PROJECT MANUAL FOR: CRITICAL CARE ADDITION - INTERVENTIONAL RADIOLOGY EXPANSION

PROJECT NUMBER: CP180491

AT
UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI

FOR:
THE CURATORS OF THE UNIVERSITY OF MISSOURI

PREPARED BY:
THE CLARK ENERSEN PARTNERS
2020 BALTIMORE AVENUE, SUITE 300
KANSAS CITY, MO 64108-1914
816.474.8237

DATE: SEPTEMBER 18, 2019

I hereby certify that Drawing Sheets G0.00, G0.01, G0.20, A0.00, A0.01, A0.20, A1.11, A1.20, A2.10, A6.20, A6.21, A6.40, AS1.01, F1.12 as well as Specification Sections 017329, 024119 and Specification Divisions 6-13 have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the University of Missouri.

Signature: ____________________________

I hereby certify that Drawing Sheet S2.01 and Specification Section 055000 have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the University of Missouri.

Signature: ____________________________

I hereby certify that M0.00, M0.01, M0.02, M1.01, M1.02, M1.03, M1.04, M2.01, M2.02, M3.01, M3.02, M3.03, M4.01, M4.02, P0.01, P0.02, P1.01, P1.02 as well as Specification Divisions 22-23 have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the University of Missouri.

Signature: ____________________________

I hereby certify that Drawing Sheet FP1.01 as well as Specification Section 211313 have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the University of Missouri.

Signature: ____________________________
I hereby certify that Drawing Sheets E0.00, E0.01, E0.10, E1.01, E2.01, E2.02, E3.01, E4.01, E4.02, E5.01, E5.02, T1.01 as well as Specification Divisions 26-27 have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the University of Missouri.

Signature: __________________________

I hereby certify that Drawing Sheet G0.10 has been prepared by me, or under my supervision. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the University of Missouri.

Signature: __________________________

BID SET
VOLUME III OF III
SECTION 01 73 29 - CUTTING AND PATCHING

1. GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for cutting and patching.

1.3 QUALITY ASSURANCE

A. Requirements for Structural Work: Do not cut and patch structural elements in a manner that would reduce the load-carrying capacity or load-deflection ratio.

B. Operational and Safety Limitations: Do not cut and patch operating elements or safety related components in a manner that would result in reducing the capacity to perform as intended.

C. Visual Requirements: Do not cut and patch exposed work in a manner that results in visual evidence of cutting and patching. Remove and replace work cut and patched in a visually satisfactory manner as determined by Architect.

2. PRODUCTS

2.1 MATERIALS

A. Use materials that are identical to existing materials. If identical materials are not available, use materials that match existing adjacent surfaces to the fullest extend possible. Use materials whose installed performance will equal or surpass that of existing materials.

3. EXECUTION

3.1 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

1. Protection: Protect existing construction during cutting and patching.

3.2 PERFORMANCE

A. General: Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.
CUTTING AND PATCHING

B. Cutting: Cut existing construction using methods least likely to damage elements to be retained or adjoining construction.

C. Patching: Patch with durable seams that are invisible.

1. Restore exposed finishes in a manner that will eliminate evidence of patching and refinishing.
2. Where removal of walls or partitions extends one finished area into another, patch and repair floor and wall surfaces in the new space to provide an even surface of uniform color and appearance. Remove existing floor and wall coverings and replace with new materials as required to achieve uniform color and appearance.
   a. Where patching occurs in a smooth paint surface, extend final paint coat over entire unbroken surface after the patched area has received primer and second coat.
3. Patch, repair or rehabbing existing ceiling as necessary to provide an even plane surface of uniform appearance.

3.3 CLEANING

A. Thoroughly clean areas and spaces where cutting and patching are performed.

END OF SECTION 01 73 29
SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT TRACKING

1. GENERAL

1.1 RELATED DOCUMENTS

A. All of the Contract Documents, including General and Supplementary Conditions and Division 01 General Requirements, apply to the work of this Section.

1.2 SUMMARY

A. This Section specifies requirements for the Contractor's implementation of waste management controls and systems for the duration of the Work.

The intent of this Section is to develop and implement a Construction Waste Management Plan (CWMP) in order to quantify material diverted from Solid Waste Disposal Facility or incineration. Quantities must be reported by weight and consistent in units reported and calculation method throughout.

Diversion Methods and Materials Eligible for Reporting:

1. Appropriate materials suitably placed in a Clean Fill Site may be reported
2. Appropriate materials diverted for use as Wood Derived Fuel (WDF) may be reported

Diversion Methods and Materials Ineligible for Reporting:

3. Material disposal by incineration
4. Excavated soil and land-clearing debris
5. Material for use as Alternative Daily Cover (ADC)
6. Hazardous waste; should be disposed of according to relevant regulations

B. Contractor may subcontract work of this Section to a sub-contractor specializing in recycling and salvaging of construction waste.

1.3 DEFINITIONS

A. ALTERNATIVE DAILY COVER (ADC): Material (other than earthen material) that is placed on the surface of the active face of a municipal solid waste landfill at the end of each operating day.

B. AVERAGE RECYCLING RATE: The weighted average for the diversion of materials by the commingled (mixed-stream) recycling facility over time.
CONSTRUCTION WASTE MANAGEMENT TRACKING

University of Missouri Teaching Hospital
Critical Care Addition – Interventional Radiology Expansion
Columbia, Missouri

MU Project #: CP180491
TCEP Project #: 624-149-17

C. CLEAN FILL SITE: Re-grading fill site for land reclamation or other beneficial use. Typically requiring permits, regular site maintenance and hours of operation. With material consisting of demolition debris and construction waste from buildings, roads and highway pavement, and other structures. Commonly comprised of brick, ceramics, concrete, and asphalt paving fragments that are virtually inert and pose neither a pollution threat to ground or surface waters nor a fire hazard. May contain minimal amounts of wood, metal and inert solids.

D. COMMINGLED WASTE: Waste streams that are combined on the project site and hauled away for sorting into recyclable streams. Also known as mixed or single-stream recycling.

E. DEMOLITION AND CONSTRUCTION DEBRIS: Debris, waste and surplus materials, including recyclables, generated as a result of the Contractor’s onsite activities while executing the requirements of the contract. Also, commonly includes materials from renovation, demolition, or deconstruction activities.

F. RECYCLE: Recovery of materials, otherwise diverted from the solid waste stream for remanufacturing.

G. SALVAGE: Recovery of useful items repurposing without the need for remanufacturing or reducing to raw materials due to their intrinsic value.

H. SOLID WASTE DISPOSAL FACILITY: A managed landfill, regulated at the Federal, State, and/or Local level.

1.4 INTENT

A. The Owner and Architect have established that this Project shall track the amount of Demolition and Construction debris. The Contractor shall develop and employ processes that ensure that the amount of demolition and construction debris actually generated during the execution of this project due to error, poor planning, breakage, mishandling, contamination or other factors is minimized.

B. Of the construction and demolition debris generated, as much as is economically feasible shall be reused, salvaged, or recycled. Disposal of construction and demolition debris in solid waste disposal facilities shall be minimized to the greatest extent practical.

C. The Contractor shall develop, for the Architect's review, a Construction Waste Management Plan (CWMP) for this Project.

D. Contractor shall be responsible for ensuring that construction and demolition debris, not otherwise salvaged or recycled will be disposed of at appropriately licensed solid waste disposal facilities.
1.5 SUBMITTALS

A. Construction Waste Management Plan (CWMP): Within 21 calendar days [adjust date for restricted timelines] after receipt of Notice to Proceed, the Contractor shall provide a plan for review and approval by architect and owner. The Construction Waste Management Plan shall be uploaded in the format provided at the end of this section (available for download here: http://www.cf.missouri.edu/cf/pdc/contractor_information) and shall at a minimum contain the following:

1. Analysis of the proposed jobsite waste to be generated, including types and estimated quantities.
2. Solid Waste Disposal Facility Options: The name of the facilities landfills where construction and demolition debris not otherwise salvaged or recycled will be disposed of, the applicable landfill tipping disposal fees, and the projected cost of such disposal.
3. Solid Waste Disposal Facility Certification: Contractor’s statement of verification that facilities proposed for use are licensed for types of waste to be deposited and have sufficient capacity to receive waste from this project.
4. Recycling Facility Options: Facilities providing commingled or mixed-stream recycling must provide diversion rates either specific to the project, or an average diversion rate that is regulated by the local or state authority. The average recycling rate for the facility must exclude ADC. Measurements must be based on weight (not volume), using scales. Reporting increments shall be no more than annually, and must use consistent time increments throughout calculations.
5. Alternatives: A list of each material proposed to be salvaged or recycled during the course of the Project and the planned reuse strategy or diversion destination of each. Include the following and any additional items proposed:

   a. Cardboard
   b. Clean wood
   c. Beverage containers
   d. Concrete
   e. Slurry wall materials
   f. Bricks and masonry
   g. Asphalt
   h. Metals from framing, banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze
   i. Mechanical and electrical equipment
   j. Building components which can be removed relatively intact from existing construction
   k. Packaging materials
   l. Glass
   m. Scraps from new gypsum wall board
   n. Carpet and pad
   o. Acoustical ceiling panels
   p. Plastics
6. Meetings: A description of the regular meetings to be held to ensure proper execution of the construction waste management plan.

7. Debris Handling Procedures: A description of the means by which any construction waste materials identified above will be protected from contamination, and a description of the means to be employed in recycling the above materials consistent with requirements for acceptance by designated facilities.

8. Transportation: A description of the means of transportation of the debris (whether debris will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler and removed from the site).

B. Waste Management Progress Report: Concurrent with each Application for Payment, submit a written Waste Management Progress Report in the same format as required for Final Report. Submission of this report shall be a pre-requisite to the Owner’s approval of the Contractor’s application for Payment. Provide statement indicating original estimated total diversion rate, diversion to date, and expected final diversion rate. Include narrative regarding discrepancies or activity since the previous report.

C. Waste Management Final Report: Within five (5) calendar days of Substantial Completion, submit a written Construction Waste Management Final Report summarizing the types and quantities of materials recycled, salvaged and disposed of under the Construction Waste Management Plan. This report shall be in the same format as the monthly reports. Include the name and location of disposal facilities. Quantities must be reported by weight and consistent in units reported and calculation method throughout. Include the following:

1. Material category
2. Generation point
3. Total quantity of waste by category
4. Total quantity of waste reused
5. Total quantity of waste salvaged, both estimated and actual
6. Total quantity of waste recycled, both estimated and actual
7. Total quantity of waste diverted (salvaged and recycled)
8. Total quantity of waste diverted (salvaged and recycled) as a percentage of total waste

D. Other Submittals:

1. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations.
2. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations.
3. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
4. Landfill Disposal Records: Indicate receipt and acceptance of waste by landfills facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
5. Wood Derived Fuel Processing Facility Records: Indicate receipt and acceptance of materials by (WDF) processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
6. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 ON-SITE OPERATIONS

A. Manager: The Contractor shall designate an on-site person responsible for instructing workers and overseeing and documenting results of the Waste Management Plan for the Project.

B. Distribution: The Contractor shall distribute copies of the Waste Management Plan to the Job Site Foreman, each Subcontractor, and the Owner’s Representative.

C. Instruction: The Contractor shall provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the Project.

D. Separation Facilities: The Contractor shall lay out and label a specific area to facilitate separation of materials for recycling, salvage, and return. Recycling and waste bin areas are to be kept neat and clean and clearly marked in order to avoid contamination of materials. Location shall be acceptable to the Owner’s Representative.

1. Commingling Waste: Commingling waste at the job site may be allowed, provided that the following conditions are met:

   a. Comminglers shall be included in the Construction Waste Management Plan (CWMP)
   b. Additional comminglers must be pre-approved by the Architect via CWMP addenda, prior to tipping on the job site.

E. Hazardous Wastes: Any unforeseen hazardous wastes shall be separated, stored, and disposed of according to local regulations and as directed by the Owner.
## Construction Waste Management Plan Example

### Construction Waste Management Report

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<tr>
<th>Material</th>
<th>Recycled</th>
<th>Diversion Method / Location</th>
<th>Notes (Material)</th>
<th>Source</th>
<th>Units / Cubic Feet</th>
<th>Square Feet</th>
<th>Linear Feet</th>
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| ACTUAL Total Waste Diverted | 0.00 lbs |

### Landfill Materials Description - ACTUAL

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| ACTUAL Total Waste to Landfill | 0.00 lbs |

### Percentage of Waste Diverted From Landfill - ACTUAL

0.00%

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Worksheet available for download here: [http://www.cf.missouri.edu/cf/pdc/contractor_information](http://www.cf.missouri.edu/cf/pdc/contractor_information)
PART 1 GENERAL

1.01 DESCRIPTION
   A. Burns and McDonnell (BMcD) will act as the Commissioning Authority, hired to verify that the systems work as intended. The Commissioning Authority will inform the Owner of the results of the commissioning and provide suggestions, as necessary, to correct deficiencies in observed performance or installation.
   B. Commissioning is the process to verify to the Owner that systems, equipment, mechanical, electrical, controls and special systems function together properly to meet performance requirements and design intent, and as described in the Contract Documents. The Sub contractor shall be responsible for participation in the commissioning process as outlined below and in references and attachments throughout the Contract Documents. The Sub contractor shall furnish labor and materials sufficient to meet all requirements of building commissioning under this contract.
   C. Various sections in the Division 22, 23 and 26 Specifications outline the specific commissioning responsibilities of each Sub contractor for the division and also obligate the Construction manager (CM) to coordinate and manage the commissioning responsibility of those subcontractors.

