and/ or state authorities having jurisdiction over the work.

3.6 EXISTING EQUIPMENT

A. Local Control Panels: The Contractor may reuse existing local control panel to locate new equipment. Redundant equipment within these panels must be removed. Panel face cover must be patched to fill holes caused by removal of unused equipment or replaced with new

B. Unless otherwise directed, the Contractor is not responsible for the repairs or replacement of existing energy equipment and systems, valves, dampers, or actuators. Should the contractor find existing equipment that requires maintenance, the engineer is to be notified immediately.

C. Temperature Sensor Wells: The Contractor may reuse existing wells in piping for temperature sensors. These wells shall be modified as required for proper fit of new sensors.

D. Indicator Gauges: Where these devices remain and are not removed, they must be made operational and recalibrated to ensure reasonable accuracy. Maintain the operation of existing pneumatic transmitters and gauges.

E. Modify existing starter control circuits, if necessary, to provide hand/off/auto control of each starter controlled.

F. Patch holes and finish to match existing walls.

3.7 WIRING

A. Control and interlock wiring shall comply with national and local electrical codes, Section 16120 – Wire and Cable, and Section 16131 - Conduit. Where the requirements of this section differ from those in Division 16, the differences shall be submitted to IDC for determination.

B. NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway according to NEC and Division 16 requirements.

C. Low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current limit.)

D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL Listed for the intended application. For example, cables used in ceiling plenums shall be UL Listed specifically for that purpose.

E. Wiring in mechanical, electrical, or service rooms or where subject to mechanical damage shall be installed in raceway at levels below 3m (10 ft).

F. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

G. Do not install wiring in raceway containing tubing.

H. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3m (10 ft) intervals.

I. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.

J. Wire-to-device connections shall be made at a terminal block or terminal strip. Wire-to-wire connections shall be at a terminal block.

K. Wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

L. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, provide step-down transformers.

M. Wiring shall be installed as continuous lengths, with no splices permitted between termination points.

N. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.

O. Size of raceway and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

P. Include one pull string in each raceway 2.5 cm (1 inch) or larger.

Q. Use coded conductors throughout with conductors of different colors.

R. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

S. Conceal raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 inches) from high-temperature equipment (e.g., steam pipes or flues).

T. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

U. Adhere to Section 16132, Surface Raceways requirements where raceway crosses building expansion joints.

V. Install insulated bushings on raceway ends and openings to enclosures. Seal top end of all vertical raceways.

W. Terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

X. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal raceway less than 1/2- inch electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.

Y. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.8 COMMUNICATION WIRING

A. Adhere to the items listed in the "Wiring" paragraph in Part 3.7 of the specification.

B. Cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

C. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

D. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

E. Verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to the manufacturer's instructions.

G. Runs of communication wiring shall be un-spliced length when that length is commercially available.

H. Communication wiring shall be labeled to indicate origination and destination data.

I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.9 INSTALLATION OF SENSORS

A. Provide sensor where shown on the drawings and where necessary to adequately implement the Sequences of Operations. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

D. Wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

E. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m of sensing element for each 1 m2 (1 ft of sensing element for each 1 ft) of coil area.

F. Differential Air Static Pressure:

1. Supply Duct Static Pressure: Pipe the high pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
2. Exhaust Duct Static Pressure: Pipe the high pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
3. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
4. Pressure transducers shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
5. Differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

G. Current Sensors and Transformers:
1. Provide where shown on the Drawings as an input to the control system. Provide all wiring associated with the sensor as required for a fully operational sensor input.

3.10 ACTUATORS

A. Mount and link control damper actuators according to manufacturer's instructions.
1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
3. Provide mounting hardware and linkages for actuator installation.

B. Electric/Electronic:
1. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.
2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.11 WARNING LABELS

A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the DDC system.
   1. Labels shall use white lettering (12-point type or larger) on a red background.
   2. Warning labels shall read as follows: C A U T I O N - This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

B. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.
   1. Labels shall use white lettering (12 point type or larger) on a red background.
   2. Warning labels shall read as follows: C A U T I O N - This equipment is fed from more than one power source with separate disconnects. Disconnect power sources before servicing. The label will identify the power sources.

3.12 IDENTIFICATION OF HARDWARE AND WIRING

A. Wiring and cabling, including that within factory fabricated panels, shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum 1 cm (1/2 inch) letters on laminated plastic nameplates.

D. Identify other control components with permanent labels. Plug-in components shall be labeled such that removal of the component does not remove the label.

E. Identify room sensors relating to terminal box or valves with nameplates.

F. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

G. Identifiers shall match record documents.

H. DDC network conduit should be clearly labeled.

3.13 CONTROLLERS

A. Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with

the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.

B. Building controllers and custom application controllers shall be selected to provide a minimum of 15 percent spare I/O point capacity for each point type found at each location. If input points are not universal, 15 percent of each type is required. If outputs are not universal, 15 percent of each type is required. A minimum of one spare is required for each type of point used.
   1. Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional controller boards or point modules shall be required to implement use of these spare points.

3.14 PROGRAMMING

A. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25 percent of available memory free for future use.

B. Point Naming - System point names shall be modular in design, allowing easy operator interface without the use of a written point index. Use the following naming convention:
   1. AA.BBB.CCDDE where:
      a. AA is used to designate the location of the point within the building, such as mechanical room, wing, or level, or the building itself in a multi-building environment.
      b. BBB is used to designate the mechanical system with which the point is associated (e.g., A01, HTG, CLG, LTG).
      c. CC represents the equipment or material referenced (e.g., SF for supply fan, RW for return water, EA for exhaust air, ZN for zone).
      d. D or DD may be used for clarification or for identification if more than one CC exists (e.g., SF10, ZNB).
      e. E represents the action or state of the equipment or medium (e.g., T for temperature, H for humidity, C for control, S for status, D for damper control, I for current).

C. Software Programming:
   1. Provide programming for the system and adhere to the sequences of operation provided. Provide all other system programming necessary for the operation of the system, but not specified in this document. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:

a. Text-based:
   1) Must provide actions for all possible situations.
   2) Must be modular and structured.
   3) Must be commented.
b. Graphic-based:
   1) Must provide actions for all possible situations.
   2) Must be documented.
c. Parameter-based:
   1) Must provide actions for all possible situations.
   2) Must be documented.

D. Operator Interface:
   1. Standard graphics provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.
   2. Show terminal equipment information on a "graphic" summary table. Provide dynamic information for each point shown.
   3. Provide the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third party software installation and integration required for successful operation of the operator interface.

3.15 SEQUENCES OF OPERATION

A. General:
   1. System operation: AHU-4 fans and EF-4,5,6,7 are intended to operate from the same system enable command so as to preserve positive pressure within laboratory when the system is operating. The AHU-4 variable frequency drives will account for filter loading and wind pressures to maintain constant supply air flow.
   2. System startup: After the system is enabled to start, the supply fan should ramp up to a speed set during system commissioning that allows the exhaust fans EF,4,5,6,7 to sequentially start without drawing the laboratory negative.
   3. System Shutdown:
      a. Before the system is disabled, the exhaust fans should be sequentially shut down as the supply fan speed ramps down so as to preserve positive pressure within the laboratory. Sequencing of each fan and the ramp down speed should be determined during commissioning.
      b. System shutdown should only be initiated under conditions described in the Alarm Matrix. A time delay should be incorporated into the

shutdown signal to avoid transient pressures and to prove the failure condition.

4. Lead lag assignment change: The AHU-4 and EF-4, 5 fans should rotate lead and lag assignments monthly. Fans roles should be reassigned during unoccupied hours after notifying maintenance staff and research staff of the scheduled change. AHU-4 fans and EF-4, 5 fans should rotate positions simultaneously to avoid negative pressure in the laboratory. The lead EF should first stop, the AHU-4 fans should simultaneously speed up (lead fan) and slow down (lag fan) so as to maintain constant duct pressure, then the lag EF should be started.
5. Alarms: Alarms should be delivered to recipients as described in the Alarm Matrix shown on the drawings. Time delays should be built into the alarm signal to prove failure.

B. AHU-4:
1. Supply fans: Modulate the lead supply fan speed to maintain the duct static pressure set point. Rotate the lead and lag roles monthly, with switchover of roles as described above. Switch the fan roles whenever the lead fan fails, and maintain this role change until the next monthly interval.
   a. Interlock the supply fan operation with the respective fan isolation damper proof of open switch, freeze stat, AHU-4 isolation damper proof of open switch and supply air duct smoke detector.
2. Cooling coil: Modulate the control valve position to maintain the discharge air temperature set point of 60F (adjustable).
3. Heating coil: Modulate the heating water valve position to maintain the discharge air temperature set point of 2F less than the cooling set point.
   a. P-1: Operate the pump when the heating coil is activated while the outside temperature is below 40F. Command the pump off when the outside temperature is above 40F.
4. AHU-4 isolation damper: Command the damper open when the system is enabled and closed when the system is disabled.

C. EF-4, 5:
1. Command the lead fan on when the system is enabled. Startup and shutdown of fan should be integrated with the AHU-4 fan startup as described above. Rotate the lead and lag roles monthly, with switchover of roles as described above. Switch the fan roles whenever the lead fan fails, and maintain this role change until the next monthly interval.
   a. Interlock the fan operation with the respective isolation damper proof of open switch.
2. Interlock the respective isolation damper with each fan. Command the damper open when the fan is commanded on, and closed when the fan is commanded off.

D. EF-6:
   1. Command the fan on when the system is enabled. Startup and shutdown of fan should be integrated with the AHU-4 fan startup as described above.

E. EF-7:
   1. Command the fan on when the system is enabled. Startup and shutdown of fan should be integrated with the AHU-4 fan startup as described above.

F. RH-26, 27, 28:
   1. Modulate the heating water valve position to maintain the respective space air temperature set point as adjusted at the wall sensor.

G. H-1:
   1. Humidifier to operate under self contained controls by the humidifier manufacturer. Provide an enable/disable command to H-1 that disables the unit when the AHU-4 system is disabled. Initiate the H-1 enable command when all devices in the AHU-4 system are proven operational.

H. Miscellaneous equipment:
   1. Provide an enable/disable command to each of five fume hood 120V plug circuits. Interlock this enable command based on conditions in the Alarm Matrix.

3.16 CONTROL SYSTEM CHECKOUTAND TESTING

A. Startup Testing: Testing listed in this paragraph shall be performed by the Contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Owner's representative is notified of the system demonstration.
   1. Furnish labor and test apparatus required to calibrate and prepare for service of instruments, controls, and accessory equipment furnished under this specification.
   2. Verify that control wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.
   3. Enable the control systems and verify calibration of input devices individually. Perform calibration procedures according to manufacturers' recommendations.
   4. Verify that binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
   5. Verify that analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.