1.02 REQUIREMENTS INCLUDED
   A. Duties of Construction Manager and Sub Contractor
   B. Duties of Commissioning Authority
   C. Acceptance Procedures
   D. Performance Period
   E. Training and Instruction

1.03 RELATED SECTIONS
   A. Section 220800 – Commissioning of Plumbing Systems
   B. Section 230800 – Commissioning of Mechanical Systems
   C. Section 260800 – Commissioning of Electrical Systems

1.04 TERMS
   A. Acceptable Performance: A component or system being able to meet specified design parameters under actual load including satisfactory documented completion of all functional performance tests, control system trending and resolution of outstanding issues.
   B. Basis of Design: The Basis of Design is the documentation provided by the design engineer documenting design decisions that were made to meet the design intent as defined by Owner. The Basis of Design describes the systems, components, conditions and methods to meet the design intent.
   C. Commissioning Plan: The Commissioning Plan is prepared by the Owner’s Commissioning Authority and defines the scope and format of the commissioning process and the responsibilities of all involved parties. The Commissioning Plan is provided to all commissioning team members to inform them of the intent and scope of
the commissioning work to ensure inclusion in the project scope and to expedite the commissioning process.

D. Functional Performance Testing: That full range of checks and tests carried out to determine if all components, sub-systems, systems and interfaces between systems function in accordance with the Contract Documents. In this context, “function” includes all modes and sequences of control operation, all interlocks and conditional control responses and all specified responses to abnormal emergency conditions. The functional performance tests will be prepared by the Commissioning Authority.

E. Commissioning: The process to assure the Owner that building equipment, controls and systems function together properly to meet design intent and performance requirements shown in a composite manner in the Contract Documents.

F. Resolution Log: The purpose of this log is to provide a method for tracking and resolution of deficiencies discovered as a result of the commissioning process. This list also includes the current disposition of issues and the date of final resolution as confirmed by the Commissioning Authority. Deficiencies are defined as those issues where products, execution or performance do not satisfy the Specifications and/or the design intent. The Resolution Log will be created and managed by the Commissioning Authority.

G. Pre-functional Construction Checklists: Checklist is prepared by the Commissioning Authority. Checklist shall be by system or equipment to verify installation and start-up of equipment is complete and ready for functional testing. These documents require signature by the Sub contractor prior to continuing with the commissioning process.

1.05 DUTIES OF CONSTRUCTION MANAGER AND SUB CONTRACTORS

A. Provide copies of all shop drawings, manufacturer’s literature, maintenance information or other information as may be needed for systems to be commissioned to the Commissioning Authority.

B. Collect the information requested by Commissioning Authority for development of a complete Commissioning Plan, (BMcD)’s on-line and cloud based Commissioning application, and functional tests and provide to the Commissioning Authority. The Sub contractor shall review these documents and confirm in writing to the Owner, and Commissioning Authority any known areas of conflict or areas requiring clarifications.

C. Collect all proposed start-up and Pre-functional Construction Checklists documentation

D. To use (BMcD)’s on-line and cloud based Commissioning application to fill out Construction Checklist and to track issues resolutions. Attendance at one BMcD training class is required for all sub-contractors. This training will take place at the construction Cx kick off. The application will need to be loaded on to sub-sub contractors’ tablet/computer and taken into the field. Checklist must be completed in the field (computer or tablet will need to be supplied by each sub-sub-contractor)

E. Plan for and incorporate commissioning activities into the construction schedule.

F. Provide Commissioning Authority with submittals for all systems to be commissioned including controls system and wiring diagrams and narrative sequences of operation, in time for use in preparing the Functional Test Procedures.

G. Provide a fully operational system per Specifications, started, verified, debugged, calibrated, balanced, tested and under automatic control.

H. Provide at the end of the job the following items for inclusion in the systems manual.

1. As built, Control drawings, sequences of control/operation
2. A table of all set points
3. Schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown. This needs to be listed in a word or excel formatted document.
4. A list of all manufacture recommended preventive maintenance procedures for all equipment and systems (including but not limited to Architectural, Mechanical Electrical, Security and Fire protection). This needs to be listed in a word formatted document.

I. Provide qualified personnel to participate in the commissioning tests, including seasonal testing.
J. Cooperate with the Commissioning Authority’s personnel.
K. Provide access to site for the Commissioning Authority for review, verification and testing activities.
L. Provide organized storage space for project drawings, Specifications, equipment and materials submittals, shop drawings and operation and maintenance manuals in the job site trailers or job site office space.
M. Provide updates to all project documentation to reflect all supplemental instructions, addenda or other revisions to the project construction documents. Updates and supplemental instructions must be posted to the master set of documentation for review and reference by all Contractors and for the Commissioning Authority’s use.
N. Provide adequate time and resources to perform functional testing of system to be commissioned in contract.
O. Coordinate participation of the mechanical, electrical, controls and TAB subcontractors in the commissioning process.
P. Participate in any efforts to finalize sequences of operations with Owner, Designers and Commissioning Authority.
Q. Verify that coordination, installation, quality control and final testing have been completed such that installed systems and equipment comply with construction documents.
R. Review the Commissioning Plan, Project Reports and test results and submit comments to the Commissioning Authority.
S. In a timely manner, address issues identified during construction that may affect the commissioning process or final system performance.
T. Perform start-up and testing of mechanical and electrical equipment and systems and document as required with start-up reports and completion of Pre-functional Construction Checklists. These checklists include installation documentation, start-up documentation, controls point-to-point documentation and calibration documentation, verification that controls sequence of operations meets design intent and TAB final documentation. Reports will be stored in the Sub contractor’s field trailer. Sub-contractor will coordinate efforts to complete the pre-functional documentation.
U. Lead verification testing of fire/smoke dampers and direct the resolution of deficiencies. Each damper and all functions of shall be tracked in a matrix spreadsheet.
V. Provide preliminary TAB report, indicating all actual field values recorded to the Commissioning Authority, prior to initiation of functional testing. Let the Commissioning Authority know when the TAB will be ready for the verification of 25% of the systems. Issue a written Notice of Readiness for each system to Commissioning
Authority upon completion of all systems work, start-up and Pre-functional Construction Checklists requirements by trade sub-contractors.

W. Provide a detailed start up plan for CxA’s review, comment and recommendation.

X. Operate equipment and systems as required for functional performance testing. This includes, but is not limited to, manipulating the appropriate controls systems to execute the Functional Test Procedures.

Y. Participate in the fine-tuning or troubleshooting of system performance, if either of these measures becomes necessary.

Z. Compensate owner for retesting and/or troubleshooting time required by the Commissioning Authority because Sub contractor’s systems do not meet specified performance. Back-charge Sub contractors as necessary to collect reimbursement for Commissioning Authority compensation.

AA. Review operating and maintenance data for verification, organization, distribution and conformance to requirement of the Contract Documents.

BB. Submit complete operation and maintenance information and as-built drawings to the Commissioning Authority for compliance review of the requirement of the Contract Documents.

CC. Provide documentation of training for the systems listed to be commissioned.

DD. Provide proprietary test equipment required to test all the systems and equipment in this project.

1.06 DUTIES OF COMMISSIONING AUTHORITY

A. Develop the Commissioning Plan.

B. Develop Functional Test Procedures from Contract Documents and final equipment submittals including narrative sequences of operation, control diagrams and software code for execution with the assistance of Contractor staff as required.

C. Review the Sub contractor’s submittals relative to the systems to be commissioned.

D. Perform site observations to follow installation progress and to verify system installation quality and readiness for testing.

E. Observe or review documentation of validation activities including: Proper test and balance activities, rotating equipment drive alignment, vibration testing, acoustical testing, electrical testing and functional tests for normal and off-normal operating sequences.

F. Review submittal of all required pre-functional and start-up documentation provided by Sub contractor for completeness and reasonableness. This includes installation documentation, start-up documentation, point-to-point checklists and preliminary TAB report, prior to initiation of functional testing.

G. Witness a random selection of TAB readings performed by the TAB sub-contractor.

H. Schedule, direct and witness complete functional testing as defined in the Commissioning Plan and Functional Test Procedures. All testing shall be performed by the Sub contractors and documented by the Commissioning Authority.

I. Witness and verify satisfactory completion of equipment and system tests and inter-systems functional performance tests.

J. Conduct commissioning meetings.

K. Provide site observation, functional tests or other project reports in a timely manner.
L. Document inconsistencies or deficiencies in system operations and system compliance. System deficiencies shall be forwarded to the Owner’s Representative and documented in a Resolution Log.

M. Coordinate via the Construction manager participation of Owner’s personnel with equipment, component and systems performance verification and participation in required training.

N. When commissioning has been successfully completed, recommend acceptance to the Owner.

O. Once all functional tests have been successfully completed and all outstanding issues resolved, the Commissioning Authority will provide the Owner with a Final Commissioning Report of all commissioning activities that occurred during the project.

P. Provide technically qualified personnel when scheduled.

Q. Verify that the specified training schedule of Owner’s personnel is provided.

R. Provide the Owner with a systems manual that contains the information required for re-commissioning the building.

S. Near the end of the warrant period, the Commissioning Authority will review building operation with the operation and maintenance staff and provide a plan for correction of any outstanding issues.

T. The Commissioning Authority will formally communicate with the Sub contractor via approved project channels. It is expected, however, that informal communication and coordination will be conducted directly with the subcontractors; records of all contacts will be sent to the Architect through the normal channels.

U. The Commissioning Authority is not authorized to release, revoke, alter or expand requirements of Contract Documents, to approve or accept any portion of the work or to perform any duties of the Sub contractor.

1.07 COMMISSIONING PLAN

A. The Commissioning Plan is a tool through which the commissioning process is described and incorporates the Owner, Architect, Sub contractor and Commissioning Authority roles relative to the commissioning process. Commissioning team members are all sub contractors, contractors and design professionals whose participation is of benefit in the delivery of a fully functioning building to the Owner. The plan shall describe the communication, authority and responsibility of commissioning team members. The Commissioning Plan will include the following:
   1. The purpose of commissioning
   2. Detail the commissioning process
   3. Commissioning team members’ responsibilities
   4. Describe Pre-functional Construction Checklist Procedures
   5. Provide a guideline for acceptance of each piece of equipment or system
   6. Systems to be commissioned

1.08 SYSTEMS TO BE COMMISSIONED

A. Systems and Equipment to Be Functionally Tested: The above system features are to be functionally tested and other building features will be evaluated for installation quality during construction. The functional performance testing will include the following systems and equipment: (note: If there is 1 failure encountered during TAB or functional testing, the Sampling Rate shall increase by 10%.)
<table>
<thead>
<tr>
<th>System</th>
<th>Description</th>
<th>Total Quantity</th>
<th>Quantity Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Handling Units</td>
<td>AHU-3</td>
<td>1</td>
<td>1.00</td>
</tr>
<tr>
<td>Exhaust Fans</td>
<td>EF-2</td>
<td>1</td>
<td>1.00</td>
</tr>
<tr>
<td>Variable Air Volume Units</td>
<td>Supply VAV</td>
<td>7</td>
<td>7.00</td>
</tr>
<tr>
<td>Variable Air Volume Units</td>
<td>Tracking return box</td>
<td>7</td>
<td>7.00</td>
</tr>
<tr>
<td>Domestic Water Heating Systems</td>
<td>Only CX equipment tied into existing system</td>
<td>1</td>
<td>1.00</td>
</tr>
<tr>
<td>Hot Water Pumping System</td>
<td>Only CX equipment tied into existing system</td>
<td>1</td>
<td>1.00</td>
</tr>
<tr>
<td>Lighting and Lighting Control System</td>
<td>E-power and Lighting controls</td>
<td>1</td>
<td>1.00</td>
</tr>
</tbody>
</table>

1.09 **COMMISSIONING ACTIVITIES**

A. The Commissioning Schedule: This schedule defines the milestones and conditions that must be achieved before system testing and other commissioning activities can commence. The schedule also includes the expected duration of the various tasks so that the commissioning process can be incorporated into the overall construction schedule.

B. Preparation for Testing: To prepare for the system performance testing, the Commissioning Authority will examine the design and Construction Documents, develop with appropriate Sub contractors Pre-functional Construction Checklists of construction responsibilities that must be completed prior to testing and develop detailed Functional Test Procedures and data forms.

C. Using the Pre-functional Construction Checklists, the Sub contractor must verify that the systems they install are in compliance with the Construction Documents and are fully functional. Commissioning is not intended to be a testing or inspection function that replaces any of the Sub contractors’ obligations for testing and proof of performance. Functional testing will only begin when checklists are completed by the appropriate subcontractors, submitted on line and verified by the Commissioning Authority.

D. Functional Testing: Functional testing is performed by experienced and qualified technicians of the Sub contractor(s), responsible for installation as facilitated by the Commissioning Authority and may be observed by other members of the commissioning team. Functional testing will verify proper sequencing, operation and performance of installed equipment and systems under realistic operating conditions. The functional testing will follow with written Functional Test Procedures with test results documented for permanent record.
E. Documentation: In addition to the Pre-functional Construction Checklists and Functional Test Procedures, written documentation will be maintained for all other commissioning activities. Project communication reports shall be issued by the Commissioning Authority to the Sub contractor and key members of the commissioning team to document apparent deficiencies identified during examination of design and construction documents, daily activities on-site, construction deficiencies and successful or unsuccessful functional test results. At the end of the commissioning process, all documentation will be assembled and summarized in the Final Commissioning Report.

F. Deficiency Resolution: When a Project Report is issued to address an identified deficiency, the Sub contractor shall forward the reports to the appropriate parties to initiate corrective action in an expeditious manner. The designer is relied on for supplemental instructions or design modifications and issuance of final design details and the Sub contractors are relied on for implementation of that design. Change orders must be issued through proper contract channels.

1.10 FUNCTIONAL TEST PROCEDURES

A. The Functional Test Procedures include, but are not limited to, the following:
   1. Verification of testing, adjusting and balancing performance.
   2. Verification of all equipment’s ability to perform to the design intent.
   3. Verification of the performance of sub-systems consisting of combinations of equipment (e.g., refrigeration cycle, pumps and interconnecting piping).
   4. Verification of the performance of the automatic controls in all seasonal modes.
   5. Verification of the performance of the HVAC system as a whole.
   6. Verification of the performance of all life safety devices and systems that interface with the HVAC systems.

PART 2 PRODUCTS

2.01 Not used in this section.

PART 3 EXECUTION

3.01 GENERAL

A. Operating equipment and systems shall be tested in presence of Owner’s Commissioning Authority to demonstrate compliance with specified requirements.
   1. Notify Owner, in writing, fourteen (14) days prior to tests scheduled under requirements of this Section.
   2. Testing shall be conducted under specified design operating conditions as recommended or approved by Owner.

B. Functional performance testing shall be completed and accepted by Owner as a condition of final completion.

C. All elements of systems shall be tested to demonstrate that total systems satisfy all requirements of these Specifications. Testing shall be accomplished on hierarchical basis. Test each piece of equipment for proper operation, followed by each sub-system, followed by entire system, followed by entireties to other major systems.
D. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment through the installing sub contractor. Manufacturer shall provide the test equipment, demonstrate its use, and assist the Commissioning Authority in the commissioning process.

E. Acceptance Documentation: A copy of the functional performance tests results shall be necessary acceptance documentation along with other specified requirements.

3.02 ACCEPTANCE PROCEDURES

A. Prior to functional performance testing of each system, the Commissioning Authority shall observe and verify that the physical installation of components and systems being tested is substantially installed in accordance with the Contract Documents.

B. Sub contractor’s Tests

1. System shall be checked for proper installation, shall be adjusted and calibrated to verify that it is ready to function as specified.
2. All system elements shall be checked to verify that they have been installed properly and that all connections have been made correctly.
3. All discrete elements and sub-systems shall be adjusted and checked for proper operation.
4. Start-up and operational tests shall be complete, with all required Pre-functional Construction Checklists submitted for review by Commissioning Authority within five (5) days of each activity, prior to starting functional performance testing.

C. CxA-witnessed Functional Tests

1. Objective of these tests is to demonstrate that system is operating and complying with specified performance requirements.
2. Owner-witnessed functional performance tests shall be performed on complete system. Each function shall be demonstrated to satisfaction of the Owner’s Commissioning Authority on paragraph-by-paragraph basis of Commissioning Authority’s written test procedure, developed to demonstrate conformance to requirements of the Specifications.
3. Functional performance tests shall be witnessed and endorsed by the Commissioning Authority upon satisfactory completion.
4. Actual testing program shall be conducted in accordance with prior approved procedures and shall be documented as required herein.
5. Sub contractor shall notify Commissioning Authority and Owner at least two (2) weeks prior to date of functional performance tests.

D. The functional performance testing process shall be accomplished for all equipment, sub-systems, systems and system interfaces. All must be tested for acceptances and there shall be a separate checklist for each to ensure documentation specific to each is complete.

E. Each system shall be operated through all modes of system operation (e.g., seasonal, occupied, unoccupied, warm-up, cool-down, etc., as applicable) including every individual interlock and conditional control logic, all control sequences, both full-load and part-load conditions and simulation of all abnormal conditions for which there is a specified system or controls response. The warm-up and cool-down test shall be a performance test.
F. Temporary upsets of systems, such as distribution fault, control loss, setpoint change, equilibrium upset and component failure, shall be imposed at different operation loads to determine system stability and recovery time.

G. When the functional performance of all individual systems has been proven, the interface or coordinated responses between systems shall be checked. The systems involved may be within the overall HVAC work or they may involve other systems, such as emergency systems for life safety.

H. Corrective Measures: If acceptable performance cannot be achieved, the cause of the deficiency will be identified. If it is determined that the deficiency was caused by the system or component not being installed per the manufacturer’s recommendations or Contract Documents, the necessary corrective measures shall be carried out by the Sub contractor. Every check or test for which acceptable performance was not achieved shall be repeated after the necessary corrective measures have been completed. This re-testing process should be repeated until acceptable performance is achieved. The Sub contractor will be allowed one retest after initial testing of the equipment. If the retest fails the Sub contractor shall be financially responsible, at standard rates, to reimburse the Commissioning Authority for the additional time taken to achieve acceptable performance.

3.03 TRAINING AND INSTRUCTION
A. Training and instruction of Owner personnel is a part of the commissioning process and essential for the proper operation of the facility. The sub contractors and vendors providing the training will complete training plans and submit to the Commissioning Authority for review and approval in conjunction with the Owner’s representative.

3.04 SEASONAL COMMISSIONING AND OCCUPANCY VARIATIONS
A. Seasonal commissioning pertains to testing under full-load conditions during peak heating and peak cooling seasons, as well as part-load conditions in the spring and fall. Initial commissioning will be done as soon as contract work is completed, regardless of season. Subsequent commissioning may be undertaken at any time thereafter to ascertain adequate performance during the different seasons.

B. All equipment and systems will be tested and commissioned in a peak season to observe full-load performance. Heating equipment will be tested during winter design extremes. Cooling equipment will be tested during summer design extremes, with a fully occupied building. Each Sub contractor and supplier will be responsible to participate in the initial and the alternate peak season test of the systems required to demonstrate performance.

C. Subsequent commissioning may be required under conditions of minimum and/or maximum occupancy or use. All equipment and systems affected by occupancy variations will be tested and commissioned at the minimum and peak loads to observe system performance. Each Contractor and supplier will be responsible to participate in the occupancy sensitive testing of systems to provide verification of adequate performance.

3.05 RETESTING OR ADDITIONAL TESTING DUE TO FAILURES
A. The cost, including the CxA’s time, to retest a PC or FPT shall be the Construction Manager’s (CM).

B. The time for the CxA to direct any retesting required because a specific PC or start-up test item, reported to have been successfully completed, but determined during functional
testing to be faulty, will be back charged to the Construction Manager, who may choose
to recover costs from the party responsible for executing the faulty pre-functional test.

C. If a second, subsequent startup, retest, or increased sampling is required, for any reason,
or if Installing Sub contractor is not ready for a startup or test at the scheduled time, the
CM shall compensate the Owner for the CxA’s additional time and expenses.
Compensation shall be computed by multiplying hours worked by CxA times CxA’s
established billing rate and adding the cost of CxA’s expenses (including by way of
example but not limitation: air travel, car rental, lodging, long distance, reproduction,
special insurance, procured equipment, leased equipment, delivery service, and postage).
CM may unilaterally withhold said funds from payments otherwise due to Installing Sub
contractor.

1. The Sub contractor shall respond in writing to the CxA and CM at least as often
as commissioning meetings are being scheduled concerning the status of each
apparent outstanding discrepancy identified during commissioning. Discussion
shall cover explanations of any disagreements and proposals for their resolution.

2. The CxA retains the original non-conformance forms until the end of the project.

3. Any required retesting or increased test sampling by any sub contractor shall not
be considered a justified reason for a claim of delay or for a time extension by the
prime sub contractor.

D. Failure Due to Manufacturer Defect: If 10%, or three, whichever is greater, of identical
pieces (size alone does not constitute a difference) of equipment fail to perform to the
Contract Documents (mechanically or substantively) due to manufacturing defect, not
allowing it to meet its submitted performance spec, all identical units may be considered
unacceptable by the CM. In such case, the Sub contractor shall provide the Owner with
the following:

1. Within one week of notification from the CM, the Sub contractor or
manufacturer’s representative shall examine all other identical units making a
record of the findings. The findings shall be provided to the CM within two
weeks of the original notice.

2. Within two weeks of the original notification, the Sub contractor or manufacturer
shall provide a signed and dated, written explanation of the problem, cause of
failures, etc. and all proposed solutions which shall include full equipment
submittals. The proposed solutions shall not significantly exceed the
specification requirements of the original installation.

3. The CM will determine whether a replacement of all identical units or a repair is
acceptable.

4. Two examples of the proposed solution will be installed by the Sub contractor
and the CM will be allowed to test the installations for up to one week, upon
which the CM will decide whether to accept the solution.

5. Upon acceptance, the Sub contractor and/or manufacturer shall replace or repair
all identical items, at their expense and extend the warranty accordingly, if the
original equipment warranty had begun. The replacement/repair work shall
proceed with reasonable speed beginning within one week from when parts can
be obtained.
3.06 SCHEDULE

A. Refer to Commissioning Plan for commissioning milestones that need to be incorporated into construction schedule.

END OF SECTION 019113
SECTION 02 41 19 - SELECTIVE DEMOLITION

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Demolition and removal of selected portions of building or structure.
      2. Demolition and removal of selected site elements.
      3. Salvage of existing items to be reused or recycled.
   
   B. Related Requirements:
      1. Section 01 10 00 "Summary" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.
      2. Section 01 73 00 "Execution" for cutting and patching procedures.
      3. Section 31 10 00 "Site Clearing" for site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS
   A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
   
   B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.
   
   C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
   
   D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP
   A. Unless otherwise indicated, demolition waste becomes property of Contractor.
B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

A. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control, and for noise control. Indicate proposed locations and construction of barriers.

B. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner’s on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner’s continuing occupancy of portions of existing building and of Owner’s partial occupancy of completed Work.

C. Predemolition Photographs or Video: Submit before Work begins.

1.7 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner’s operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

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

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

1.8 WARRANTY

A. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.

C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

E. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.
   a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
   f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.

3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

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. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. 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 fire watch and 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 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.

B. Removed and Salvaged Items:

1. Store items in a secure area until delivery to Owner.

2. Transport items to Owner's storage area designated by Owner.

3. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

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

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them.

B. Burning: Do not burn demolished materials.

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

3.7 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.
SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Steel framing and supports for countertops.
2. Steel tube reinforcement for low partitions.
3. Steel framing and supports for mechanical and electrical equipment.
4. Steel framing and supports for applications where framing and supports are not specified in other Sections.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Paint products.
2. Grout.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

C. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

C. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
D. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.

E. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

F. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

G. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

H. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

I. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.

D. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

E. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

   1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.


2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 09 91 23 “Interior Painting.” Shop primers shall not be alkyd-based for High-Performance Coatings, Typical. Shop primers for “Exterior Painting” and “Interior Painting” on Ferrous Metal may be alkyd-based.

B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
   1. Fabricate units from slotted channel framing where indicated.
   2. Furnish inserts for units installed after concrete is placed.
C. Fabricate supports for operable partitions from continuous steel beams of sizes indicated with attached bearing plates, anchors, and braces as recommended by partition manufacturer. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

D. Galvanize miscellaneous framing and supports where indicated.

E. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.7 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.8 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.9 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

4. Other Items: SSPC-SP 3, "Power Tool Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2.10 ALUMINUM FINISHES

A. As-Fabricated Finish: AA-M12.


PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
   1. Cast Aluminum: Heavy coat of bituminous paint.
   2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for operable partitions securely to, and rigidly brace from, building structure.
3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 05 50 00
SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Wood blocking at windows
2. Wood blocking, cants, and nailers.
3. Plywood backing panels.

B. Related Requirements:

1. Section 06 16 00 "Sheathing."

1.3 DEFINITIONS

A. Exposed Framing: Framing not concealed by other construction.

B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.

C. Lumber grading agencies, and the abbreviations used to reference them, include the following:

2. NLGA: National Lumber Grades Authority.
3. RIS: Redwood Inspection Service.
5. WCLIB: West Coast Lumber Inspection Bureau.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.

4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. Fastener Patterns: Full-size templates for fasteners in exposed framing.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

B. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated wood.
2. Fire-retardant-treated wood.
3. Engineered wood products.
4. Shear panels.
5. Power-driven fasteners.
7. Expansion anchors.
8. Metal framing anchors.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.
PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
4. Provide dressed lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
3. Design Value Adjustment Factors: Treated lumber shall be tested according ASTM D 5664 and design value adjustment factors shall be calculated according to ASTM D 6841.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.
E. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat items indicated on Drawings, and the following:

1. Framing for raised platforms.
2. Framing for stages.
3. Concealed blocking.
4. Framing for non-load-bearing partitions.
5. Framing for non-load-bearing exterior walls.
6. Roof construction.
7. Plywood backing panels.

2.3 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Nailers at windows
2. Rooftop equipment bases and support curbs.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.

C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

D. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.4 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F 1667.

D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).

F. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.


2.6 METAL FRAMING ANCHORS

A. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.


1. Use for interior locations unless otherwise indicated.

C. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch (0.9 mm) thick.

1. Use for wood-preservative-treated lumber and where indicated.

D. Stainless-Steel Sheet: ASTM A 666, Type 304.

1. Use for exterior locations and where indicated.

2.7 MISCELLANEOUS MATERIALS

A. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to suit width of sill members indicated.

B. Adhesives for Gluing to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Framing Standard: Comply with AF&PA’s WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

C. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer’s written instructions.

D. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels.

E. Shear Wall Panels: Install shear wall panels to comply with manufacturer’s written instructions.

F. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer’s written instructions. Install fasteners through each fastener hole.

G. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.

H. Do not splice structural members between supports unless otherwise indicated.

I. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.

J. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.

2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal- (38-mm actual-) thickness.
3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.

4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.

K. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

L. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

M. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.

N. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully 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. Drive nails snug but do not countersink nail heads unless otherwise indicated.

O. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.

1. Comply with indicated fastener patterns where applicable.
2. Use finishing nails unless otherwise indicated. Countersink nail heads and fill holes with wood filler.
3. Use common nails unless otherwise indicated. Drive nails snug but do not countersink nail heads.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
C. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

END OF SECTION 06 10 00
SECTION 06 16 00 - SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Roof sheathing.
4. Underlayment.
5. Sheathing joint and penetration treatment.

B. Related Requirements:

1. Section 07 25 00 "Weather Barriers" for water-resistant barrier applied over wall sheathing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
2. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
4. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For following products, from ICC-ES:
   1. Preservative-treated plywood.
   2. Fire-retardant-treated plywood.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.