6. Verify that the system operation adheres to the sequences of operation and complies with paragraph 1.8 System Performance. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune DDC loops and optimum start/stop routines.
7. Alarms and Interlocks:
    a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
    b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.17 CONTROL SYSTEM DEMONSTRATIONAND ACCEPTANCE

A. Demonstration:
1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
2. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, startup, and debugging process and as specified in the Control System Checkout and Testing article in Part 3 of this Specification. The Owner will be present to observe and review these tests. The Owner shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in Submittal Schedule. The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. Provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Test equipment required to prove the proper operation shall be provided by and operated by the Contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
2. Demonstrate compliance with paragraph 1.8, System Performance.
6. Demonstrate compliance with sequences of operation through all modes of operation.
7. Demonstrate complete operation of operator interface.
8. Additionally, the following items shall be demonstrated:

a. DDC Loop Response: Supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25 percent of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.

b. Optimum Start/Stop: The Contractor shall supply a trend data output showing the capability of the algorithm. The change-of value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.

c. Interface to the building fire alarm and security system.

d. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the Owner. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.

9. Tests that fail to demonstrate the operation of the system shall be repeated at a later date. The Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance:

1. Tests described in this specification shall have been performed to the satisfaction of both IDC and Owner prior to the acceptance of the control system as meeting the requirements of completion. Tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.

2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Submittal Schedule.

3.18 CLEANING

A. Clean up debris resulting from his/her activities daily. Remove cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

B. At the completion of work in any area, the Contractor shall clean work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.19 TRAINING

A. Provide a minimum of two onsite or classroom training sessions, 8 hours each, throughout the contract period for personnel designated by the Owner.

B. Train the designated staff of Owner's representative and Owner to enable them to do the following:
   1. Day-to-day Operators:
      a. Proficiently operate the system.
      b. Understand control system architecture and configuration.
      c. Understand DDC system components.
      d. Understand system operation, including DDC system control and optimizing routines (algorithms).
      e. Operate the workstation and peripherals.
      f. Log on and off the system.
      g. Access graphics, point reports, and logs.
      h. Adjust and change system set points, time schedules, and holiday schedules.
      i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
      j. Understand system drawings and Operation and Maintenance manual.
      k. Understand the job layout and location of control components.
      l. Access data from DDC controllers and ASCs.
      m. Operate portable operator's terminals.
   2. Advanced Operators:
      a. Make and change graphics on the workstation.
      b. Create, delete, and modify alarms, including annunciation and routing of these.
      c. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals.
      d. Create, delete, and modify reports.
      e. Add, remove, and modify system's physical points.
      f. Create, modify, and delete programming.
      g. Add panels when required.
      h. Add operator interface stations.
      i. Create, delete, and modify system displays, both graphical and others.
      j. Perform DDC system field checkout procedures.
      k. Perform DDC controller unit operation and maintenance procedures.

l. Perform workstation and peripheral operation and maintenance procedures.
m. Perform DDC system diagnostic procedures.
n. Configure hardware including PC boards, switches, communication, and I/O points.
o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware.
p. Adjust, calibrate, and replace system components.

3. System Managers/Administrators:
   a. Maintain software and prepare backups.
   b. Interface with job-specific, third-party operator Software Admin.
   c. Add new users and understand password security procedures.

C. Provide course outline and materials in accordance with the "Submittals" paragraph in Part 1 of this specification. The instructor(s) shall provide one copy of training material per student.

D. The instructor(s) shall be factory-trained instructors experienced in presenting this material.

3.20 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT
1	A written description of the proposed DDC system.
2	System block diagram shall show schematically the entire building system with major components identified.
3	Include manufacturer's literature for each type of panel, controller, or device that is shown on the system block diagram.
7	Direct Digital Control System Hardware: A complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data. Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for all relevant items ▪ Direct Digital Controller (controller panels). ▪ Transducers/Transmitters. ▪ Sensors (including accuracy data). ▪ Actuators. ▪ Valves. ▪ Relays/switches. ▪ Control panels. ▪ Power supply. ▪ Batteries. ▪ Operator interface equipment. ▪ Wiring.

ITEM NO.	SUBMITTAL REQUIREMENT
	Valve and damper schedules with engineering calculations used for sizing modulating valves and dampers. Wiring diagrams and layouts for each control panel. Show termination numbers. Schematic diagrams for field sensors and controllers. Provide floor plans of sensor locations and control hardware.
8	Central System Hardware and Software: A complete bill of material of equipment used, indicating quantity, manufacturer, model number, and other relevant technical data. Manufacturer's description and technical data, such as product specification sheets and installation/maintenance instructions for the items listed below and other relevant items not listed below: ▪ Central processing unit. ▪ Monitors. ▪ Keyboard. ▪ Power supply. ▪ Battery backup. ▪ Interface equipment between cpu and control panels. ▪ Operating system software. ▪ Operator interface software. ▪ Color graphic software. ▪ Third-party software. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label cables and ports with computer manufacturers' model numbers and functions. Show interface wiring to the control system.

ITEM NO.	SUBMITTAL REQUIREMENT
	Riser diagrams of wiring between central control unit and all control panels. A list of the color graphic screens to be provided. For each screen, provide a conceptual layout of pictures and data and show or explain which other screens can be directly accessed.
9	Controlled Systems: A schematic diagram of each controlled system. The schematics shall have control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system. A schematic wiring diagram for each controlled system. Each schematic shall have elements labeled. Where a control element is the same as that shown on the control system schematic, it shall be labeled with the same name. Terminals shall be labeled. An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number. A mounting, wiring, and routing location drawing. The design shall take into account HVAC, electrical and other systems' design and elevation requirements. The drawing shall show the specific location of concrete pads and bases and special wall bracing for panels to accommodate this work. A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. A point list for each system controller including both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, and the location of the I/O device. Software flag points, alarm points, etc.
10	Quantities of items submitted shall be reviewed but are the responsibility

ITEM NO.	SUBMITTAL REQUIREMENT
	of the Contractor.
11	A description of the proposed process along with all report formats and checklists to be used in paragraph 3, Control System Demonstration and Acceptance.

END OF SECTION

SECTION 15951

PIPING SYSTEMS TESTING, ADJUSTING, AND BALANCING

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements for a testing and balancing agency, hereinafter referred to as the testing, adjusting, and balancing contractor (TABC), to test, measure, adjust, balance, and record performance of the general facility and cleanroom support piping systems listed below to comply with the specified performance requirements.
   1. Chilled water systems.
   2. Heating water systems.
   3. Humidification systems.
   4. Domestic hot, cold, recirculation, industrial, and safety shower water systems.

B. Include work required to retest, readjust, rebalance, and revise reports in order to comply with the specified system performance.

C. Act in the Owner's behalf to resolve deficiencies, repairs, and/or corrections that may occur during the execution of the project.

1.2 WORK REQUIRED BUT NOT INCLUDED IN THIS SECTION

A. The installing Contractor shall complete changes or repairs to installed systems required to comply with the specified performance.

1.3 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for piping systems testing, adjusting and balancing.
   1. Section 15050 - Basic Mechanical Requirements.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

C. In the event of conflict regarding piping systems testing, adjusting, and balancing requirements between this Section and another section, the provisions of this Section govern.

1.4 CONSTRUCTION STANDARDS

A. Follow current editions of practices, methods, or standards as prepared by the following technical societies and associations. Comply with more stringent requirements where conflicts exist between standards.

B. Comply with the latest editions of the following standards and references:
   1. AABC: National Standards for Total System Balance.
   2. ASHRAE 111: Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air Conditioning, and Refrigeration Systems.
   3. ASHRAE HVAC Applications Handbook, Testing, Adjusting, and Balancing.
   4. ASHRAE 41.3: Standard Method for Pressure Measurement.
   5. ASHRAE 41.1: Standard Method for Temperature Measurement.
   6. ASHRAE 41.8: Standard Methods of Measurement of Flow of Liquids in Pipes Using Orifice Flowmeters.
   7. ASME PTC 19.2, Part 2 - Pressure Measurement Instruments and Apparatus.
   8. ASME PTC 19.3, Part 3 - Temperature Measurement Instruments and Apparatus.
   9. NEBB: Procedural Standards for Measurement and Assessment of Sound and Vibration.
   10. SMACNA, HVAC Systems: Testing, Adjusting, and Balancing.
   11. UBC: Uniform Building Code, Chapter 23.

C. Comply with the following reference standards for all field tests and project record documents:
   1. AABC: National Standards for Total Systems Balance.
   2. NEBB: Procedural Standards for Certified Testing of Cleanrooms.

1.5 DEFINITIONS

A. Test: to determine quantitative performance of equipment.

B. Adjust: to regulate for specified flow rates at terminal equipment.

C. Balance: to proportion within distribution mains, submains, branches, and terminal systems for specified design flow quantities.

1.6 QUALITY ASSURANCE

A. Certificate of Conformance: NEBB or AABC certification that the TABC has performed the contracted services in accordance with the applicable standards and procedures of the NEBB or AABC National Office.

B. Archive Final Report: Retain final report for minimum 7 years and available for examination, reproduction, discussion, or clarification.

1.7 QUALIFICATIONS

A. Certification Requirements: Submit TABC's current NEBB or AABC certification for piping systems.

B. Previous Experience:
   1. Minimum Years Certified: 5 years for piping systems.
   2. Minimum Projects Completed: five similar in size and complexity.
   3. Project List - Submit the following information for projects completed:
      a. Project name.
      b. Description of water systems balanced.
      c. Range of services provided.
      d. Name and phone number of design consultant.
      e. Name and phone number of Owner's representative responsible for final acceptance.
      f. Name of TABC project manager.
      g. Name of TABC field engineer.

C. TABC Personnel Requirements:
   1. Field Engineer:
      a. Qualifications:
         1) Minimum of 2 years' experience as field engineer or field technician on piping systems.
         2) Trained in knowledge of water system adjustment.
      b. Responsibilities:
         1) Supervise all aspects of field testing, adjusting, and balancing.
         2) Report to and be directed by the Project Manager.
         3) Witness or complete all field tests.
   2. Field Technician:
      a. Qualifications:
         1) Minimum of 2 year's experience as field technician on piping systems.
         2) Trained in knowledge of water system measurement and adjustment.
      b. Responsibilities:
         1) Assist the Field Engineer to complete testing, adjusting, and balancing.
         2) Report to and be directed by the Field Engineer.

1.8 ACCEPTABLE TESTING AND BALANCING CONTRACTORS

A. Proposal Requirements - Submit proposal in two separate sealed envelopes with the project identification on the front and further identified as:
   1. Technical requirements listed in this Section.
   2. Price proposal for services specified in this Section.