2.2 SUBFLOORING AND UNDERLAYMENT

A. Cement board floor panels

   1. Products: Subject to compliance with requirements, provide one the following:
      a. USG Structural Panel Concrete Subfloor
      b. Pycem CemDeck Cement Board Floor Panels

   2. 1. Span Rating: Not less than 12 o.c.
B. Underlayment, General: Provide underlayment in nominal thicknesses indicated or, if not indicated, not less than 1/4 inch (6.4 mm) over smooth subfloors and not less than 3/8 inch (9.5 mm) over board or uneven subfloors.

2.3 WALL SHEATHING

A. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. G-P Gypsum Corporation; Dens-Glass Gold.
   b. National Gypsum Company; Gold Bond e(2)XP.
   c. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

2. Type and Thickness: Type X, 5/8 inch thick.

2.4 ROOF SHEATHING

A. Oriented-Strand-Board Roof Sheathing: Exposure 1 sheathing.

1. Span Rating: Not less than 24/0.
2. Nominal Thickness: Not less than 1/2 inch.

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.


D. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C 1002.
2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C 954.
2.6 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

   1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

   1. NES NER-272 for power-driven fasteners.
   2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
   3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.
3.2 WOOD STRUCTURAL PANEL INSTALLATION


B. Fastening Methods: Fasten panels as indicated below:

1. Wall and Roof Sheathing:
   a. Screw to cold-formed metal framing.
   b. Space panels 1/8 inch apart at edges and ends.

3.3 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer’s written instructions.

1. Fasten gypsum sheathing to wood framing with screws.
2. Fasten gypsum sheathing to cold-formed metal framing with screws.
4. Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.

1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.

D. Seal sheathing joints according to sheathing manufacturer’s written instructions.

1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel silicone emulsion sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

END OF SECTION 06 16 00
1. PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Interior standing and running trim.
2. Interior frames and jambs.
4. Closet and utility shelving.
5. Shop finishing of interior woodwork.
7. Closet Coat Rods and Shelf System.
9. Steel bracket supports.
10. Pedestal Leg/Base.

B. Related Sections include the following:

1. Division 00 Section 00 73 00 “Supplementary Conditions”, if included, for requirements relating to interpretation of the drawings and specifications.
2. Division 01 Section 01 21 00 “Allowances”, if included, for use of allowances and what may and may not be included in them.
3. Division 06 Section “Rough Carpentry” for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.
4. Division 06 Section “Finish Carpentry” for interior carpentry exposed to view that is not specified in this Section.
5. Division 09 Section "Painting" for field finishing of installed interior architectural woodwork.

1.3 DEFINITIONS

A. Interior architectural woodwork includes wood furring, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, including cabinet hardware and accessories and finishing materials and processes.
B. Product Data: For high-pressure decorative laminate, adhesive for bonding plastic laminate, solid-surfacing material, fire-retardant-treated materials, cabinet hardware and accessories, handrail brackets and finishing materials and processes.

1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

1. Show details full size.
2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
3. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers and other items installed in architectural woodwork.
4. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
5. Apply AWI-certified compliance label to first page of Shop Drawings.

D. Samples for Initial Selection:

1. Shop-applied transparent finishes.
2. Standing and running trim.
4. PVC edge material if applicable.
5. Solid-surfacing materials.

E. Samples for Verification:

1. Particleboard.
2. Plastic laminates, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish, with 1 sample applied to core material and specified edge material applied to 1 edge.
3. Solid-surfacing materials, 6 inches (150 mm) square.
4. Quartz-surfacing materials, 6 inches (150 mm) square.

F. Product Certificates: For each type of product, signed by product manufacturer.

G. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates

H. Qualification Data: For Installer and fabricator.
1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project, whose products have a record of successful in-service performance, and have sufficient capacity to produce required units without causing delay in the Work. Shop is a certified participant in AWI's Quality Certification Program.

B. Installer Qualifications: Fabricator of products who can demonstrate successful experience in installing architectural woodwork items similar in type and quality to those required for this project.

C. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork with sequence-matched wood veneers and transparent-finished wood doors that are required to be of same species as woodwork.

D. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

   1. Provide AWI Quality Certification Program labels and certificates indicating that woodwork, including installation, complies with requirements of grades specified.
   2. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with such selections and requirements in addition to the quality standard.

E. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

F. Forest Certification: Provide interior architectural woodwork produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

G. Mock-ups: Build mock-ups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

   1. Approved mock-ups may become part of the completed Work if undisturbed at time of Substantial Completion.

H. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination".
1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect woodwork during delivery, storage, and handling to prevent damage, soilage, and deterioration.

B. Do not deliver woodwork until painting, wet work, grinding, and similar operations that could damage, soil, or deteriorate woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in “Project Conditions” Article.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 25 and 55 percent during the remainder of the construction period.

B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.

2. Established Dimensions: Where field measurement cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.8 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Division 08 Section “Door Hardware (Scheduled by Describing Products)” to fabricator of architectural woodwork; coordinate Shop Drawings and fabrication with hardware requirements.

2. PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that comply with requirements of AWI’s quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
B. Wood Species and Cut for Transparent Finish: White Oak, Espresso 42-95 (Note: See Section 08 14 16 Flush Wood Doors)

C. Wood Products: Comply with the following:

4. Particleboard: Straw-based particleboard complying with requirements in ANSI A208.1, Grade M-2, except for density.

D. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.

1. High-Pressure Decorative Laminate: Subject to compliance with requirements, manufacturers offering high-pressure decorative laminates that may be incorporated into the Work include, but are not limited to, the following:
   a. See finishes Legend for all Plastic Laminate selections
2. Or equal product from other approved manufacturers, if and as specifically approved by Architect by Addendum during the bidding period:
   a. Abet Laminati, Inc.
   b. Arborite; Division of ITW Canada, Inc.
   c. Formica Corporation.
   d. Lamin-Art, Inc.
   e. Nevamar Company, LLC; Decorative Products Div.
   f. Panolam Industries International Incorporated.
   g. Westinghouse Electric Corp.; Specialty Products Div.
   h. Wilsonart International; Div. of Premark International, Inc.

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this Article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified.

1. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment type:

2. Interior Type: Low-hygroscopic formulation.
3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking plant certified by testing and inspecting agency.
4. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
5. Kiln-dry materials before and after treatment to levels required for untreated materials.

C. Fire-Retardant Particleboard: Panels complying with the following requirements, made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E 84.

1. For panels 3/4 inch (19 mm) thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi (11 MPa); modulus of elasticity, 300,000 psi (2070 MPa); internal bond, 80 psi (550 kPa); and screw-holding capacity on face and edge, 250 and 225 lbf (1100 and 1000 N), respectively.
2. For panels 13/16 to 1-1/4 inches (20 - 32 mm) thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi (9 MPa); modulus of elasticity, 250,000 psi (1720 MPa); linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf (1100 and 780 N), respectively.
3. Product: Subject to compliance with requirements, provide “Duraflake FR” by Weyerhaeuser.

D. Fire-Retardant Fiberboard: Medium-density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.

1. Product: Subject to compliance with requirements, provide “Medite FR” by SierraPine Ltd.; Medite Div.

2.3 CABINET HARDWARE AND ACCESSORIES
A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08 Section “Door Hardware (Scheduled by Describing Products).”

B. Butt Hinges: 2-3/4” (70-mm), 5-knuckle steel hinges made from 0.095-inch (2.4 mm) thick metal, and as follows:

1. Semi-Concealed Hinges for Flush Doors: BHMA A156.9, B01361.
2. Semi-Concealed Hinges for Overlay Doors: BHMA A156.9, B01521.

C. Back-Mounted Pulls: BHMA A156.9, B02011.


1. Product 117.05.600, 146 mm (5.75” overall length) / 96 mm (CTC/screw to screw).

E. Catches: Magnetic catches, BHMA A156.9, B03141

F. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081

G. Shelf Rests: BHMA A156.9, B04013; metal. Metal shelf rests in 5 mm holes, line bored 32 mm o.c.

H. Drawer Slides: BHMA A156.9, B05091.

1. Heavy Duty (Grade 1HD-100 and Grade 1HD0200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
2. Box Drawer Slides: Grade 1 for drawers not more than 6 inches (150 mm) high and 24 inches (600 mm) wide.
3. File Drawer Slides: Grade 1HD-200; for drawers not more than 6 inches (150 mm) high and 24 inches (600 mm) wide.
4. Pencil Drawer Slides: Grade 1; for drawers not more than 3 inches (75 mm) high and 24 inches (600 mm) wide.
5. Grass 6036. Other equivalent products may be accepted if and as specifically approved by Architect by Addendum during bidding period.

I. Aluminum Slides for Sliding Glass Doors: BHMA A156.9, B07063.

J. Door Locks: BHMA A156.11, E07121. (If noted on the drawings).

K. Drawer Locks: BHMA A156.11, E07041. (If noted on the drawings).

L. Grommets for Cable Passage through Countertops: Doug Mockett & Company at (800) 523-1269. Provide a minimum of one grommet per knee space whether indicated on the drawings or not.
1. 3" Overall Diameter Grommets with Flip-Top shall be Doug Mockett & Company, Model—EDP with Flip-Top, Finish—Light Grey (92) for cable passage through countertops at locations as shown on drawings.

2. Other equal products may be provided if and as specifically approved by Architect by Addendum during bidding period.

M. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated. Match finish with door hardware specified for room in which woodwork is installed. Where possible, note that all fasteners shall be concealed.

1. Satin Stainless Steel: BHMA 630/US32D.

N. For concealed hardware, provide manufacturer’s standard finish that complies with product class requirements in BHMA A156.9.

2.4 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.

B. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant treated softwood lumber, kiln dried to less than 15 percent moisture content.

C. Rough Carriages for Stairs: No. 1 grade and the following species, kiln dried to 15 percent maximum moisture content.

1. Douglas fir-larch.
5. Hem-fir (north).
7. Spruce-pine-fir (south).

D. Rough Carriages for Stairs: Laminated veneer lumber, made with an exterior-type adhesive complying with ASTM D2559, and with the following allowable design values as determined according to ASTM D5456.

1. Extreme Fiber Stress in Bending, Edgewise: 2850 psi (19.7 MPa) for 12-inch nominal-(286-mm actual-) depth members.
2. Modulus of Elasticity, Edgewise: 2,000,000 psi (13 800 MPa).

E. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts and anchors, as required, to be set into concrete or masonry work for subsequent woodwork anchorage.
F. Handrail Brackets: Self-aligning wall brackets from stainless steel with wall flange drilled and tapped for concealed hanger bolt and with support arm for screwing to underside of rail. Sized to provide 1-1/2 inch (38 mm) clearance between handrail and wall.


G. Handrail/Bumper Rail Brackets: Pairs of extruded-aluminum channels; one for fastening to back of rail and one for fastening to face of wall. They are then assembled in overlapping fashion and fastened together top and bottom with self-tapping screws. Sized to provide 1-1/2 inch (38 mm) clearance between handrail and wall.

H. Adhesives: Do not use adhesives that contain urea formaldehyde.

I. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Wood Glues: 30 g/L.
2. Contact Adhesive: 250 g/L.

J. Adhesives for Bonding Plastic Laminate:

2. Vertical Surfaces: PVA (Wilsonart 3000 Rigid Set Glue) or approved equal.
3. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

K. Fasteners: Select material, type, size, and finish required for each use. Comply with FS FF-S-111 for screws; FS FF-N-105 for nails.

L. Steel Bracket Supports: Provide primed steel bracket supports at locations as shown on drawings.

1. Brackets shall by Hafele America Co. at (919) 889-2322. Length as required to adequately support countertop.

2.5 FABRICATION, GENERAL

A. Interior Woodwork Grade: Unless otherwise indicated, provide Custom-grade interior woodwork complying with referenced quality standard.
B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

D. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:

1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members 3/4-inch (19 mm) Thick or Less: 1/16 inch (1.5 mm).
2. Edges of Rails and Similar Members More Than 3/4-inch (19 mm) Thick: 1/8-inch (3 mm).
3. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members and Rails: 1/16-inch (1.5 mm).

E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Notify Architect seven days in advance of the dates and times woodwork fabrication will be complete.
2. Trim fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.

F. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

1. Seal edges of openings in countertops with a coat of varnish.

G. Install glass to comply with applicable requirements in Division 08 Section “Glazing” and in GANA’s “Glazing Manual”. For glass in wood frames, secure glass with removable stops.

2.6 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

A. Grade: Custom. Comply with AWI Section 300.

B. Wood Species and Cut: White Maple Quarter Cut
1. Provide split species on trim that faces areas with different wood species, matching each face of woodwork to species and cut of finish wood surfaces in areas finished.

C. Profile: As noted on drawings.

D. For trim items wider than available lumber, use veneered construction. Do not glue for width.

E. For rails wider or thicker than available lumber, use veneered construction. Do not glue for width or thickness.

F. Back-out or groove backs of flat trim members and kerf backs of other wide, flat member, except for members with ends exposed to finished work.

G. Assemble casings in plant except where limitations of access to place of installation require field assembly.

H. Assemble moldings in plant to maximum extent possible. Miter corners in plant and prepare for field assembly with bolted fittings designed to pull connections together.

2.7 INTERIOR FRAMES AND JAMBS FOR TRANSPARENT FINISH

A. Grade: Custom. Comply with AWI Section 300.

B. Wood Species and Cut: White Maple, Quarter Cut.

C. For frames or jambs items wider than available lumber, use veneered construction. Do not glue for width.

D. Fire-Rated Interior Frames and Jambs: Products fabricated from fire-retardant particleboard or fire-retardant medium-density fiberboard with veneered, exposed surfaces and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.

   1. Fire Rating: 20 minutes.

2.8 WOOD CABINETS FOR TRANSPARENT FINISH

A. Quality Standard: Comply with AWI Section 400.

B. Grade: Premium.

C. AWI Type of Cabinet Construction: Flush Overlay

D. Reveal Dimension: 1/2-inch (13 mm)

E. Wood Species and Cut for Exposed Surfaces: White Maple – Quarter Cut.
1. Grain Direction: Vertically for drawer fronts, doors, and fixed panels.
5. Veneer Matching within Room: Provide cabinet veneers in each room or other space from a single flitch with doors, drawer fronts, and other surfaces matched in a sequenced set with continuous match where veneers are interrupted perpendicular to the grain.
6. Comply with veneer and other matching requirements indicated for blueprint-matched paneling.
7. Edge Treatment: Solid wood matching face for species and cut

F. Semi-Exposed Surfaces: Provide surface materials indicated below:

1. Surfaces Other than Drawer Bodies: Same species and cut indicated for exposed surfaces.
2. Drawer Sides and Backs: Solid-hardwood lumber, same species indicated for exposed surfaces match.
3. Drawer Bottoms: Hardwood plywood.
4. Shelf Edge Treatment: Solid wood matching face for species and cut.

G. Provide dust panels of 1/4-inch (6.4 mm) plywood or tempered hardboard above compartment and drawers, unless located directly under tops.

H. Finish: Stain to match prefinished wood doors. See Section 081416 “Flush Wood Doors” and Section 081433 “Stile and Rail Wood Doors”.

2.9 PLASTIC-LAMINATE CABINETS

A. Quality Standard: Comply with AWI Section 400 and its Division 400B “Laminate Clad Cabinets”.

B. Grade: Premium.

C. AWI Type of Cabinet Construction: Flush Overlay

D. Reveal Dimension: 1/2-inch (13 mm).

E. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:

1. Horizontal Surfaces Other Than Tops: **Grade HGS** (0.050-inch / 1.2 mm or greater thickness).
2. Post-formed Surfaces: **Grade HGP** (0.050-inch / 1.2 mm or greater thickness).
3. Vertical Surfaces: **Grade VGS** (0.028-inch / 0.7 mm thickness).
4. Edges: **Grade HGS** (0.050-inch / 1.2 mm or greater thickness). **PVC tape shall not be allowed for edges.**
F. Materials for Semi-Exposed Surfaces:

1. Surfaces Other than Drawer Bodies: High-pressure decorative laminate, Grade VGS.
   
   a. Edges of Plastic-Laminate Shelves: Grade HGS (0.050-inch / 1.2 mm thickness).
   
   b. For semi-exposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, VGS (0.028-inch / 0.7 mm thickness).

2. Drawer Sides and Backs: Solid-hardwood lumber.
3. Drawer Bottoms: Hardwood plywood.

G. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL (0.020-inch / 0.7 mm thickness).

H. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated by laminate manufacturer’s designations.
3. As selected by Architect from laminate manufacturer’s full range in the following categories:
   
   a. Solid colors, Matte or Gloss
   b. Solid colors with core same color as surface, Matte finish.
   c. Patterns, Matte finish.

I. Provide dust panels of 1/4-inch (6.4 mm) plywood or tempered hardboard above compartment and drawers, unless located directly under tops.

J. Thermoset decorative overlay (Melamine) will not be allowed for any exposed or semi-exposed surfaces.

2.10 PLASTIC-LAMINATE COUNTERTOPS

A. Quality Standard: Comply with AWI Section 400 and its Division 400C “Countertops”.

B. Grade: Custom.

C. High-Pressure Decorative Laminate Grade: Grade HGS (0.050-inch / 1.2 mm or greater thickness).
D. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated by laminate manufacturer’s designations.
3. As selected by Architect from laminate manufacturer’s full range in the following categories:
   a. Solid colors, Matte finish.
   b. Solid colors with core same color as surface, Matte finish.
   c. Patterns, Matte finish.

E. Grain Direction: Parallel to cabinet fronts.

F. Edge Treatment: Same as laminate cladding on horizontal surfaces.

G. Core Material: Particleboard or medium-density fiberboard.

H. Core Material at Sinks: Particleboard made with exterior glue.

I. Backer Sheet: Provide plastic-laminate backer sheet, Grade BKL, or underside of countertop substrate.


3. **PART 3 - EXECUTION**

3.1 **PREPARATION**

A. Before installation, condition woodwork to average prevailing humidity conditions in installation.

B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and back-priming.

3.2 **INSTALLATION**

A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.

B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.

C. Install woodwork plumb, level, true, and straight with no distortions. Shim as required with concealed shims. Install to a tolerance of 1/8 inch in 8'-0" (3 mm in 2400 mm) for plumb and level (including tops) and with no variations in flushness of adjoining surfaces.
D. Scribe and cut woodwork to fit adjoining work and refinish cut surfaces or repair damaged finish at cuts.

E. Fire-Retardant Treated Wood: Handle, store, and install fire-retardant treated wood to comply with chemical treatment manufacturer’s written instructions, including those for adhesives used to install woodwork.

F. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

G. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to the greatest extent possible. Do not use pieces less than 36 inches (900 mm) long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members. Stagger joints in adjacent and related members. Cope at returns and miter at corners.

1. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and finish same as wood base if finished.
2. Install wall railings on indicated metal brackets securely fastened to wall framing.
3. Install standing and running trim with nor more variation from a straight line than 1/8-inch in 8'-0" (3 mm in 2400 mm).

H. Paneling: Anchor paneling to supporting substrate with splined connection strips. Do not use face fastening, unless covered by trim.

1. Install flush paneling with no more than 1/16-inch in 8'-0" (1.5 mm in 2400 mm) vertical cup or bow and 1/8-inch in 8’—0” (3 mm in 2400 mm) horizontal variation from a true plane.

I. Stairs: Securely anchor carriages to supporting substrates. Install stairs with treads and risers no more than 1/8-inch (3 mm) from indicated position.

J. Cabinets: Install without distortion so that doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

1. Install cabinets with no more than 1/8-inch in 8’-0” (3 mm in 2400 mm) sag, bow, or other variation from a straight line.
2. Maintain veneer sequence matching of cabinets with transparent finish.
3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches (400 mm) o.c. with No. 10 wafer-head screws sized for 1-inch (25 mm) penetration into wood framing, blocking, or hanging strips.
K. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

1. Align adjacent solid-surfacings material countertops and form seams to comply with manufacturer’s written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
2. Install countertops with no more than 1/8-inch in 8'-0" (3 mm in 2400 mm) sag, bow, or other variation from a straight line.
3. Secure backsplashes to tops with concealed metal brackets at 16 inches (400 mm) o.c..
4. Caulk space between backsplash and wall with sealant specified in Division 07 Section “Joint Sealants”.

L. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

M. Refer to Division 09 Sections for final finishing of installed architectural woodwork.

N. Quality Standard: Install woodwork to comply with AWI Section 1700. Quality Standard: Install woodwork to comply with AWI Section 1700.

O. Miscellaneous Accessories: Install per manufacturer’s instructions using fasteners appropriate to substrate and recommended by manufacturer of unit. Install units plumb and level, firmly anchored, at locations as indicated on drawings.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective woodwork where possible to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes restoring damaged or soiled areas.

3.4 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, which insures that woodwork is without damage or deterioration at time of Substantial Completion.

END OF SECTION 06 40 23
SECTION 07 42 19 - INSULATED METAL WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Foamed-insulation-core metal wall panels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.

2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).

C. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below.

1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, tests performed by a qualified testing agency.

C. Field quality-control reports.
1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 72:

1. Wind Loads: As indicated on Drawings.
2. Deflection Limits: For wind loads, no greater than 1/180 of the span.

C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E 283 at the following test-pressure difference:


D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:


E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
F. Fire-Test-Response Characteristics: Provide metal wall panels and system components with the following fire-test-response characteristics, as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

2. Intermediate-Scale Multistory Fire Test: Tested mockup, representative of completed multistory wall assembly of which wall panel is a part, complies with NFPA 285 for test method and required fire-test-response characteristics of exterior non-load-bearing wall panel assemblies.
3. Radiant Heat Exposure: No ignition when tested according to NFPA 268.
4. Potential Heat: Acceptable level when tested according to NFPA 259.
5. Surface-Burning Characteristics: Provide wall panels with a flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E 84.

2.2 FOAMED-INSULATION-CORE METAL WALL PANELS

A. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and insulation core foamed in place during fabrication, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.

1. Insulation Core: Modified isocyanurate or polyurethane foam using a non-CFC blowing agent, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.

   a. Closed-Cell Content: 90 percent when tested according to ASTM D 6226.
   b. Density: 2.0 to 2.6 lb/cu. ft. (32 to 42 kg/cu. m) when tested according to ASTM D 1622.
   c. Compressive Strength: Minimum 20 psi (140 kPa) when tested according to ASTM D 1621.
   d. Shear Strength: 26 psi (179 kPa) when tested according to ASTM C 273/C 273M.

B. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Metl Span- CF Architectural Horizontal
   b. Or equal if and as specifically approved by Architect by Addendum during the bidding period.
2. Metallic-Coated Steel Sheet: Facings of zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

a. Nominal Thickness: 0.028 inch (0.71 mm).

1) Color: Custom to match existing (Platinum by Reynobond)

3. Panel Coverage: As indicated on drawings.

4. Panel Thickness: As indicated on drawings.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.

2.4 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

   a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.
2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:
   1. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
   1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
   2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
      a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
2. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal wall panel manufacturer.

1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
3.4 INSULATED METAL WALL PANEL INSTALLATION

A. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.

1. Fasten foamed-insulation-core metal wall panels to supports with fasteners at each lapped joint at location and spacing and with fasteners recommended by manufacturer.
2. Apply panels and associated items true to line for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
3. Provide metal-backed washers under heads of exposed fasteners on weather side of insulated metal wall panels.
4. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
5. Provide sealant tape at lapped joints of insulated metal wall panels and between panels and protruding equipment, vents, and accessories.
6. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weathertight.
7. Apply snap-on battens to exposed-fastener, insulated-core metal wall panel seams to conceal fasteners.

B. Foamed-Insulation-Core Metal Wall Panels: Fasten metal wall panels to supports with concealed clips at each joint at location and spacing and with fasteners recommended by manufacturer. Fully engage tongue and groove of adjacent panels.

1. Install clips to supports with self-tapping fasteners.

C. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

D. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

3.5 FIELD QUALITY CONTROL

A. Water-Spray Test: After installation, test area of assembly for water penetration according to AAMA 501.2.

B. Manufacturer’s Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.

C. Metal wall panels will be considered defective if they do not pass test and inspections.

D. Additional tests and inspections, at Contractor’s expense, are performed to determine compliance of replaced or additional work with specified requirements.

E. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer’s written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.
SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

B. Related Sections:

1. Section 078446 "Fire-Resistive Joint Systems" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency. Show typical installation details for methods of installation.

1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer’s written recommendations.
C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 QUALITY ASSURANCE

A. Installer Documentation: General Contractor shall engage a single Firestop Contractor to perform all firestopping. Submit document from firestop manufacturer wherein manufacturer recognized, i.e. approves installer for said manufacturer’s firestop products.

B. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, “Approval of Firestop Contractors,” or been evaluated by UL and found to comply with its “Qualified Firestop Contractor Program Requirements.”

C. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in “Penetration Firestopping” Article. Provide rated systems complying with the following requirements:
   a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
   b. Classification markings on penetration firestopping correspond to designations listed by the following:
      1) UL in its “Fire Resistance Directory.”
      2) Intertek ETL SEMKO in its “Directory of Listed Building Products.”
      3) FM Global in its “Building Materials Approval Guide.”

D. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer’s written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

C. Notify Owner’s testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Grace Construction Products.
3. Hilti, Inc.
6. NUCO Inc.
8. RectorSeal Corporation.
9. Specified Technologies Inc.
10. 3M Fire Protection Products.
12. USG Corporation.
13. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. Fire-resistance-rated walls include fire walls fire-barrier walls smoke-barrier walls and fire partitions.
2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
Horizontal assemblies include floors floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.

2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.

3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at 0.30-inch wg (74.7 Pa) at both ambient and elevated temperatures.

E. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.

F. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

G. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

H. Low-Emitting Materials: Penetration firestopping sealants and sealant primers shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

I. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:
   a. Slag-wool-fiber or rock-wool-fiber insulation.
   b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
   c. Fire-rated form board.
   d. Fillers for sealants.

2. Temporary forming materials.
5. Steel sleeves.
2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer’s written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer’s written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer’s recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping’s seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer’s written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413
SECTION 078446 - FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Joints in or between fire-resistance-rated constructions.
   2. Joints in smoke barriers.
B. Related Sections:
   1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers.
   2. Section 079500 "Expansion Control" for fire-resistive architectural joint systems.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Product Schedule: For each fire-resistive joint system. Include location and design designation of qualified testing agency. Show typical installation details for methods of installation.
   1. Where Project conditions require modification to a qualified testing agency's illustration for a particular fire-resistive joint system condition, submit illustration, with modifications marked, approved by fire-resistive joint system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified Installer.
B. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.
C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.
1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, “Approval of Firestop Contractors,” or been evaluated by UL and found to comply with UL’s “Qualified Firestop Contractor Program Requirements.”

B. Fire-Test-Response Characteristics: Fire-resistive joint systems shall comply with the following requirements:

1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.

2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:

   a. Fire-resistive joint system products bear classification marking of qualified testing agency.
   b. Fire-resistive joint systems correspond to those indicated by reference to designations listed by the following:

      1) UL in its "Fire Resistance Directory."
      2) Intertek ETL SEMKO in its "Directory of Listed Building Products."

C. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

C. Notify Owner's testing agency at least seven days in advance of fire-resistive joint system installations; confirm dates and times on day preceding each series of installations.
PART 2 - PRODUCTS

2.1 FIRE-RESISTIVE JOINT SYSTEMS

A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:

1. Joints include those installed in or between fire-resistance-rated walls floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies.
2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. CEMCO.
   c. Fire Trak Corp.
   d. Grace Construction Products.
   e. Hilti, Inc.
   f. Johns Manville.
   g. Nelson Firestop Products.
   h. NUCO Inc.
   j. RectorSeal Corporation.
   k. Specified Technologies Inc.
   l. 3M Fire Protection Products.
   n. USG Corporation.
   o. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide fire-resistive joint systems with rating determined by ASTM E 119 based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa) or ASTM E 2307.

1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Grace Construction Products.
   c. Hilti, Inc.
d. Johns Manville.
e. Nelson Firestop Products.
f. NUCO Inc.
g. Passive Fire Protection Partners.
h. RectorSeal Corporation.
i. Specified Technologies Inc.
j. 3M Fire Protection Products.
k. Thermafiber, Inc.
m. USG Corporation.
n. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

D. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.

1. L-Rating: Not exceeding 5.0 cfm/ft (0.00775 cu. m/s x m) of joint at 0.30 inch wg (74.7 Pa) at both ambient and elevated temperatures.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Grace Construction Products.
   c. Hilti, Inc.
   d. Johns Manville.
   e. Nelson Firestop Products.
   f. NUCO Inc.
   g. Passive Fire Protection Partners.
   h. RectorSeal Corporation.
   i. Specified Technologies Inc.
   j. 3M Fire Protection Products.
   l. USG Corporation.
   m. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

E. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

F. VOC Content: Fire-resistive joint system sealants shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

G. Low-Emitting Materials: Fire-resistive joint system sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
H. **Accessories:** Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

**PART 3 - EXECUTION**

3.1 **EXAMINATION**

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 **PREPARATION**

A. **Surface Cleaning:** Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. **Priming:** Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. **Masking Tape:** Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.3 **INSTALLATION**

A. **General:** Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply fill materials so they contact and adhere to substrates formed by joints.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.

C. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.
B. Provide final protection and maintain conditions during and after installation that ensure fire-resistant joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistant joint systems immediately and install new materials to produce fire-resistant joint systems complying with specified requirements.

END OF SECTION 078446
SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Nonstaining silicone joint sealants.
   2. Urethane joint sealants.
   3. Mildew-resistant joint sealants.
   4. Latex joint sealants.

B. Related Requirements:
   1. Section 07 92 19 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.
   2. Section 32 13 73 "Concrete Paving Joint Sealants" for sealing joints in paved roads, parking lots, walkways, and curbing.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.

B. Sample Warranties: For special warranties.
1.5 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.6 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

A. Special Installer’s Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer’s Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer’s written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.
PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:

1. Architectural sealants shall have a VOC content of 250 g/L or less.
2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
3. Sealants and sealant primers for nonporous substrates shall have a VOC content of 775 g/L or less.

C. Low-Emitting Interior Sealants: Sealants and sealant primers shall comply with the testing and product requirements of the California Department of Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 URETHANE JOINT SEALANTS

A. Urethane, M, NS, 50, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 50, Use NT.

B. Urethane, M, NS, 50, T, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 50, Uses T and NT.

C. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade P, Class 50, Uses T and NT.

2.3 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.
B. Silicone, Nonstaining, S, NS, 100/50 NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.

1. Products: Subject to compliance with requirements, provide the following:
   a. Pecora Corporation; 890FTS/TXTR.

2.4 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

1. Products: Subject to compliance with requirements, provide the following:
   a. Pecora Corporation; 898NST.

2.5 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

2.6 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant: Manufacturer’s standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following requirements:

1. Product is effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies per ASTM E 90.
2. Product has flame spread and smoke developed ratings of less than 25 per ASTM E 84.

B. Acoustical Sealant for Concealed Joints: Manufacturer’s standard, nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic rubber sealant recommended for sealing interior concealed joints to reduce transmission of airborne sound.

C. Products: Subject to compliance with requirements, provide one of the following:

1. Acoustical Sealant:
2. Acoustical Sealant for Concealed Joints:

3. Smoke and Sound Acoustical Spray (alternate to sealant)

D. Uses: All locations requiring sound isolation from another room or space and elsewhere as noted on the drawings. (i.e. Any walls with sound batts specified in them)

2.7 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330. As approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
   a. Concrete.
   b. Masonry.
   c. Unglazed surfaces of ceramic tile.
   d. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.

4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
   a. Metal.
   b. Glass.
   c. Porcelain enamel.
   d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer’s written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.
2. Provide flush joint profile at locations indicated on Drawings according to Figure 8B in ASTM C 1193.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.
3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.

1. Joint Sealant: Urethane T.
2. Joint-Sealant Color: As selected by Architect from manufacturer’s full range of colors.


1. Joint Locations:
   b. Joints between plant-precast architectural concrete units.
   c. Control and expansion joints in unit masonry.
   d. Joints in dimension stone cladding.
   e. Joints in glass unit masonry assemblies.
   f. Joints in exterior insulation and finish systems.
   g. Joints between metal panels.
   h. Joints between different materials listed above.
   i. Perimeter joints between materials listed above and frames of doors, windows and louvers.
   j. Control and expansion joints in ceilings and other overhead surfaces.
   k. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane 50 NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer’s full range of colors.

C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:
   a. Control and expansion joints on exposed interior surfaces of exterior walls.
   b. Tile control and expansion joints.
   c. Vertical joints on exposed surfaces of unit masonry concrete walls and partitions.
   d. Joints on underside of plant-precast structural concrete.
   e. All vertical interior urethane resisting joints.

2. Joint Sealant: Urethane, NS, 50, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer’s full range of colors.
D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.

1. Joint Locations:
   a. All interior joints not otherwise indicated.

3. Joint-Sealant Color: As selected by Architect from manufacturer’s full range of colors.

E. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:
   a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
   b. Tile control and expansion joints where indicated.

3. Joint-Sealant Color: As selected by Architect from manufacturer’s full range of colors.

END OF SECTION 07 92 00
SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes hollow-metal work.

B. Related Requirements:

1. Section 08 71 00 "Door Hardware" for door hardware for hollow-metal doors.

1.3 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.
C. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

B. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch- (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. **Ceco Door Products:** an Assa Abloy Group company.
2. **Curries Company:** an Assa Abloy Group company.
3. **Republic Doors and Frames.**
4. **Steelcraft:** an Ingersoll-Rand company.
5. **West Central Manufacturing**
6. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.
2.2 REGULATORY REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

B. Fire-Rated, Borrowed-Light Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

2.3 INTERIOR DOORS AND FRAMES

A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2. All interior locations.

   1. Physical Performance: Level B according to SDI A250.4.
   2. Doors:

      a. Type: As indicated in the Door and Frame Schedule.
      b. Thickness: 1-3/4 inches (44.5 mm).
      c. Face: Uncoated, cold-rolled steel sheet, minimum thickness of 0.042 inch (1.0 mm).
      d. Edge Construction: Model 2, Seamless.
      e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.

   3. Frames:

      a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
      b. Construction: Full profile welded.


2.4 HOLLOW-METAL PANELS

A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.
2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (51 mm) wide by 10 inches (254 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick.
3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch (1.0 mm), and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at finish floor surface.

2.6 MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

E. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

F. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
G. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

H. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.

I. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

J. Glazing: Comply with requirements in Section 08 80 00 "Glazing."

K. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.7 FABRICATION

A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow-Metal Doors:

1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch (0.66 mm), steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches (152 mm) apart. Spot weld to face sheets no more than 5 inches (127 mm) o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.

2. Fire Door Cores: As required to provide fire-protection ratings indicated.

3. Vertical Edges for Single-Acting Doors: Bevel edges 1/8 inch in 2 inches (3.2 mm in 51 mm).

4. Top Edge Closures: Close top edges of doors with inverted closures, except provide flush closures at exterior doors of same material as face sheets.

5. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.

6. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.

7. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.

5. Jamb Anchors: Provide number and spacing of anchors as follows:

   a. Masonry Type: Locate anchors not more than 16 inches (406 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c., to match coursing, and as follows:

      1) Two anchors per jamb up to 60 inches (1524 mm) high.
      2) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
      3) Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
      4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.

   b. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:

      1) Three anchors per jamb up to 60 inches (1524 mm) high.
      2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
      3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
      4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.

   c. Compression Type: Not less than two anchors in each frame.
   d. Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

6. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.
E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

F. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
4. Provide loose stops and moldings on inside of hollow-metal work.
5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.8 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.9 ACCESSORIES

A. Louvers: Provide louvers for interior doors, where indicated, which comply with SDI 111C, with blades or baffles formed of 0.020-inch- (0.5-mm-) thick, cold-rolled steel sheet set into 0.032-inch- (0.8-mm-) thick steel frame.

1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.

B. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

C. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION
A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.
B. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
   1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
      a. At fire-rated openings, install frames according to NFPA 80.
      b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
      c. Install frames with removable stops located on secure side of opening.
      d. Install door silencers in frames before grouting.
      e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
      f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
g. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
   a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Grout jamb members full.
4. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
5. In-Place Metal or Wood-Stud Partitions: Secure slip-on drywall frames in place according to manufacturer’s written instructions.
6. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:
   a. Between Door and Frame Jambs and Head: 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).
   b. Between Edges of Pairs of Doors: 1/8 inch (3.2 mm) to 1/4 inch (6.3 mm) plus or minus 1/32 inch (0.8 mm).
   c. At Bottom of Door: [3/4 inch (19.1 mm)] [5/8 inch (15.8 mm)] plus or minus 1/32 inch (0.8 mm).
   d. Between Door Face and Stop: 1/16 inch (1.6 mm) to 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.

D. Glazing: Comply with installation requirements in Section 08 80 00 “Glazing” and with hollow-metal manufacturer’s written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.
3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

F. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 11 13
1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 SUMMARY

A. This Section includes the following:

1. Extent and location of each type of flush wood door is indicated on drawings and in schedules.
2. Types of doors required include the following:
   a. High Impact acrylic modified vinyl faced doors

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. See Section 06 40 23 “Interior Architectural Woodwork” for wood frames.
2. See Section 08 11 13 “Hollow Metal Frames” for hollow metal frames.
3. See Section 08 71 00 “Door Hardware” for door hardware.
4. See Section 08 80 00 “Glazing” for vision lite glass.

1.3 SUBMITTALS

A. Product Data: Door manufacturer's technical data for each type of door, including details of core and edge construction.

B. Shop Drawings: Submit shop drawings indicating location and size of each door, elevation, details of construction, hardware locations, and other pertinent data.

C. Samples for verification in the form and size indicated below:

1. Corner sections of doors approximately 12 inches (300 mm) square with door faces and
1.4 QUALITY ASSURANCE

A. Quality Standards: Comply with the following standards:

1. Adhesive Bonding Durability: WDMA TM-6
2. Cycle Slam: WDMA TM-7
3. Hinge Loading: WDMA TM-8
4. Screw Holding: WDMA TM-10
   a. Door Face
   b. Vertical Door Edge
   c. Horizontal Door Edge

   a. NWWMA Quality Marking: Mark each door with NWWDA Wood Flush Door Certification Hallmark certifying compliance with NWWDA I.S.1 or provide written certification of compliance.

2. AWI Quality Standard: "Architectural Woodwork Quality Standards"; including Section 1300 "Architectural Flush Doors", of Architectural Woodwork Institute (AWI) for grade of door, core construction, finish and other requirements.

3. Fire-Rated Wood Doors: Provide wood doors that comply with NFPA 80; are identical in materials and construction to units tested in door and frame assemblies per ASTM E152; and are labeled and listed by UL, Warnock Hersey, or another testing and inspection agency acceptable to authorities having jurisdiction.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Protect doors during transit, storage and handling to prevent damage, soiling and deterioration. Comply with referenced standards and recommendations of NWWDA, as well as with manufacturer's instructions.

B. Identify each door with individual opening numbers which correlate with designation system used on shop drawings for door, frames, and hardware, using temporary, removable or concealed markings.

1.6 PROJECT CONDITIONS

A. Conditioning: Do not deliver or install doors until conditions for temperature and relative humidity have been stabilized and will be maintained in storage and installation areas during remainder of construction period to comply with referenced AWI quality standard including Section 100-S-3 "Moisture Content." Acceptable humidity shall be not less than 25%, nor greater than 55%.

1.7 WARRANTY

A. General: Warranties shall be in addition to, and not a limitation of, other rights the Owner may have
under the Contract Documents.

B. 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 that have warped (bow, cup or twist) or that show telegraphing of core, or do not conform to tolerance limitations.

1. Warranty shall be for life of installation.

C. Contractor's Responsibilities: Replace or refinish doors where Contractor’s work contributed to rejection or to voiding of manufacturer's warranty.

2. PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

1. Algoma Hardwoods, Inc.
2. Eggers Industries
3. C/S Acrovyn Door Systems, Inc.

2.2 HIGH IMPACT, ACRYLIC MODIFIED VINYL FACED DOORS

A. Basis of Design Product: Subject to compliance with requirements, provide Marshfield Door Systems “Durable Door” or an approved equal product by one of the following

B. Color: White Oak, Espresso 42-95.

C. Grade: WDMA Premium Grade

D. WDMA Performance Grade I.S.1-A: Extra Heavy Duty.

E. Faces: Chemical and stain resistant, high-impact, acrylic modified vinyl faces. Color as selected from manufacturer’s full range of wood grain patterns.

F. Vertical edges shall be 1/8 inch matching high impact acrylic material bonded to structural composite lumber. Removable edges are not permitted.

G. Horizontal edges: Bond smooth PVC edge band to structural composite lumber to provide cleanable surface.

H. Core: Wood-based particleboard, structural composite lumber, fire-resistant composite or specialty core as required.

I. Construction: Five plies. Stile and rails are bonded to core, then entire unit is abrasive planed before
faces and crossbands are applied.

J. Barrier-Resistant (Wicket) type as shown on the drawings. Barrier-Resistant doors shall have a compact door contained within the main door. The compact door shall be constructed the same as the main, outer leaf.