B. Proposal Evaluation and Acceptance:
   1. The Owner will evaluate proposals, select TABC, and contract for the required services.
   2. Owner retains the right of final approval for selection of TABC and to accept appropriate alternative bids submitted as part of the proposal.

1.9 COORDINATION

A. Project Manager Responsibilities:
   1. Project Control - Schedule work activities and coordinate with the Owner and allow for:
      a. Critical tests to be completed to permit partial occupancy of cleanroom per overall project schedule.
      b. Coordination with all other contractors to ensure that test ports, thermowells, and flow-measuring devices are installed to permit proper testing, adjusting, and balancing.
   2. Written Correspondence: Confirm site visits and balancing activities are completed per Contract requirements.
   3. Owner Coordination: Coordinate with Owner and facility manager to allow all field tests to be observed.

B. Field Engineer Responsibilities:
   1. Field Coordination: Coordinate with other contractors who adjust systems and activate electrical and control systems that will affect TABC work included to ensure that utility support systems comply with the specified acceptance criteria.

1.10 SUBMITTALS

A. Provide the following submittals:
   1. TABC Firm Qualifications:
      a. Brief written description of firm history, staff, size, ownership, and milestones in firm development.
      b. Documentation of current status with NEBB or AABC as described in this Specification.
      c. Previous experience as described in this Specification.

2. TABC Personnel Qualifications:
    a. Written description of assigned project manager, field engineers, and field technicians indicating compliance with the requirements as described in this Specification.
3. Technical Requirements:
    a. Proposed adjustment and balancing procedures and sequence of activities specific to this project.
    b. Sample test report of a similar project indicating expertise in collecting, interpreting, and recording data. Modify the report forms to maintain confidentiality of previous project and client.
    c. List of project instrumentation and test equipment proposed for use on this project, including the following information:
        1) Description.
        2) Model number.
        3) Serial number.
        4) Date of purchase.
        5) Last calibration date.
        6) Use restrictions of each instrument.
4. Price Requirements: complete breakdown of price for each staff member for each task described in this Specification.

B. Submit the following during the construction period at the time interval indicated:
1. Preliminary (draft) field reports completed from each step of test measurements after each area or system is complete.
2. Working field logs at the end of each week, at the completion of tests on each system, or when a specific area is finished.
3. Evaluation of problems which affect final test results or project schedule as soon as identified.
4. Preliminary (draft) of final assembled (as-built) test report after all tests are complete and before final report submittal. Quantity: one bound in three-ring binder and one unbound copy.

C. Submit the final report when testing is complete and include the following information:
1. General: typed or computer-generated field reports, charts, and forms complete with measured data referenced to the test location.
2. Certificate of Conformance: as described in this Specification.
3. Operating Conditions: complete for piping systems tested.
4. Reduced Size Drawings: set of mechanical drawings, 11-inch by 17-inch finished size, obtained from the Owner indicating test and sample locations referenced on the field data sheets and test results of all field conditions.
5. Problem Descriptions: separate section describing operating problems that still remain after balancing is complete and its affect on system performance.

6. Test Equipment List - Instrumentation and Test Equipment Used for Balancing Procedures, Including:
    a. Manufacturer.
    b. Model number.
    c. Serial number.
    d. Most recent calibration date and next required calibration date.
7. Error Analysis: calculated for each representative system test procedure to estimate combined instrument, system-induced, and random errors.
8. Test Descriptions - Complete for tests performed, including:
    a. Purpose.
    b. Instrumentation used.
    c. Procedure.
    d. Analysis of data.
    e. Results.
    f. Graphic diagrams to convey test understanding.
    g. Date of test.
    h. Personnel performing tests.
9. Nameplate Data - Provide for primary and accessory equipment serving the piping systems, including:
    a. Equipment tag number or identification.
    b. Component data.
    c. Operating data.
    d. System conditions.
    e. Temperature, pressure, and flow data.
10. Quantity and Format: Submit one copy bound in three-D-ring binders and one unbound camera-ready original.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. General: Provide materials, tools, test equipment, computers, and instrumentation required to complete the work included.

B. Cleanroom Clothing:
    1. Garments: Utilize cleanroom garments provided and laundered by Owner if required for TABC work under cleanroom construction protocol.
    2. Footwear: Provide personnel footwear per cleanroom construction protocol.

C. Office Requirements: Owner will provide suitable office space with telephone, photocopy equipment, and secure/locked storage area for test equipment.

2.2 INSTRUMENTATION

A. General: Provide instrumentation required to complete work included.

B. Equipment Used: most current generation available.

C. Sampling Procedures: based on accepted industry standard sampling and statistical procedures.

D. Instrument Calibration:
   1. When required: per manufacturer's requirements at the beginning of balancing work.
   2. National Balancing Agency Requirement: calibration required at National Institute of Standards and Technology (NIST) within previous 6 months.
   3. Recalibration: prior to start of balance work if due date falls within project work schedule.
   4. Field Correlation: Calibrate field instruments used to test cleanroom systems per Section 13009, Cleanroom Certification.

E. Minimum Instrumentation Required:
   1. Airflow Measuring:
      a. Inclined/vertical manometer.
      b. Electronic (digital) manometer.
      c. Pitot tube.
      d. Pressure gauge (magnehelic).
   2. Hydronic Measuring Instruments:
      a. U-tube manometer.
      b. Calibrated pressure gauge.
      c. Differential pressure gauge.
   3. Rotation Measuring Instruments:
      a. Chronometric tachometer.
      b. Contact tachometer (digital).
      c. Electronic tachometer (stroboscope).
   4. Temperature Measuring Instruments:
      a. Glass tube thermometers.
      b. Dial thermometers.
      c. Electronic thermometers.
      d. Psychrometers.
      e. Electronic psychrometers.
   5. Electrical Measuring Instruments: volt-ammeter.

PART 3 -- EXECUTION

3.1 REQUIRED SITE CONDITIONS

A. Facility Completion:
   1. Piping systems are cleaned and flushed.
   2. Piping system pressure tests are complete.

B. Facility Utility Support Systems:
   1. Piping systems are operating under automatic system controls.
   2. Support systems have been in stable operation for at least 5 days.
   3. Domestic plumbing fixtures are installed and operational.
   4. Safety equipment is installed and operational.
   5. The system is capable to artificially load.

3.2 BALANCING PREPARATION, SETUP, AND PROTOCOL

A. Inspection:
   1. Review the facility accompanied by the Owner [jpk1] and identify existing conditions that could affect the balancing results.
   2. Do not proceed with balancing without written release and authorization from the Owner.[jpk2]

3.3 BALANCING PROCEDURES AND FIELD TESTS

A. Equipment Data Collection:
   1. Purpose:
      a. Verify equipment nameplate data compared to submittals.
      b. Provide complete list of equipment for maintenance records.
   2. Procedures - Record nameplate data on all equipment tested, including the following:
      a. Equipment tag or identification number.
      b. Motor data.
      c. Drive data.
      d. Motor starter and heater data.
   3. Acceptance Criteria:
      a. Record equipment nameplate data for all equipment tested.
      b. Document equipment location on reduced-size facility plans.

B. Primary Heating and Cooling Systems Balancing:
   1. Purpose:
      a. Distribute flow required to portions of the distribution system as defined on the equipment schedules.
      b. Adjust water flow to each component.

2. Procedure:
    a. Adjust glycol and/or water flow using the specified flow control devices to the specified flow quantity at each individual system component, including:
        1) Pumps.
        2) Coils.
    b. Measure and adjust flow through control valves and control valve bypass lines. Adjust valves for full flow through the equipment prior to flow adjustment.
    c. Permanently mark the final position of adjustable balancing devices.
    d. Verify and adjust, if necessary, final operating set points for primary equipment, such as chillers, pumps, cooling towers, and coils.
3. Acceptance Criteria:
    a. Adjust scheduled water flow rates within plus 10 minus zero percent of specified values.
    b. Confirm component pressure differentials are within plus or minus 20 percent of specified values.

C. Domestic Water and Safety System Balancing:
1. Purpose:
    a. Achieve proper flow at each safety shower and eyewash fixture.
2. Procedure:
    a. Adjust water flow in all domestic water systems for reasonable water flows at each plumbing fixture, terminal device, and recirculation loop.
3. Acceptance Criteria:
    a. Adjust to water flow rates recommended by the manufacturer within plus or minus 20 percent.
    b. Confirm component pressure differentials are within plus or minus 20 percent of specified values.

D. Support System Balancing:
1. Purpose:
    a. Achieve proper flow to fume exhaust scrubber fluid beds.
    b. Verify proper steam pressure at humidifiers and steam heating devices.
2. Procedure:
    a. Adjust water flow in fume exhaust acid and solvent scrubbers.
3. Acceptance Criteria: Adjust to scheduled water flow rates within plus or minus 10 percent.

3.4 FIELD QUALITY CONTROL

A. Demonstrate balancing procedures to the Owner after submitting the preliminary final report and before final report submission as indicated below:
   1. Test a random 10 percent sample of the total water balance fittings with the original test instruments as selected by the Owner.
   2. Verify test results are within 10 percent of values in the preliminary final report.
   3. Rebalance those portions of the system where directed by the Owner where test results fail.
   4. Repeat Steps 1 and 2.
   5. Rebalance the entire system if the retest values fail.
   6. Repeat process until the demonstration is successful.

B. Include all system adjustments in the final report.

END OF SECTION

SECTION 15952

AIR SYSTEMS TESTING, ADJUSTING, AND BALANCING

PART 1 -- GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements for a testing and balancing agency, hereinafter referred to as the testing, adjusting, and balancing contractor (TABC), to test, measure, adjust, balance, and record performance of the air handling and exhaust systems, including:
   1. General purpose and comfort air handling systems.
   2. General purpose and building exhaust systems.

B. Include work required to retest, readjust, rebalance, and revise reports in order to comply with the specified system performance.

C. Act in the Owner's behalf to resolve deficiencies, repairs, and/or corrections that may occur during the execution of the project.

D. Test, adjust, and balance existing air handling systems as scheduled at the end of this Section.

E. Test, adjust, and balance the air handling systems that are modified by installation of process equipment as scheduled at the end of this Section.

1.2 WORK REQUIRED BUT NOT INCLUDED IN THIS SECTION

A. The Contractor shall complete changes or repairs to installed systems required to comply with the specified performance.

1.3 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total requirements for air systems, testing, adjusting and balancing.
   1. Section 15050 - Basic Mechanical Requirements.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.4 CONSTRUCTION STANDARDS

A. Follow current editions of practices, methods, or standards of the following technical societies and associations. Comply with more stringent requirements where conflicts exist between standards.

B. Comply with the latest editions of the following standards and references:
1. AABC - National Standards for Total System Balance.
2. AMCA 203 - AMCA Fan Applications Manual, Field Performance Measurements.
3. ANSI S1.13 - Measurement of Sound Pressure Levels in Air.
4. ANSI S12.2 - Criteria for Evaluating Room Noise.
5. ANSI S2.7-1980 - Techniques of Machinery Vibration Measurement.
6. ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air Conditioning, and Refrigeration Systems.
7. ASHRAE HVAC Applications Handbook, Testing, Adjusting, and Balancing.
8. ASHRAE 41.3 - Standard Method for Pressure Measurement.
9. ASHRAE 41.4 - Standard Method for Temperature Measurement.
10. ASHRAE 41.8 - Standard Methods for Measurement of Flow of Fluids - Liquid.
11. ASME PTC 19.2, Part 2 - Pressure Measurement Instruments and Apparatus.
12. ASME PTC 19.3, Part 3 - Temperature Measurement Instruments and Apparatus.
13. IES-RP-CC-006 - Testing HEPA Filters, ULPA Filter Testing.
14. NEBB - Procedural Standards for Measuring Sound and Vibration.
15. SMACNA, HVAC Systems Testing, Adjusting, and Balancing.
16. UBC - Uniform Building Code, Chapter 23.

C. Comply with the following reference standards for all field tests and project record documents:
1. AABC - National Standards for Total Systems Balance.
2. NEBB - Procedural Standards for Certified Testing of Cleanrooms.

1.5 DEFINITIONS

A. Test: to determine quantitative performance of equipment.

B. Adjust: to regulate for specified flow rates at terminal equipment.

C. Balance: to proportion within distribution mains, submains, branches, and terminal systems for specified design flow quantities.

1.6 QUALITY ASSURANCE

A. Certificate of Conformance: NEBB or AABC certification that the TABC has performed the contracted services in accordance with the applicable standards and procedures of the NEBB or AABC national office.

B. Archive Final Report: Retain final report for minimum 7 years and have it available for examination, reproduction, discussion, or clarification.

1.7 QUALIFICATIONS

A. Certification Requirements: Submit TABC's current NEBB, AABC, or IES certification for air systems.

B. Previous Experience:
   1. Minimum Years Certified: 5 years for HVAC air-handling systems.
   2. Minimum Projects Completed: five, similar in size and complexity.
   3. Project List - Include the following information for projects completed:
      a. Project name.
      b. Description of air systems balanced.
      c. Range of services provided.
      d. Name and phone number of design consultant.
      e. Name and phone number of Owner’s representative responsible for final acceptance.
      f. Name of TABC project manager.
      g. Name of TABC field engineer.

C. TABC Personnel Requirements:
   1. Field Engineer:
      a. Qualifications:
         1) Minimum of 2 years' experience as field engineer or field technician on air systems.
         2) Trained in knowledge of air system measurement and adjustment.
      b. Responsibilities:
         1) Supervise all aspects of field testing, adjusting, and balancing.
         2) Report to and be directed by the Project Manager.
         3) Witness or complete all field tests.

1.8 ACCEPTABLE TESTING AND BALANCING CONTRACTORS

A. Proposal Requirements - Submit proposal in two separate sealed envelopes with project identification on the front and further identified as:
   1. Technical requirements listed in this Section.
   2. Price proposal for services specified in this Section.

B. Proposal Evaluation and Acceptance:
   1. Owner will evaluate proposals, select TABC, and contract for the required services.
   2. Owner retains the right of final approval for selection of TABC and to accept appropriate alternative bids submitted as part of the proposal.

1.9 COORDINATION

A. Project Manager Responsibilities:
   1. Project Control - Schedule work activities and coordinate with the Owner and allow for:
      a. Critical tests to be completed to permit partial occupancy of cleanroom per overall project schedule.
      b. Coordination with all other contractors to ensure that test ports, thermowells, and flow measuring devices are installed to permit proper testing, adjusting, and balancing.
   2. Written Correspondence: Confirm site visits and balancing activities are completed per Contract requirements.
   3. Owner Coordination: Coordinate with Owner and facility manager to allow all field tests to be observed.

B. Field Engineer Responsibilities:
   1. Field Coordination: Coordinate with other contractors who adjust systems and activate electrical and control systems that will affect TABC work included to ensure that utility support systems comply with the specified acceptance criteria.

1.10 SUBMITTALS

A. Provide the following submittals:
   1. TABC firm qualifications:
      a. Documentation of current status with NEBB or AABC as described in this Specification.
      b. Previous experience as described in this Specification.
   2. TABC Personnel Qualifications: written description of assigned project manager, field engineers, and field technicians indicating compliance with the requirements described in this Specification.
   3. Technical Requirements:
      a. Proposed adjustment and balancing procedures and sequence of activities specific to this project.
      b. Sample test report of a similar project indicating expertise in collecting, interpreting, and recording data. Modify the report forms to maintain confidentiality of previous project and client.

c. List of all project instrumentation and test equipment proposed for use on this project, including the following information:
    1) Description.
    2) Model number.
    3) Serial number.
    4) Date of purchase.
    5) Last calibration date.
    6) Use restrictions of each instrument.

4. Price Requirements: complete breakdown of price for each staff member for each task described in this Specification.

B. Submit the following during the construction period at the time interval indicated:
1. Preliminary (draft) field reports completed from each step of test measurements after each area or system is complete.
2. Working field logs at the end of each week, at the completion of tests on each system, or when a specific area is finished.
3. Evaluation of problems which affect final test results or project schedule as soon as identified.
4. Preliminary (draft) of final assembled (as-built) test report after all tests are complete and before final report submittal. Quantity: one bound in three-ring binder and one unbound copy.

C. Submit the final report when testing is complete and include the following information:
1. General: typed or computer-generated field reports, charts, and forms, complete with all measured data referenced to the test location.
2. Certificate of Conformance: as described in this Specification.
3. Operating Conditions: complete for piping systems tested.
4. Reduced Size Drawings: set of mechanical drawings, 11-inch by 17-inch finished size obtained from the Owner indicating test and sample locations referenced on the field data sheets and test results of all field conditions.
5. Problem Descriptions: separate section describing operating problems that still remain after balancing is complete and its affect on system performance.
6. Test Equipment List - All Instrumentation and Test Equipment Used for Balancing Procedures, Including:
    a. Manufacturer.
    b. Model number.
    c. Serial number.
    d. Most recent calibration date and next required calibration date.
7. Error Analysis: calculated for each representative system test procedure to estimate combined instrument, system induced, and random errors.
8. Test Descriptions - Complete for Tests Performed, Including:
    a. Purpose.

b. Instrumentation used.
c. Procedure.
d. Analysis of data.
e. Results.
f. Graphic diagrams to convey test understanding.
g. Date of test.
h. Personnel performing tests.

9. Nameplate Data - Provide for primary and accessory equipment serving the piping systems, including:
   a. Equipment tag number or identification.
   b. Component data.
   c. Operating data.
   d. System conditions.
   e. Temperature, pressure, and flow data.
10. Quantity and Format: Submit one copy bound in three D-ring binder, and one unbound copy.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. General: Provide materials, tools, test equipment, computers, and instrumentation required to complete the work included.

2.2 INSTRUMENTATION

A. General: Provide instrumentation required to complete work included.

B. Equipment Used: most current generation available.

C. Sampling Procedures: based on accepted industry standard sampling and statistical procedures.

D. Instrument Calibration:
   1. When Required: per manufacturer's requirements at the beginning of balancing work.
   2. National Balancing Agency Requirement: balance required at National Institute of Standards and Technology (NIST) within previous months.
   3. Recalibration: prior to start of balance work if due date falls within project work schedule.
   4. Field Correlation: Calibrate all field instruments used to test cleanroom systems in accordance with Section 13009, Cleanroom Certification.

E. Minimum Instrumentation Required:
   1. Airflow Measuring:
      a. Inclined/vertical manometer.
      b. Electronic (digital) manometer.
      c. Pitot tube.
      d. Pressure gauge (magnehelic).
      e. Hot wire anemometer.
   2. Hydronic Measuring Instruments:
      a. U-Tube manometer.
      b. Calibrated pressure gauge.
      c. Differential pressure gauge.
      d. Electronic clamp-on ultrasonic flow meter.
   3. Rotation Measuring Instruments:
      a. Chronometric tachometer.
      b. Contact tachometer (digital).
      c. Electronic tachometer (stroboscope).
   4. Temperature/Humidity Measuring Instruments:
      a. Glass tube thermometers.
      b. Dial thermometers.
      c. Electronic thermometers.
      d. Psychrometers.
      e. Electronic psychrometers.
   5. Electrical Measuring Instruments: volt-ammeter.
   6. Communication/Control Devices:
      a. Computer terminal compatible with DDC control system.
   7. Vibration Measuring Devices:
      a. Manufacturer: General Radio or Bruel Kjaer.
      b. Description: sound meter with octave band analyzer, filter, calibrator, thermal tape printer, pickup microphone sensors, and storage/carrying case.
   8. Sound Measuring Devices:
      a. Manufacturer: Wave Tek.
      b. Description: vibration meter with accelerometer, analyzer, and digital plotter.
   9. Data Logging Devices:
      a. Manufacturer: Yokogawa.
      b. Description: 12-channel multipoint, electronic, data logging panel with amplifier and thermocouples to provide 0.01 degree F resolution.

PART 3 -- EXECUTION

3.1 REQUIRED SITE CONDITIONS

A. Facility Completion:
   1. Duct systems are cleaned and flushed.
   2. Duct leakage system tests are complete.
   3. Building interior walls are complete to isolate air zones.

B. Facility Utility Support Systems:
   1. Temporary duct closures and blank panels are removed before fans are energized.
   2. Air handling systems are automatically controlled from the EMS or local control and have been in stable operation for at least 5 days.
   3. Safety equipment is installed and operational.
   4. The system is capable to artificially load.

3.2 BALANCING PREPARATION, SETUP, AND PROTOCOL

A. General:
   1. Test Procedures - Use procedures as described herein and as developed by:
      a. AABC.
      b. NEBB.
      c. ASHRAE.
      d. IES.
   2. Airflow Correction Factors: Calculate and record velocity and mass correction factors used to provide equivalent standard airflow quantities at jobsite elevation.

B. Preparation - Require onsite personnel to comply with the following:
   1. Schedule and direct a prebalance conference to review the proposed testing and balancing.

C. Inspection:
   1. Review the entire facility accompanied by the Owner and identify any existing conditions that could affect the balancing results.
   2. Do not proceed with balancing without written release and authorization from the Owner.

3.3 BALANCING PROCEDURES AND FIELD TESTS

A. General, Test Procedures - Use procedures as described herein and as developed by:
   1. AABC.
   2. NEBB.
   3. ASHRAE.
   4. IES.