2.3 FABRICATION

A. Factory fit doors to suit field verified and frame-opening sizes indicated, with the following uniform clearances and bevels, unless otherwise indicated:

1. Comply with clearance requirements of referenced quality standard for fitting. Comply with requirements in NFPA 80 for fire-rated doors.

2. NOTE: At all doors scheduled to be installed in existing frames, contractor shall field verify frame size as well as existing hardware to coordinate door prep.

B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.

1. Coordinate measurements of hardware mortises in existing and new metal frames to verify dimensions and alignment before factory machining.

2. Metal Astragals: Pre-machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Openings: Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of door(s) required.

1. Light Openings: Trim openings with moldings of material and profile indicated.

3. EXECUTION

3.1 EXAMINATION

A. Examine installed door frames prior to hanging door:

1. Verify that frames comply with indicated requirements for type, size, location, and swing and have been installed with plumb jambs and level heads.

2. Reject doors with defects.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Hardware: For installation, see Division 08 Section "Door Hardware."

B. Manufacturer's Written Instructions: Install doors to comply with manufacturer's written instructions, referenced quality standard, and as indicated.

1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.

C. Field-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

1. Clearances: Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold unless otherwise indicated.

   a. Comply with NFPA 80 for fire-rated doors.

2. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.

3. Trim bottom rail only to extent permitted by labeling agency.

3.3 FINISHING

A. FACTORY FINISHING

1. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.4 ADJUSTING AND PROTECTION

A. Operation: Rehang or replace doors which do not swing or operate freely.

B. Protect doors as recommended by door manufacturer to ensure that wood doors will be without damage or deterioration at time of Substantial Completion.

END OF SECTION 08 14 16
SECTION 08 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Access doors and frames for walls and ceilings.
2. Floor access doors and frames.

B. Related Requirements:

1. Section 07 72 00 "Roof Accessories" for roof hatches.
2. Section 23 33 00 "Air Duct Accessories" for heating and air-conditioning duct access doors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, fire ratings, materials, individual components and profiles, and finishes.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Detail fabrication and installation of access doors and frames for each type of substrate.

C. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics according to the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
2. NFPA 288 for fire-rated access door assemblies installed horizontally.

2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Larsen's Manufacturing Company.
3. Milcor Inc.
4. Bauco Access panel Solutions Inc.
5. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.

C. Recessed Access Doors

1. Assembly Description: Fabricate door in the form of a pan recessed 5/8 inch for gypsum board, acoustical tile infill. Provide frame with gypsum board bead for concealed flange or no bead for acoustical tile installation.
2. Locations: Wall and ceiling
3. Door Size: As required for access. 16" x 16" min.
4. Stainless-Steel Sheet for Door: Nominal 0.062 inch, 16 gage
   a. Finish: No. 4
5. Frame Material: Same material and thickness as door
6. Hinges: Manufacturer's standard
7. Hardware: Lock
D. Fire-Rated, Flush Access Doors with Concealed Flanges

1. Assembly Description: Fabricate door to fit flush to frame,[with a core of mineral-fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide frame with gypsum board beads for concealed flange installation.
2. Locations: Wall and ceiling
3. Fire-Resistance Rating: Not less than that of adjacent construction, 1 hour minimum.
4. Temperature-Rise Rating: 450 deg F at the end of 30 minutes
5. Stainless-Steel Sheet for Door: Nominal 0.038 inch, 20 gage.
   a. Finish: No. 4
6. Frame Material: Same material, thickness, and finish as door
7. Hinges: Manufacturer’s standard
8. Hardware: Lock

E. Hardware:
   1. Latch: Cam latch operated by screwdriver.
   2. Lock: As shown on Drawings.

2.3 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

C. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.

E. Rolled-Stainless-Steel Floor Plate: ASTM A 793, manufacturer’s standard finish.

F. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304. Remove tool and die marks and stretch lines or blend into finish.


I. Aluminum Sheet: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H15; with minimum sheet thickness according to ANSI H35.2.

J. Frame Anchors: Same type as door face.

K. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.4 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.
2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded metal lath and exposed casing bead welded to perimeter of frames.
3. Provide mounting holes in frames for attachment of units to metal or wood framing.
4. Provide mounting holes in frame for attachment of masonry anchors.

D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.

1. For recessed doors with plaster infill, provide self-furring expanded metal lath attached to door panel.

E. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

1. For cylinder locks, furnish two keys per lock and key all locks alike.
2. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

F. Extruded Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.
2.5 FINISHES

A. Comply with NAAMM’s "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Steel and Metallic-Coated-Steel Finishes:

1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

2. Factory Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry-film thickness of 1 mil (0.025 mm) for topcoat.

E. Stainless-Steel Finishes:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.
3.3 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08 31 13
SECTION 08 34 49 – SPECIAL FUNCTION DOORS – RADIATION SHIELDING DOORS

PART 1. GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section describes the requirements for providing electric operated, top hung sliding, radiation shielding doors as shown on the Drawings and as specified.

1. Provide complete operating door assemblies including door sections, guides, hardware, operators, and installation accessories.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. See Section 13 49 00 “Radiation Protection” for additional radiation protection requirements.

C. Concrete or grout work is specified in Division 3, and is by others.

D. Opening framing and support steel is specified in Division 5, and is by others.

E. Finish painting is specified in Division 9, and is by others.

F. Electrical connections, including disconnects, conduit, wire, junction boxes, and field wiring of high and low voltage systems for powered operators and accessories are specified in Division 26, and is by others.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide materials and workmanship, including joints and fasteners that maintain continuity of radiation protection at all points and in all directions equivalent to materials specified in thicknesses and locations indicated.

1. Materials, thicknesses, and configurations indicated are based on radiation protection design prepared by Owner’s radiation health physicist. This design is available to Contractor on request.

B. Make joints, fasten to substrates, and shield penetrations to maintain lead equivalence at all points and in all directions.
1.4 SUBMITTAL

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product Data: Submit manufacturer’s product data, roughing-in diagrams, and installation instructions for each type and size of top hung sliding shielding door. Provide operating instructions, maintenance information, and electrical rough-in instructions.

C. Shop Drawing: Show construction details; clearance requirements, metal gauges, finish, lead thickness or lead equivalence, electrical requirements, design data, and interface requirements for Work of other Sections of this Specification.

1.5 QUALITY ASSURANCE

A. Furnish each top hung sliding shielding door as a complete unit produced by one manufacturer, including hardware, accessories, mounting and installation components.

B. Door manufacturer shall have at least 5 years experience in manufacturing doors of the type specified.

C. Single Source: Furnish each top hung sliding shielding door unit from one manufacturer for the entire Project.

D. Inserts and Anchorages: Furnish setting drawings, templates, instructions and directions for installation of anchoring devices. Coordinate delivery with work in other divisions to avoid delays.

E. See concrete and masonry Sections of these specifications for installation of inserts and anchorage devices.

PART 2. PRODUCTS

2.1 MANUFACTURER

A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:


Or equal if and as specifically approved by Architect by Addendum during the bidding period.
2.2 MATERIALS AND FABRICATION

A. General: Comply with the following standards for forms and types of material for the required items of work.

2. Steel Tubing, Structural Welded: ASTM A500 Grade B.
5. Face Sheets: 14 gauge, Type 316 Stainless Steel, 4 Finish.
6. **The use of cold formed shapes for structural members or stiffeners fabricated from sheets or strips of any material will not be allowed.**

B. Door Panel Construction: Custom Metal Fabrications as Indicated:

1. Door panel frames (leaves) will have both horizontal and vertical structural framing, and shall be constructed of standard structural steel, square steel tubing sections of ample size and strength for loads and stresses imposed under the specified conditions. Interior door panel frame members shall be steel tubing spaced at not more than 24 inches center to center. The interior members shall run horizontally. Pan style construction or the use of cold / hot formed sheet metal channels, hats, angles, or other sheet formed members in the panel construction will not be allowed.

2. The structural frames for the door panels shall be of welded construction and all joints shall be ground smooth wherever exposed and / or where sheeting overlaps the framing members. Exposed welds and welds which interfere with the installation of various parts shall be ground smooth.

3. Door panel frame members shall be true to dimension and square in all directions. Door panels shall not be bowed, warped, or out of line by more than 1/8” in 20 feet.

4. Each panel shall be lined with minimum 1/16” lead to meet the radiation requirement. Lead shall be a minimum of 7’ high and will be glued and/or taped to the door panel frames.

5. Door panel frames shall be sheeted on both sides with 14 gauge stainless steel sheeting which is glued and/or taped to the door panel frames.

6. The leading door panel will have a cut-out to fit tightly around the energy chain box.

7. Door sections shall be insulated with 2” of fibrous glass batt-type insulation. The insulating material shall be fitted to cover the entire surface of the door panel between the structural members.

2.3 HARDWARE

A. Door hardware system shall include guide tracks and support brackets, track and operator covers, interlocking panel angles, door capture assembly, trolleys, stay rollers, door pulls, and special seals on both sides of the opening.

1. Guide Tracks: Shall be low profile, precision machined hardened rails integrated with hardened steel races. Rails will be bolted to supports.

2. Trolleys: Shall be multi-wheel with sealed bearings and hardened steel rollers.
3. Track and Operator Covers: Shall be constructed from minimum 14 gauge ASTM 1011 hot rolled flat steel.
4. Guide tracks and trolleys shall only require 8" of headroom.

2.4 OPERATION

A. Operator: Doors will be electrically operated by EPD Model #5400 Poly-Belt Drive System. Electric operator shall be suitable for operation on 208 volt, 3 phase power. Doors shall automatically move from the fully closed position to the fully open position.

1. Provide interlocks to prevent one door from opening before the other.
2. Doors shall be capable of manual operation in the event of a power failure.
3. Doors shall be capable of reset after power failure using pushbutton controls.

B. Control Panel: Each door shall be furnished with a NEMA 4 control panel enclosure. The control panel assembly shall be U.L. labeled and house a reversing across-the-line type magnetic motor starter having thermal-overload protection along with variable frequency drive, control relays, timers, fuses, terminal strips, and other electronic components as required to provide the specified operating sequences. All components shall be neatly labeled and pre-wired to numbered terminal strips that correspond to all the door's additional electrical components that are located outside of the electrical control panel enclosure.

1. Pushbuttons: Pushbuttons shall be located on the interior of the building where shown and shall be the three-button type, with the buttons marked “OPEN”, “CLOSE”, and “STOP”. The “OPEN” button shall be of the type requiring only momentary pressure by the operator to cause the door to go from the closed to the fully open position. The “CLOSE” button shall require constant pressure from the operator to maintain the closing motion of the door. When the door is in motion and the “STOP” button is pressed, the door shall stop instantly and remain in the stop position; from the stop position, the door may then be operated in either direction by pushing the “OPEN” or “CLOSE” button. Pushbuttons shall be NEMA 4 rated. Provide keyed pushbutton stations where necessary.
2. Limit Switches: Shall be rotary can-type switches with NEMA rated micro switches and shall stop the doors in the fully closed or fully opened positions.
3. Photo Eyes: A photo electric eye shall be located on both sides of the opening. These photo eyes will automatically reverse the door if an obstruction is in the door opening during closing. Photo eyes shall be through beam type. Photo enclosures to be NEMA 4X or IP6.
4. Reversing Device: Electric reversing edges shall be located the full length of the doors on the leading edge of the lead door panels. Reversing edges will automatically reverse the doors should they come in contact with an obstruction during closing. The reversing edges shall not substitute for limit switches.
2.5 SHOP FINISHING

A. General: Thoroughly clean, pre-treat, prime, and finish carbon steel surfaces of door assembly including fixed panels trim, support and closure pieces.

1. Pre-Treatment: Surface preparation on structural carbon steel surfaces shall be SSPC-SP6 commercial sand blast.
2. Primer and Finish: Where required, carbon steel surfaces will be shop prime painted with Tneme Zinc (Organic Zinc Primer) and shop finish painted with an epoxy finish paint.

PART 3. EXECUTION

3.1 INSPECTION

A. Verify that conditions are satisfactory for installation of electric operated, top hung sliding shielding doors.

B. Do not proceed with the Work of this Section until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. The installation of doors shall be by a factory trained and certified door company of the door manufacturer or supervised by an authorized representative of the door manufacturer.

B. Install door and operating equipment complete with necessary hardware, jamb and head weather strips, anchors, inserts, hangers, and equipment supports in accordance with final Shop Drawings, manufacturer’s instructions, and as specified herein.

C. Upon completion of installation including work by other trades, lubricate, test and adjust doors to operate easily, free from warp, twist, or distortion and fitting weather tight for entire perimeter.

END OF SECTION 08 34 49
SECTION 08 71 00 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes finish hardware for the proper operation and control of all doors in the Project. Prior to bidding, notify Architect of any doors that do not have hardware meeting this intention.

B. Hardware supplier will be responsible to furnish and install hardware on labeled doors to satisfy State and Local Building Codes.

C. Related Sections include the following:

1. Division 8 Section "Hollow Metal Doors and Frames."
2. Division 8 Section "Flush Wood Doors."

1.3 SUBMITTALS

A. Product Data: For each product and material indicated, submit manufacturer's technical product data. Include information necessary to show compliance with requirements, installation instructions and maintenance instructions.

B. Hardware Schedule: Submit a hardware schedule organized into sets, including the information below. Designations for door numbers and hardware sets shall match those used in the construction documents.

1. Opening Number
2. Door Type and Size
3. Frame Type and Size
4. Frame Anchoring Method
5. Hardware Set
6. Assembly Rating

C. Hardware Schedule shall be coordinated with the doors, frames and related work to ensure proper size, thickness, hand function and finish of door hardware.
1.4 QUALITY ASSURANCE

A. Supplier Qualifications: A recognized Architectural Finish Hardware Supplier, with warehousing facilities, who has been furnishing hardware in the Project's vicinity for a period of not less than two (2) years. Supplier shall be or employ an experienced Architectural Hardware Consultant (AHC) who is certified by and member of the Door and Hardware Institute. The Architectural hardware Consultant shall be available, at reasonable times during the course of the work, for consultation about Project's hardware requirements, to Owner, Architect and Contractor.