B. Equipment Data Collection:
   1. Purpose:
      a. Verify equipment nameplate data compared to submittals.
      b. Provide complete list of equipment for maintenance records.
   2. Procedures:
      a. Record nameplate data on all equipment tested, including the following:
         1) Equipment tag or identification number.
         2) Motor data.
         3) Drive data.
         4) Motor starter and heater data.
      b. Verify proper rotation, belt tension and alignment, and lubrication of each air-handling unit.
   3. Acceptance Criteria:
      a. Record equipment nameplate data for all equipment tested.
      b. Document equipment location on reduced-size facility plans.

C. Primary Air-Moving System Balancing:
   1. Purpose:
      a. Adjust supply, return, and exhaust airflow as described in the drawings.
      b. Confirm operating parameters of air-moving equipment.
   2. Procedure:
      a. System Startup:
         1) Verify all dampers are open.
         2) Start fan and verify fan, motor, drive, and motor amperage are acceptable.
         3) Verify proper damper control.
         4) Verify related fan systems are operational and function will not adversely affect system air balance.
      b. Fan Testing:
         1) Test and record fan airflow and adjust for design air quantity.
         2) Make drive and belt changes required to adjust to design airflows with written notice to manufacturer if any drive or belt changes are required.
         3) Adjust main and branch duct dampers for proper flow.
         4) Record inlet and outlet static pressure readings at the following locations:
            a) Overall unit.
            b) Each coil.
            c) Each damper.
         5) Simulate dirty filters by restricting airflow to simulate average pressure drop through filter bank.
         6) Measure motor ampere readings and verify motor is operating within nameplate rating.

7) Compare fan performance with manufacturer's published data and resolve differences.
8) Adjust fan speed on units equipped with variable speed drives to maximum setting, measure maximum airflow, and determine the upper operating limit for each specific job duty cycle or unit size/type.

3. Acceptance Criteria: Adjust scheduled airflow rates within plus 10, minus 5 percent of specified values.

D. Air Outlet and Inlet Balancing:
1. Purpose:
a. Adjust supply, return, and exhaust airflow for each device and balance for proportional flow throughout the zone.
b. Adjust air diffusion devices for proper throw and projection.
c. Adjust ULPA filter units for the proper airflow quantities.
2. Procedure:
a. System Startup:
1) Verify outlet dampers are open.
2) Verify outlet diffusers, registers, and grilles are in place.
3) Verify related fan systems are operational and their function will not adversely affect system air balance.
b. Device Testing:
1) Measure and adjust diffusers, registers, and grilles for design airflow.
2) Verify proper deflection and throw on adjustable outlets and inlets.
3) Adjust for elimination of drafts or noise problems at inlets and outlets.
4) Label or tag final damper positions indicating:
a) Test date.
b) Balancing procedure.
c) Set point value.
d) Technician.
5) Readjust affected system air distribution when major adjustments are made to a portion of a system.
6) Compare outlet totals with main and branch duct traverses and total fan airflow delivery.
3. Acceptance Criteria: Adjust scheduled airflow rates within plus 10 percent, minus 5 percent of specified values.

E. Process and General Exhaust Systems:
1. Purpose:
a. Adjust exhaust airflow for each system, including:
1) Process exhaust.

2) General exhaust.

b. Confirm operating parameters of air-moving equipment.

2. Procedure:

a. System Startup:

1) Verify dampers are open.

2) Start fan and verify fan, motor, drive, and motor amperage are acceptable.

3) Verify proper fan speed control.

4) Verify related fan systems are operational and function will not adversely affect system air balance.

b. Device Testing:

1) Measure and adjust inlets for design airflow.

2) Label or tag final damper positions, indicating:

a) Test date.

b) Balancing procedure.

c) Set point value.

d) Technician.

3) Readjust affected system air distribution when major adjustments are made to a portion of a system.

4) Measure, adjust, and record operating data for each fan.

5) Measure and record main and branch duct traverses.

6) Compare inlet totals with main and branch duct traverses and total fan airflow delivery.

3. Acceptance Criteria: Adjust scheduled airflow rates within plus 10 percent, minus 5 percent of specified values.

3.4 NOISE TESTING

A. Test Requirements:

1. Measure and record sound power levels at uniform spacing throughout the laboratories.

2. Plot sound power levels on noise criteria curve to determine overall compliance with specified requirements.

END OF SECTION

SECTION 16011

BASIC ELECTRICAL CONSTRUCTION MATERIALS AND METHODS

PART 1 -- GENERAL

1.1 WORK INCUDED

A. General requirements specifically applicable to Division 16.

B. Work Included:
1. Demolition.
2. Conduit.
3. Cable trays.
4. Wire and cable.
5. Boxes.
6. Cabinets and enclosures.
7. Terminal blocks and accessories.
8. Wiring devices.
9. Supporting devices.
10. Electrical identification.
11. Disconnect switches.
12. Grounding.
13. Panelboards.
14. Individually mounted motor starters.
15. Lighting.
16. Communication pathways.
17. Equipment and systems to meet project seismic requirements.

C. Work Excluded:
1. Power company metering facilities.
2. Incoming communication service.
3. Interior communication system.

D. The Contractor shall be responsible for furnishing and installing incidental items not actually shown or specified but which are required by good practice to provide complete functional systems.

E. Intent of Drawings:
1. Electrical plan drawings show only general locations of equipment, devices, and raceways unless specifically dimensioned.
2. The Contractor shall be responsible for the proper routing of raceway.

1.2 RELATED WORK

A. Use this Section in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project electrical systems and equipment.
   1. Division 1 sections included in the project specifications.
   2. The Contract.
   3. Attached panel schedules.

B. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.3 DESIGN REQUIREMENTS

A. For materials specified in this Section, minimum standard of quality shall be in accordance with applicable industry standards, including, but not limited to, NEMA, ANSI, IEEE, UL, and federal standards publications.

B. Electrical components shall be UL listed and labeled and meet applicable requirements of Factory Mutual..

C. Compliance by the Contractor with the provisions of this Specification does not relieve him of the responsibilities of furnishing equipment and materials of proper design, mechanically and electrically suited to meet operating guarantees at the specified service conditions.

D. Where applicable, equipment and installation shall meet requirements for corrosive and hazardous locations.

E. Conform to the latest codes and legal requirements, obtain permits, and arrange for inspections.

1.4 SUBMITTALS

A. Provide product data on the following within 4 weeks of the Bid:
   1. Cable trays.
   2. Wire and cable.
   3. Wiring devices.
   4. Disconnect switches.
   5. Panelboards.
   6. Individually mounted motor starters.
   7. Lighting.

B. Provide test reports within 30 days of test.

C. Provide the following as soon as they are available: inspection and permit certificates, certificates of final inspection and acceptance from the authority having jurisdiction, and operation and maintenance manuals.

PART 2 -- PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and Equipment: labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended.

B. Where two or more units of the same class of material are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

C. Provide manufacturer's standard finish color except where specific color is indicated.

2.2 METAL CONDUIT AND FITTINGS

A. Rigid Steel Conduit: rigid galvanized steel.

B. Intermediate Metal Conduit (IMC): galvanized steel.

C. PVC Externally Coated Conduit: rigid steel conduit with external 20-mil PVC coating and internal phenolic coating over a galvanized surface.

D. Electrical Metallic Tubing (EMT): galvanized tubing.

E. Flexible Metal Conduit: steel.

F. Liquidtight Flexible Conduit: flexible metal conduit with PVC jacket.

G. Fittings and Conduit Bodies: threaded type or setscrew type for EMT; material to match conduit.

2.3 NONMETALLIC CONDUIT AND FITTINGS

A. Rigid Nonmetallic Conduit: Schedule 40 PVC.

B. Electrical Plastic Tubing (EPT): PVC.

C. Liquidtight Nonmetallic Flexible Conduit: flexible plastic conduit.

D. Fittings and Conduit Bodies: PVC.

2.4 CONDUIT SUPPORTS

A. Conduit Clamps, Straps, and Supports: galvanized steel, cadmium plated, or malleable iron for metallic conduit, nonmetallic for nonmetallic conduit.

2.5 CABLE TRAYS

A. Tray: Class 20C plus 200-pound concentrated static load applied between side rails at midspan with safety factor of 1.5.

B. Material and Finish of Tray, Fittings, and Accessories: steel, hot-dipped galvanized before fabrication copperfree aluminum.

C. Inside Width: as indicated.

D. Inside Depth: as indicated.

E. Straight Section Rung Spacing: 6 inches on center.

F. Inside Radii of Fittings: as indicated.

G. Tray Grounding: Conform to NFPA and NEMA standards.

H. Accessories and Fittings: manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

I. Covers: ventilated cover.

J. Engraved Nameplates: 1/2-inch-high black letters on yellow laminated plastic nameplate, engraved with the following wording. Warning: Do not use cable tray as walkway, ladder, or support. Use only as mechanical support for cables and tubing.

2.6 BUILDING WIRE

A. Power and Lighting Systems 600V or Less:
   1. Conductor: stranded copper, 600-volt insulation. Minimum size 12 AWG.
   2. Insulation Type: THHN/THWN.

B. Control Circuits: copper, stranded conductor, 600-volt insulation. Minimum size 14 AWG.

C. Signal Circuits:
   1. Special cables shall be as specified on the Drawings.
   2. Conductors for General Use: stranded copper conductor, 16 AWG minimum with insulation.

2.7 OUTLET BOXES

A. Sheet Metal Outlet Boxes: galvanized steel with 1/2-inch male fixture studs where required. Minimum depth of 2 inches.

B. Nonmetallic Outlet Boxes: minimum depth of 2 inches. Provide gasketed, watertight cover.

C. Cast Boxes: copper-free aluminum or cast Feraloy, deep-type, gasketed cover, threaded hubs. Minimum depth of 2 inches. For hazardous locations, provide boxes approved for applicable atmosphere classification.

2.8 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: galvanized steel.

B. Sheet Metal Boxes Larger Than 12 Inches in Any Dimension: hinged enclosure in accordance with paragraph 2.12, Hinged Cover Enclosures.

C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast Feraloy or cast aluminum box and cover with ground flange, neoprene gasket, and stainless steel cover screws. For hazardous locations, provide boxes approved for applicable atmosphere classification.

2.9 HINGED COVER ENCLOSURES

A. Construction: NEMA 250; Type 1 for indoor dry locations where enclosed equipment is required to be ventilated, Type 4 for indoor or outdoor wet locations, 4X for indoor or outdoor wet corrosive locations, or 12 for indoor dry locations; steel, except corrosive to be FRP.

B. Finish: manufacturer's standard enamel finish.

C. Covers: gasketed with continuous hinge, held closed by flush latch operable by screwdriver.

D. Interior Panel for Mounting Terminal Blocks or Electrical Components: 14-gauge steel, white enamel finish.

2.10 CABINETS

A. Cabinet Boxes: galvanized steel with removable end walls. Provide 3/4-inch-thick plywood backboard painted matte white for mounting terminal blocks.

B. Cabinet Fronts: surface type with concealed trim clamps, screw cover front, concealed hinge, and flush lock finish same as enclosure.

2.11 TERMINAL BLOCKS AND ACCESSORIES

A. Power Terminals: unit construction, closed-back type, with tubular pressure screw connectors, rated 600 volts. Provide 25 percent spare terminals.

B. Signal and Control Terminals: modular construction type, DIN 46 277/3 channel mounted; screw clamp compression connectors, rated 300 volts. Minimum terminal width of 0.24 inch, capable of holding two 12 AWG or two 14 AWG conductors in each connector. Terminal identification numbers shall be thermoset characters (black) on a white background. Provide 25 percent spare terminals.

2.12 WALL SWITCHES

A. Wall Switches for Lighting Circuits and Motor Loads Under 1/2 Horsepower: NEMA WD; 1-ac general-use snap switch with toggle handle, rated 20 amperes and 120 to 277 Vac; handle, coordinate color with CH2M Hill screw-type terminals only.

B. Pilot Light Type: red pilot handle; handle lighted when switch is on.

C. Locator Type: lighted handle.

D. Weatherproof: switches as specified mounted in a cast metal box with gasketed, weatherproof device plate as specified.

2.13 RECEPTACLES

A. Convenience and Straight-Blade Receptacles: NEMA WD 1.

B. Locking-Blade Receptacles: type indicated on the Drawings.

C. Convenience Receptacle Configuration:
1. Type 5-20R.
2. Plastic Face: coordinate with CH2M Hill.
3. Emergency Receptacles: red plastic face with prewired neon glow lamp behind each pair of slots.

D. Weatherproof Receptacles: receptacles as specified mounted in a cast metal box with gasketed, weatherproof device plate as specified.

E. Specific-Use Receptacle Configuration: type as indicated on the Drawings, brown plastic face.

F. GFCI Receptacles: duplex convenience receptacle with integral ground fault current interrupter. NEMA Type 5-20R. Feed-through type for downstream device protection.

2.14 WALL DIMMERS

A. Wall Dimmers: linear slide type.

B. Rating: 600 watts minimum, larger size to accommodate load shown on the Drawings.

2.15 WALL PLATES

A. Decorative Cover Plate: coordinate color selection of offices and other areas with CH2M Hill Red smooth plastic for emergency receptacles. Orange smooth plastic for isolated ground receptacles. Isolated ground receptacle covers shall bear the engraved phrase "Isolated Ground" in addition to the engraved circuit number.

B. Cast Metal Plates: Use with cast metal box. Use steel plates with steel boxes and copper-free aluminum with aluminum boxes. Screws shall be stainless steel.

C. Raised Sheet Steel Plates: Use 1/2-inch-high zinc- or cad-plated covers with surface-mounted sheet steel boxes.

D. Weatherproof Cover Plate: gasketed cast metal with hinged gasketed device covers.

E. Corrosion-Resistant Plates:
1. Switches: Provide yellow neoprene, bubble-type device plate with elastomer body, Hubbell Presswitch, Type 17CM81.
2. Receptacles: Provide yellow neoprene device plate with cover caps held tightly in place with stainless steel springs, Hubbell, Type 52CM21 or 74CM24.

2.16 SUPPORTING DEVICES

A. Support Channel or Angle: galvanized steel in general, areas.

B. Hardware: cadmium- or zinc-plated in general areas.

C. For individual conduit runs not directly fastened to the structure, use rod hangers manufactured by Unistrut.

D. For multiple conduit runs, use galvanized steel or angle trapeze-type conduit support designed for maximum deflection not greater than 1/8 inch.

E. Housekeeping Pads: 3-1/2-inch concrete.

2.17 ELECTRICAL IDENTIFICATION

A. Nameplates: engraved three-layer laminated plastic, minimum 3/16-inch-high white letters on a black background. Emergency Equipment Nameplates: white letters on a red background.

B. Tape Labels: embossed adhesive tape with minimum 3/16-inch white letters on black background or 3/16-inch Kroy black letters on a white background.

C. Wire and Cable Markers: clear, heat-shrink tubing type Brady LS2000; cloth or wraparound-adhesive types not approved.

D. Conductor-Color Tape: colored vinyl electrical tape.

2.18 INDIVIDUALLY MOUNTED CIRCUIT BREAKERS

A. Enclosure: NEMA 1 unless indicated otherwise on the Drawings; provide surface-mounted box with door; interlock door with circuit breaker so that door may not be opened when circuit breaker is closed; provide defeater so that qualified personnel can open door when circuit breaker is closed.

B. Minimum Integrated Short-Circuit Rating: 65,000 amperes rms symmetrical or as indicated on Drawings.

C. Molded-Case Circuit Breakers: thermal-magnetic trip circuit breakers with common trip handle for all poles; Class 1.

2.19 DISCONNECT SWITCHES

A. Fusible Switch Assemblies: quick-make, quick-break, load-interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in on position. Handle lockable in off position. Fuse Clips: designed to accommodate Class J fuses.

B. Nonfusible Switch Assemblies: Type HD; quick-make, quick-break, load-interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in on position. Handle lockable in off position.

C. Enclosures: Type 3R.

D. Fuses 600 Amperes and Less: Class J current limiting, time delay, one-time fuse, 250 600 volts. Interrupting Rating: 200,000 amperes rms.

2.20 GROUNDING

A. Ground Connections: exothermic welded-type connectors as manufactured by Cadweld or Thermoweld or compression type of connectors designed for this special purpose as manufactured by Burndy or Thomas and Betts.

2.21 PANELBOARDS

A. Main and Distribution Panelboards:
   1. Circuit breaker type.
   2. Enclosure: Type 1.
   3. Provide cabinet front with concealed trim clamps, screw cover, and hinged door with door-in-door construction and flush lock.
   4. Bus: copper; ratings as scheduled on the Drawings. Provide copper ground bus.
   5. Minimum Integrated Short-Circuit Rating: as scheduled on the Drawings.
   6. Molded-Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide circuit breakers UL listed as Type HACR for air-conditioning equipment branch circuits. Circuit breakers shall be fully rated for fault current, series rating is not allowed.
   7. Where indicated, provide neutral bus bar of the same material as the phase bus bars and a continuous current rating 100 percent of the phase bus bars. Provide at least one terminal screw for each branch circuit.
   8. Circuit breakers to have lockable means.

B. Branch Circuit Panelboards:
   1. Circuit breaker type.
   2. Enclosure: Type 1.
   3. Cabinet Size: 5 3/4 inches deep, 20 inches wide.
   4. Provide flush cabinet front with typewritten directory, concealed trim clamps, door-in-door construction, concealed hinge and hinged door, and flush lock, all keyed alike.
   5. Provide panelboards with copper bus, ratings as scheduled on the Drawings. Provide copper ground bus.
   6. Minimum Integrated Short-Circuit Rating: as scheduled on the Drawings
   7. Molded-Case Circuit Breakers: bolt-on-type thermal magnetic trip circuit breakers with common trip handle for all poles. UL listed as Type SWD for lighting circuits; UL listed as Type HACR for air-conditioning equipment branch circuits. Circuit breakers shall be fully rated for fault current, series rating is not allowed. Branch circuit breakers shall be series rated with upstream breakers for available fault current.

8. Where indicated, provide neutral bus bar of the same material as the phase bus bars and a continuous current rating 100 percent of the phase bus bars. Provide at least one terminal screw for each branch circuit.
9. Provide lockoff device for each multipole circuit in each panelboard. Device shall be capable of accepting a single padlock.

C. Motor Starter Units:
1. Ac, general purpose, Class A, magnetic controller for induction motors rated in horsepower.
2. Construction: drawout combination type with stab connections, except where size and weight of equipment makes this impractical; readily interchangeable with starters of similar size.
3. NEMA standard rating, except none smaller than NEMA size 1.
4. Control Disconnecting Device: Each starter shall contain pull-apart unit terminal blocks to de-energize foreign circuits in the unit which are not de-energized by the starter power disconnect device; connect the hot (live) side of the foreign circuit to the female terminal; hold terminal block assembly in place with captive screws; design to withstand the effects of vibration yet be easily pulled apart.
5. Control Wiring: color coded and numbered, minimum wire size 14 AWG copper.
6. Control Devices: as indicated on the Drawings. Devices shall be heavy-duty, oiltight, NEMA 13 type.
7. Control diagram for each unit to be affixed to interior side of unit door. Provide a thermal overload heater element table in the incoming line compartment door.
8. Full-Voltage Starting: nonreversing type.
9. Two-Speed Starting: two-speed, two-winding, variable-torque type. Include integral adjustable time-delay transition between fast and slow speeds.
10. Coil-Operating Voltage: 120 volts, 60 Hz.
11. Size: size as shown on the Drawings.
12. Overload Relay: bimetal.
13. Enclosure: NEMA Type 1.
14. Combine motor starter with motor circuit protector.
15. Auxiliary Contacts: two normally open closed, field-convertible contacts in addition to seal-in contact.
16. Push Buttons: start/stop in front cover.
17. Indicating Lights: run, red, and stop, green, in front cover.
18. Selector Switches: hand/off/auto locking type in front cover.
19. Control Power Transformer: 120-volt secondary, 100-VA minimum in each motor starter.

20. Motor Circuit Breaker: circuit breakers with integral thermal magnetic trip in each pole. Provide interlock to prevent opening front cover with motor circuit protector in on position. Handle lockable in off position.

2.22 INDIVIDUALLY MOUNTED MOTOR STARTERS

A. Manual Motor Starters:
   1. Manual Motor Starters: ac general-purpose Type A manually operated nonreversing full-voltage controller for induction motors rated in horsepower with overload relay, red pilot light, NO NC auxiliary contact, and push-button operator with provisions for padlock.
   2. Fractional Horsepower Manual Starter: ac general-purpose Type A manually operated, full-voltage controller for fractional horsepower induction motors with thermal overload unit (bimetallic heaters), red (run) green (off) pilot light, and toggle with provisions for padlock operator.
   3. Enclosure: As indicated on the Drawings.

B. Magnetic Motor Starters:
   1. Similar to motor control center motor starter units listed in 2.27.S above.
   2. Size: as shown on the Drawings.
   3. Enclosure: as indicated on the Drawings.

2.23 LIGHTING

A. Interior Luminaires and Accessories:
   1. Fluorescent Luminaires: Provide hinged frames of minimum 22-gauge steel and 20-gauge end pieces with latches and minimum 0.125-inch thickness injection molded or extruded virgin acrylic lenses.
   2. Recessed Incandescent Luminaires: prewired type.
   3. Recessed Fluorescent Luminaires: Provide trim type and accessories required for installation in ceiling system installed. Maximum depth of luminaire shall be 6 inches, including yokes and bridges.
   4. Exit Signs: per luminaire schedule.
   5. HID Luminaires: prewired with integral ballast.
   6. Provide fixtures with feed-through junction boxes or provide separate junction boxes.
   7. Provide fixtures with minimum 18 AWG wiring leads.

B. Exterior Luminaires and Accessories:
   1. Enclosures: complete with gaskets to form weatherproof assembly with wet label and removable prewired ballast if exposed to weather or with damp label if installed in building soffit.
   2. Provide low-temperature ballasts.

3. When photocell is mounted on luminaire, provide factory-mounted, UL-listed unit gasketed for wet service.

C. Lamps:
1. General-Use Incandescent Lamps: inside-frosted type rated 130 volts.
2. Incandescent Reflector Lamps: shape as scheduled, rated 130 volts.
3. Fluorescent Lamps: cool white; by same manufacturer, energy-saving type.
4. Metal Halide HID Lamps: phosphor coated suitable for the burning position required.
5. High-Pressure Sodium HID Lamps: clear suitable for the burning position required.

D. Fluorescent Ballasts:
1. Fluorescent Ballasts: ANSI C82.1; electronic, high-power-factor type, energy-efficient, Class P internally thermally protected, A sound rating.
2. Ballasts for Dimming: compatible with lamp and dimming system, labeled for use and listed as compatible by dimmer manufacturer.

E. Photometrics: Provide luminaires with Illumination Engineering Society of North America (IESNA) formatted photometric files via an ETL for lighting software interface.

PART 3 -- EXECUTION

3.1 BASIC ELECTRICAL INSTALLATION REQUIREMENTS

A. Workmanship:
1. Install work using procedures defined in NECA Standard of Installation.
2. Install material and equipment in accordance with manufacturer's instructions. Provide calibrated torque wrenches and screwdrivers as required.

B. Service Continuity:
1. Maintain continuity of electric service to functioning portions of process or buildings during the hours of normal use.
2. Arrange temporary outages for cutover work with the Owner. Keep the outages to a minimum number and minimum length of time.

C. Startup Testing and Inspection of Electrical Equipment:
1. Provide tests specified hereinafter and as indicated under individual items of materials and equipment specified in other sections.
2. Performance Test:
a. At the completion of electrical system installation and at such time as CH2M HILL may indicate, conduct an operating test for acceptance.

b. Demonstrate that equipment operates in accordance with the Contract Documents.
c. Perform test in presence of CH2M HILL.
d. Furnish instruments and personnel required for the test.

3. Voltage: At completion of project, check voltage at point of termination of power supply system to project. Check voltage amplitude and balance between phases for loaded and unloaded conditions. Adjust taps of transformers such that the no-load voltage is approximately equal to or up to 3 percent above normal.
4. Test References:
   a. The testing and inspection shall comply with applicable sections of the following codes and standards:
      1) American National Standards Institute (ANSI).
      2) American Society for Testing and Materials (ASTM).
      3) Association of Edison Illuminating Companies (AEIC).
      4) Institute of Electrical and Electronics Engineers (IEEE).
      5) Insulated Power Cable Engineers Association (IPCEA).
      6) National Electrical Code (NEC).
      7) National Electrical Manufacturer's Association (NEMA).
      8) International Electrical Testing Association (NETA).
      9) National Fire Protection Association (NFPA).
      10) State and local codes and ordinances.
   b. The inspection and testing shall comply with the project plans and specifications, as well as with the manufacturer's drawings, instruction manuals, and other applicable data for the apparatus tested.
5. Responsibilities:
   a. Clean the equipment and torque down accessible bolts, perform routine insulation resistance tests on branch and feeder circuits, continuity checks on branch and control wiring, and rotation tests for distribution and utilization equipment. At each test site, provide test control power necessary to perform the tests specified. After review by CH2M HILL, correct deficiencies noted.
   b. The Owner's electrical engineer will furnish settings of protective devices unless a power system study has been required elsewhere in these Specifications.
6. Implementation:
   a. Safety practices shall comply with applicable state and local safety orders, as well as with the Occupational Safety and Health Act (OSHA). Compliance with NFPA Standard 70E and the Accident Prevention Manual for Industrial Operations of the National Safety Council shall be observed.
   b. Tests shall only be performed on apparatus which is de-energized. Work shall not proceed until it has been determined that it is safe to do so.

c. Power circuits shall have conductors shorted to ground by a hotline-grounded device approved for the purpose. Warning signs and protective barriers shall be provided as necessary to conduct the tests safely.

d. In general utilize methods outlined in acceptance testing specifications for electrical power distribution equipment and systems from the International Electrical Testing Association (NETA), but do not exceed manufacturer's limitations.

7. Reports:
   a. The test report shall include the following sections:
      1) Scope of testing.
      2) Equipment tested.
      3) Description of test.
      4) Test results.
      5) Conclusions and recommendations.
      6) Appendix, including test forms.
   b. Each piece of equipment shall be recorded on a data sheet listing the condition of the equipment as found and as left. Included shall be recommendations for necessary repair and/or replacement parts. The data sheets shall indicate the name of the engineer who tested the equipment and the date of the test completion.
8. Common Equipment Test Procedures Following NETA Guidelines:
   a. Instrument Transformers:
      1) Visual and Mechanical Inspection:
         a) Inspect each transformer for physical damage.
         b) Verify that grounding and shorting devices function correctly.
         c) Check drawout mechanisms for proper operation.
      2) Electrical Tests:
         a) Confirm that devices being driven by the current transformers respond correctly.
         b) Confirm that devices connected to the potential transformers respond correctly to voltage applied at the secondary PT leads.
   b. Molded-Case Circuit Breakers:
      1) Visual and Mechanical Inspection:
         a) Inspect cover and case and check for broken or loose terminals.
         b) Operate breaker to check operation.
      2) Electrical Tests (400-Ampere Frame and Larger):
         a) Insulation Resistance Test: Megger main poles of breaker pole to pole, from each pole to ground, and across the open contacts of each pole.

b) Calibrate to settings provided by CH2M HILL. Data shall be compared with manufacturer's published data.
(1) Where ground fault protection is provided, test ground fault.
(2) Check reset characteristics of trip unit.
c) Electrically test auxiliary devices such as shunt trips, undervoltage trips, alarm switches, and auxiliary switches.

c. Motor Control Centers, Motor Starters, Busway, Panelboards, and Transformers:
1) Visual and Mechanical Inspection:
a) Verify that the structure interiors and starter cells have been cleaned of accumulated dust, dirt, oil films, and other foreign material.
b) Inspect bolted connections. Torque wrench tighten or remake questionable connections.
c) Check mechanical operation of starters for freedom from binding.
d) Check overload relay heater size against Contractor-furnished list of motor nameplate full-load current values.
e) Adjust motor circuit protectors per manufacturer's guidelines.
2) Electrical Tests: Verify operation of each starter.

3.2 DEMOLITION

A. Verify that field measurements and circuiting arrangements are as shown on the Drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents. Report discrepancies to the CH2M HILL before disturbing existing installation.

D. Beginning of demolition means Contractor accepts existing conditions.

E. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

F. Coordinate utility service outages with utility company.

G. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

H. Maintain existing systems in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

I. Remove, relocate, and extend existing installations to accommodate new construction.

J. Remove abandoned conductors to source of supply.

K. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut embedded or concealed conduit flush with walls and floors and patch surfaces.

L. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

M. Disconnect and remove abandoned panelboards and distribution equipment.

N. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

O. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

P. Repair adjacent construction and finishes damaged during demolition and extension work.

Q. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

R. Extend existing installations using materials and methods compatible with existing electrical installations or as specified.

S. Clean and repair existing materials and equipment which remain or are to be reused.

T. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

3.3 INSTALLATION OF CONDUIT

A. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

B. Maintain minimum 6-inch clearance between conduit and piping. Maintain 12-inch clearance between conduit and heat sources such as flues, steam pipes, and heating appliances. Maintain minimum 18-inch clearance above ceiling grid.

C. Arrange conduit supports to prevent distortion of alignment by wire-pulling operations. Fasten conduit using galvanized straps, lay-in adjustable hangers, clevis hangers, or bolted split stamped galvanized hangers.

D. Do not fasten conduit with wire or perforated pipe straps. Remove wire used for temporary conduit support during construction before conductors are pulled.

E. Cut conduit square using a saw or pipecutter; deburr cut ends.

F. Bring conduit to the shoulder of fittings and couplings and fasten securely.

G. Use conduit hubs for fastening conduit to cast boxes and for fastening conduit to sheet metal boxes in damp or wet locations.

H. Except for communications conduits, use conduit bodies to make sharp changes in direction as around beams. Conduit bodies shall be readily accessible.

I. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

J. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture. Provide a permanent cap over each end of each empty conduit.

K. Provide a pull rope or pull tape in each empty conduit. Tie pull rope securely to duct plug or wall racking at each end. Provide conduit identification at each end.

L. Install expansion-deflection joints where conduit cross building expansion or structural isolation break (SIB) joints; Expansion fittings shall have copper bonding jumper.

M. Where conduit penetrates fire-rated walls and floors, seal opening around conduit with UL-listed foamed silicone elastomer compound with rating equal to or greater than the wall/floor penetrated.

N. Use PVC-coated rigid steel factory elbows for bends in plastic conduit runs longer than 100 feet or in plastic conduit runs which have more than two bends regardless of length.

O. Wipe plastic conduit clean and dry before joining. Apply full, even coat of cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum.

P. Concealed, embedded, and buried conduit shall emerge at right angles to the surface and have none of the curved portion of the bend exposed.

Q. Provide warning tapes above underground conduits.

3.4 CONDUIT INSTALLATION SCHEDULE

A. Exposed Outdoor Locations: rigid steel conduit .

B. Wet Interior Locations: rigid steel conduit .

C. Concealed Dry Interior Locations: electrical metallic tubing.

D. Exposed Dry Interior Locations: electrical metallic tubing.

E. Corrosive Interior Locations: Schedule 40 PVC conduit.

F. Hazardous (Classified) Locations: rigid steel conduit.

3.5 INSTALLATION OF SURFACE METAL RACEWAY

A. Use flat-head screws to fasten channel to surfaces. Mount plumb and level.

B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

C. Maintain grounding continuity between raceway components to provide a continuous grounding path.

D. Fastener Option: Use clips and straps suitable for the purpose.

3.6 INSTALLATION OF CABLE TRAYS

A. Installation: in conformance with NEMA requirements and in accordance with manufacturer's instructions.

B. Support cable tray at each connection point, at the end of each run, and at other points to maintain spacing between supports of 10 feet maximum. Trays shall be level with respect to grade, plus or minus 1/8 inch per 10 feet or 1/2 inch cumulative.

C. Use expansion connectors where indicated in NEMA standards or where cable tray crosses expansion joints.

D. Cut standard straight sections to length in field.

E. Install warning signs at 50-foot centers along route of cable tray, located to be visible.

F. Provide bonding continuity between cable tray sections and fittings in accordance with manufacturer's instructions.

G. Bond cable tray systems to the power system's ground every 100 feet.

3.7 INSTALLATION OF BUILDING WIRE

A. Place an equal number of conductors for each phase of a circuit in same raceway or cable.

B. Splice only in junction or outlet boxes. Control cables shall be spliced on terminal blocks and only with the written permission of CH2M HILL.

C. Neatly train and lace wiring inside boxes, equipment, and panelboards.

D. Make conductor lengths for parallel circuits equal.

E. Where connection of cables installed under this Section is to be made by others, provide pigtails of adequate length for neat, trained, and bundled connections.

F. Pull all conductors into a raceway at the same time. Use UL-listed wire-pulling lubricate for pulling 4 AWG and larger wires.

G. Install wire in raceway after interior of building has been physically protected from the weather and mechanical work likely to injure conductors has been completed.

H. Completely and thoroughly swab raceway system before installing conductors.

I. Use solderless pressure connectors with insulating covers for copper wire splices and taps 8 AWG and smaller. For 10 AWG and smaller, use insulated-spring wire connectors with plastic caps on lighting and receptacle circuits.

J. Control circuit conductors shall terminate at terminal blocks only.

K. Use split-bolt connectors for copper wire splices and taps 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.

L. Thoroughly clean wires before installing lugs and connectors.

M. Make splices, taps, and terminations to carry full ampacity of conductors without perceptible temperature rise.

N. Terminate spare conductors with electrical tape.

O. Inspect wire and cable for physical damage and proper connection.

P. Torque test conductor connections and terminations to manufacturer's recommended values.

Q. Perform continuity and insulation tests on power and equipment branch circuit conductors. Verify proper phasing connections.

3.8 INSTALLATION OF BOXES

A. Types to be Provided, Steel Raceway System:
   1. Exterior Locations: cast Feraloy with neoprene gaskets.
   2. Interior Locations With:
      a. Rigid Steel Conduit: cast Feraloy.
      b. Intermediate Metallic Conduit: cast Feraloy.
      c. Electrical Metallic Tubing: sheet steel.
      d. Communications Wireway: same material as wireway.
   3. Interior Wet Locations with Exposed and Concealed Raceways: cast Feraloy with neoprene gaskets.

B. Types to be Provided - Plastic Raceway System: nonmetallic.

C. Single In-Line Communications Conduit Runs:
   1. 2-inch Conduit and Smaller: Type C conduit bodies of cast Feraloy or nonmetallic construction as required for the location. Gaskets outdoors and in wet locations.
   2. Conduit Larger Than 2-Inch: straight-through communications wireway as specified for the location.

D. Do not install outlet boxes back to back in walls.

E. Locate outlet boxes in masonry walls to require cutting of masonry unit corner only.

F. Provide knockout closures for unused openings.

G. Support outlet boxes independently of conduit.

H. Use multiple-gang outlet boxes where multiple devices are mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

I. Install outlet boxes in walls without damaging wall insulation.

J. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

K. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire to be accessible through luminaire ceiling opening.

L. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall and adjustable steel channel fasteners for flush ceiling outlet boxes.

M. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.

N. Support pull and junction boxes independent of conduit.

O. Provide pull boxes to limit conduit runs to 150 feet and contain no more than three 90 degree, right-angle bends unless accepted by CH2M HILL. For communications raceways limit runs to 100 feet and no more than two 90 degree bends.

P. Provide communications pull boxes of sufficient size and place raceway connections in a manner that ensures the minimum inside cable bend radius is more than 10 times the inside diameter of the conduit. Do not install boxes, bends, elbows, tees, conduit, outlet bodies, and other conduit fittings which do not provide for this minimum inside cable bend radius.

Q. Outlet, pull, and junction boxes shall be accessible.

R. Install terminal boxes as indicated.

S. Communications Boxes: Provide 4- by 4- by 2-inch-deep outlet boxes with single-gang plaster rings for mounting telecommunications outlets.

T. Close openings in boxes, condulets, raceways, and equipment.

3.9 INSTALLATION OF CABINETS AND ENCLOSURES

A. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum.

B. Provide accessory feet for freestanding equipment enclosures.

C. Install trim plumb.

D. Install terminal blocks as indicated.

3.10 INSTALLATION OF WIRING DEVICES

A. Install wall switches 48 inches above floor, off position down.

B. Install wall dimmers 48 inches above floor; derate ganged dimmers as instructed by manufacturer; do not use common neutral.

C. Install devices above counters at 44 inches above floor.

D. Install convenience receptacles 18 inches above floor or raised floor, grounding pole on bottom.

E. Install specific-use receptacles at heights shown on the Drawings.

F. Install decorative plates on switch, receptacle, and blank outlets in finished areas using jumbo-size plates for outlets installed in masonry walls.

G. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.

H. Install devices and wall plates flush and level.

3.11 INSTALLATION OF SUPPORTING DEVICES

A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using precast insert system, expansion anchors, preset inserts, beam clamps, or spring steel clips.

B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

C. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

D. Do not use powder-actuated anchors without written permission from CH2M HILL.

E. Do not drill structural steel members without written permission from CH2M HILL.

F. Fabricate supports from structural steel or steel channel rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring-lock washers under nuts.

G. Install surface-mounted cabinets and panelboards with minimum of four anchors

H. Bridge studs top and bottom with channels to support recessed mounted cabinets and panelboards in stud walls.

I. Use galvanized supports in areas subject to corrosives.

J. Support systems in compliance with project seismic requirements.

3.12 INSTALLATION OF ELECTRICAL IDENTIFICATION

A. Degrease and clean surfaces to receive nameplates or tape labels.

B. Install nameplates and/or tape labels parallel to equipment lines.

C. Secure nameplates to equipment fronts using screws or rivets. Utilize adhesive for engraved nameplates. Secure nameplate to outside face of flush-mounted panelboard doors in finished locations.

D. Provide wire markers on each phase, neutral, or ground conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits and with control wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.

E. Utilize permanent black markers to identify circuits, destinations, and spares on junction and pull box lids. Clarify detail inside larger boxes.

F. Post neutral and phase color codes at each panelboard.

G. Place signs at service equipment noting the location of generator and uninterruptible power supply systems.

H. Place signs at each building disconnect noting where other building disconnects are located.

I. Intrinsically safe conductors to be light blue.

J. Conductors for power circuits shall be identified per the following schedule:

	System Voltage	
Conductor	480Y/277V	208Y/120V
Phase A	Brown	Black
Phase B	Orange (also grounded delta high-leg)	Red
Phase C	Yellow	Blue
Neutral	White with orange stripe	White
Grounding	Green	Green
Switchleg (lighting)	Purple	Pink

K. Provide nameplates to identify electrical distribution and control equipment and loads served. Letter Height: 1/8 inch for individual switches and loads served, 1/4 inch for distribution and control equipment identification.

L. Life Safety and Security System Device Identification:
1. Label devices with self-adhesive labels, 1/8-inch characters, white letters on a red background per the Life Safety Drawings.
2. Where view of the device is obstructed by ceiling tile, place an additional label on the tile to be visible from the floor.

M. Conduit color coding schedule shall be as follows:
1. Use colored tape to identify conduit by system.
2. Primary Distribution System: purple.
3. 480-Volt, Three-Phase System: blue.
4. 208-Volt, Single- and Three-Phase System: black.
5. Grounding: green.
6. General Control Systems (non-FMS line voltage): brown and white.
7. Telephone and Data System: yellow.
8. Emergency Power System: red.
9. UPS Power System: red.
10. Fire Alarm System, Voice Evacuation System: red and white.
11. Closed-Circuit Television (CCTV) System: gray and white.
12. Security System: gray.
13. Intrinsically Safe System: light blue.
14. FMS (Facility Management System) and FMS Controlled Circuitry (Low Voltage): blue and black.

3.13 INSTALLATION OF GROUNDING

A. Install grounding system in accordance with NEC Article 250 unless specifically instructed otherwise in these Contract Documents.

B. Provide communications system grounding conductor at telephone utility point-of-service entrance and connect to nearest effectively grounded building structural steel member.

C. Provide separate isolated equipment grounding conductor bonded to system at service or separately derived source where required for reduction of electrical noise.

D. Grounding conductors shall not be spliced, except in junction or outlet boxes.

E. Provide a separate, insulated equipment grounding conductor in feeder and branch circuits.

3.14 INSTALLATION OF PANELBOARDS

A. Install panelboards plumb and flush with wall finishes where recessed, in conformance with NEMA requirements.

B. Height: 78 inches to top.

C. Adjust trim to cover openings.

D. Provide filler plates for unused spaces in panelboards.

E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

F. Measure steady-state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multiwire branch circuits.

G. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers.

H. Store products specified in this Section in a dry location. Following installation, protect products from the effects of moisture, corrosion, and physical damage during construction.

I. Install ground bus in accessible location.

3.15 INSTALLATION OF LIGHTING

A. Verify ceiling types and coordinate with luminaires and accessories.

B. Furnish and install lamps in luminaires and lamp holders.

C. Recessed luminaire trims shall fit snugly to the mounting surface and shall not exhibit light leaks or gaps. Provide heat-resistant rubber gasketing where necessary.

D. Separately support from structure luminaires installed in lay-in ceilings from two opposite corners and fasten to grid.

E. Install luminaires as shown on the Drawings; install aligned, aimed, and leveled. Coordinate aiming of adjustable luminaires with CH2M HILL prior to completion of project.

F. Handle quartz lamps using new, clean white cotton or silk gloves. Do not touch lamp with bare hands.

G. Mark standard luminaires equipped with emergency power with a red adhesive sticker (not more than 3/8 inch in diameter) mounted on metal door frame.

H. Provide removable unitized ballast/component tray with separable connector in pole-mounted luminaires.

I. Handle parabolic trim cones and louvers with new, clean white cotton or silk gloves. Contractor is responsible for delivering trims in clean, sound condition at completion of project.

J. Leave luminaires clean at time of acceptance of work with lamps operational. Relamp inoperable lamps at completion of work.

3.16 INSTALLATION OF COMMUNICATION PATHWAYS

A. Verify that surfaces are ready to receive work.

B. Verify that field measurements are as shown on the Drawings.

C. Beginning of installation means installer accepts existing conditions.

D. Install pull wire or polyethylene pulling string in each empty telephone conduit.

E. Install boxes, raceways, and cable tray as indicated on the Drawings.

F. Wiring and communication equipment will be by others.

END OF SECTION