B. Fire-Rated Openings: Provide hardware for fire-rated openings in compliance with NFPA Standard No. 80, No. 101 and local building code requirements. Provide only hardware, which has been tested and listed, by UL, FM or Warnock Hersey for types and sizes of doors required and complies with requirements of door and door frame labels.

C. Standards: Comply with the requirements of the latest edition of the following standards unless indicated otherwise:

1. American National Standards Institute Publications:
   a. A115 Series – Door and Frame Preparation
   b. A156 Series – Hardware

2. Builders Hardware Manufacturer’s Association Publications:
   a. 1201 – Auxiliary Hardware
   b. 1301 – Materials and Finishes

3. Door and Hardware Institute Publications:
   a. Keying – Procedures, Systems and Nomenclature
   b. Abbreviations and Symbols
   c. Hardware for Labeled Fire Doors
   d. Recommended Locations for Builder’s Hardware for Standard and Custom Steel Doors and Frames
   e. Wood Door Standards W1, W2, WDHS-2, WDHS-3

   a. NFPA 80 – Standards for Fire Doors and Windows


1.5 DELIVERY, STORAGE, AND HANDLING

A. Package each hardware item in separate containers with all screws, wrenches, installation instructions and installation templates. Mark each box with hardware heading and door number according to approved hardware schedule.

B. Deliver individually packaged hardware items at the proper times to the proper locations (shop or project site) for installation: Provide a complete packing list showing items, door numbers and hardware headings with each shipment.
C. Store hardware in shipping cartons above ground and under cover to prevent damage. Provide secure lockup for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the Work will not be delayed by hardware losses both before and after installation.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with delivery and/or installation when ambient and substrate temperature conditions are outside limits permitted by material manufacturers.

PART 2 – PRODUCTS

2.1 HARDWARE GENERAL

A. Provide the materials of products indicated by trade names, manufacturer’s name, or catalog number. Substitutions will not be permitted except as described in Division 1.

B. Provide manufacturer’s standard products meeting the design intent of this Specification, free of imperfections affecting appearance or serviceability.

1. Provide hardware complete with all fasteners, anchors, instructions, layout templates, and any specialized tools as required for satisfactory installation and adjustment.

2. Hand of Door: Drawings show direction of slide, swing or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.

3. Furnish screws for installation with each hardware item. Provide Phillips flat head screws except as otherwise indicated or approved. Finish screws exposed under any condition to match hardware finish, or, if exposed in surface of other work, to match finish of such other work as closely as possible. Use machine screws for metal connections and wood screws for connections to wood. Use manufacturer’s screws to secure hardware.

4. Provide concealed fasteners for hardware unit with care exposed when door is closed, except to extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt, head or nut on opposite face is exposed in other work, except where indicated otherwise or where it is not feasible to adequately reinforce the work. In such cases, provide sleeves for each thru-bolt or use sex screw fasteners.

5. Special Tools: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner’s continued adjustment, maintenance and removal and replacement of finish hardware.

C. Hardware is specified in the hardware schedule by set, type and functions, which have been selected as best meeting the application requirements. Acceptable products for each category are specified in Paragraph 2.5 "Hardware Products".
2.2 SPECIAL REQUIREMENTS

A. General:
   1. Where new doors and hardware are scheduled to be installed in existing frames, contractor to coordinate hinge sizes and locations, lockset backsets, strikes, hardware mounting heights, etc with existing frames to ensure new door and hardware fits and functions properly in existing frame.

B. Hinges:
   1. Use heavy weight hinges for all doors.
   2. Use continuous hinges on all fire, corridor, and exterior doors.

C. Locksets:
   1. All locksets to be grade 1 heavy duty cylindrical or as specified.

D. Closers:
   1. Comply with manufacturer’s recommendations for unit size based on door size and usage.
   2. Provide parallel arms for all overhead closers, except as otherwise indicated.
   3. All closers UL Listed Certified to be in compliance with UBC 7.2 and UL 10C.
   4. Closers with Pressure Relief Valves will not be acceptable.
   5. Supplier to provide any brackets or plates required for proper installation of door closers.

E. Exit Devices:
   1. All latchbolts to be deadlatching type.
   2. All touchbars to be stainless steel.

2.3 KEYING

A. Contractor to turn all cylinders over to MU key shop for keying.

2.4 FINISHES

A. Standard: Comply with BHMA A156.18
   1. All door hardware to be US26D throughout project.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness and other qualities complying with manufacturer’s standards, but in no case less than specified by referenced standards for the application units of hardware.

C. Protect finishes on exposed surfaces from any damage by applying a strippable temporary protective covering before shipping.
D. BHMA Designations: Comply with base material and finish requirements indicated by BHMA standards.

2.5 HARDWARE PRODUCTS

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<tr>
<th>ITEM</th>
<th>SPECIFIED</th>
<th>APPROVED EQUAL</th>
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<td>Hinges</td>
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<td>Cylinders</td>
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<td>Rixson</td>
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<td>Zero</td>
<td>NGP, Reese</td>
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<td>Von Duprin</td>
<td>Adams Rite</td>
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<tr>
<td>Prox Card Readers</td>
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<tr>
<td>Auxiliary</td>
<td>DCI</td>
<td>Ives, Rockwood</td>
</tr>
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PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames with installer present for compliance with the requirements, for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine rough-in for electrical source power to verify actual locations of wiring connections before electrified door hardware installation.

C. Notify Architect of any discrepancies or conflicts between the door schedule, door types, frame types, drawings, scheduled hardware and built condition.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Steel Frames: Comply with ANSI/DHI A115 Series

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights indicated in the following applicable publications, or as required to comply with governing regulations:

2. Custom Steel Doors and Frames: DHI’s “Recommended Locations for Builder’s Hardware for Custom Steel Doors and Frames.”

B. Install each door hardware item to complete with manufacturer’s written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage and reinstallation of surface protective trim units to with finishing work. Do not install surface mounted items until finishes have been completed on substrates involved.

3.4 FIELD QUALITY CONTROL

A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in written report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating items of door hardware and each door to ensure proper operation of function of every unit. Replace units that cannot be adjusted to operate as intended and/or required. Adjust door control devices to compensation for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper finish, and provide final protection and maintain condition that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMOESTRATION AND TRAINING

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate and maintain door hardware and door hardware finishes.
3.8 DOOR HARDWARE SETS

HARDWARE GROUP NO. 01
For use on Door #(#s):
C2053C
Provide each SGL door(s) with the following:

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<th>DESCRIPTION</th>
<th>CATALOG NUMBER</th>
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<td>HINGE</td>
<td>5BB1HW 4.5 X 4.5</td>
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<td>1</td>
<td>CLASSROOM LOCK</td>
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<td>689</td>
<td>LCN</td>
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<tr>
<td>1</td>
<td>WALL STOP</td>
<td>WS406/407CCV</td>
<td>626</td>
<td>IVE</td>
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<tr>
<td>1</td>
<td>GASKETING</td>
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HARDWARE GROUP NO. 02
For use on Door #(#s):
C2053F  C2053J
Provide each SGL door(s) with the following:

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<td>PIVOT SET</td>
<td>7230F SET</td>
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<td>1</td>
<td>INTERMEDIATE PIVOT</td>
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<td>PUSH/PULL LATCH</td>
<td>HL6 9070 2 3/4” A L</td>
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<td>IVE</td>
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<tr>
<td>1</td>
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HARDWARE GROUP NO. 03
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C2053  C2053R
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HARDWARE HARDWARE

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<td>1</td>
<td>MOTION SENSOR</td>
<td>SCANII 12/24 VDC</td>
<td>630</td>
<td>BLK</td>
</tr>
<tr>
<td>1</td>
<td>KEY SWITCH</td>
<td>653-04</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
University of Missouri Teaching Hospital
Critical Care Addition – Interventional Radiology Expansion
Columbia, Missouri

MU Project #: CP180491
TCEP Project #: 624-149-17

2 EA DOOR CONTACT 679-05 ✓ WHT SCE
1 EA POWER SUPPLY PS902 900-2RS 120/240 VAC ✓ LGR SCE
1 EA VIDEO INTERCOM PROVIDED BY OTHERS
2 CARD READER - WORK OF DIVISION 28

OPERATION DESCRIPTION: DOOR TO REMAIN LOCKED AND CLOSED WHEN NOT IN USE. ENTRY BY CARD READER WILL RETRACT ELECTRIC STRIKE AND OPEN BOTH DOOR LEAFS. INSIDE WALL ACTUATOR WILL RETRACT ELECTRIC HARDWARE AND OPEN BOTH DOOR LEAFS. FREE EGRESS AT ALL TIMES.

HARDWARE GROUP NO. 04
For use on Door #(#s):
C2053A.2 C2053B C2053E
Provide each SGL door(s) with the following:

<table>
<thead>
<tr>
<th>QTY</th>
<th>DESCRIPTION</th>
<th>CATALOG NUMBER</th>
<th>FINISH</th>
<th>MFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>HINGE</td>
<td>5BB1HW 4.5 X 4.5</td>
<td>652</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>PASSAGE SET</td>
<td>9K30N 14D</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td>1</td>
<td>OH STOP</td>
<td>90S J (AT C2053E ONLY)</td>
<td>630</td>
<td>GLY</td>
</tr>
<tr>
<td>1</td>
<td>KICK PLATE</td>
<td>8400 10&quot; X 2&quot; LDW B-CS</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>WALL STOP</td>
<td>WS406/407CCV</td>
<td>626</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>KICK PLATE</td>
<td>188SBK PSA</td>
<td>BK</td>
<td>ZER</td>
</tr>
</tbody>
</table>

HARDWARE GROUP NO. 05
For use on Door #(#s):
C2053K
Provide each SGL door(s) with the following:

<table>
<thead>
<tr>
<th>QTY</th>
<th>DESCRIPTION</th>
<th>CATALOG NUMBER</th>
<th>FINISH</th>
<th>MFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>HINGE</td>
<td>5BB1HW 4.5 X 4.5</td>
<td>652</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>STOREROOM LOCK</td>
<td>9K37D 14D</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td>1</td>
<td>SURFACE CLOSER</td>
<td>4040XP CUSH</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>1</td>
<td>KICK PLATE</td>
<td>8400 10&quot; X 2&quot; LDW B-CS</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>3</td>
<td>SILENCER</td>
<td>SR64</td>
<td>GRY</td>
<td>IVE</td>
</tr>
</tbody>
</table>

HARDWARE GROUP NO. 06
For use on Door #(#s):
C2053G C2053H
Provide each PR door(s) with the following:

<table>
<thead>
<tr>
<th>QTY</th>
<th>DESCRIPTION</th>
<th>CATALOG NUMBER</th>
<th>FINISH</th>
<th>MFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>PIVOT SET</td>
<td>7230F SET</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>2</td>
<td>INTERMEDIATE PIVOT</td>
<td>7230F INT</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>2</td>
<td>AUTO FLUSH BOLT</td>
<td>962</td>
<td>626</td>
<td>DCI</td>
</tr>
<tr>
<td>1</td>
<td>DUST PROOF STRIKE</td>
<td>81</td>
<td>626</td>
<td>DCI</td>
</tr>
<tr>
<td>1</td>
<td>PUSH/PULL LATCH</td>
<td>HL6 9070 2 3/4&quot; A L</td>
<td>626</td>
<td>SCH</td>
</tr>
<tr>
<td>1</td>
<td>CYLINDER</td>
<td>VERIFY TYPE REQ'D</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td>1</td>
<td>ELECTRIC STRIKE</td>
<td>6223 FSE 12/16/24/28 VAC/VDC</td>
<td>✓ 630</td>
<td>VON</td>
</tr>
<tr>
<td>1</td>
<td>COORDINATOR</td>
<td>NX-600</td>
<td>630</td>
<td>DCI</td>
</tr>
</tbody>
</table>
University of Missouri Teaching Hospital  
Critical Care Addition – Interventional Radiology Expansion  
Columbia, Missouri  

MU Project #: CP180491  
TCEP Project #: 624-149-17  

<table>
<thead>
<tr>
<th>QTY</th>
<th>DESCRIPTION</th>
<th>CATALOG NUMBER</th>
<th>FINISH</th>
<th>MFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SURF. AUTO</td>
<td>9563 REG/STD MS AS REQ (120/240 VAC)</td>
<td>ANCLR</td>
<td>LCN</td>
</tr>
<tr>
<td>1</td>
<td>ACTUATOR, WALL MOUNT</td>
<td>8310-813</td>
<td>630</td>
<td>LCN</td>
</tr>
<tr>
<td>1</td>
<td>ROCKER SWITCH</td>
<td>8310-806R</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>1</td>
<td>RELAY/DOOR SEQUENCER</td>
<td>8310-845</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>2</td>
<td>GASKETING</td>
<td>188SBK PSA</td>
<td>BK</td>
<td>ZER</td>
</tr>
<tr>
<td>1</td>
<td>LEAD LINED</td>
<td>PROVIDED BY OTHERS</td>
<td>628</td>
<td>SCE</td>
</tr>
<tr>
<td>2</td>
<td>DOOR CONTACT</td>
<td>PROVIDE FACTORY POINT TO POINT WIRING DIAGRAMS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: DOOR MANUFACTURER TO WRAP LEAD LINING AROUND ELECTRIC STRIKE CUT OUT. 

NOTE: DOOR STOPS BUILT-IN TO AUTOMATIC DOOR OPERATOR FOR BOTH DOOR LEAFS. 

OPERATION DESCRIPTION: DOOR TO REMAIN LOCKED AND CLOSED WHEN NOT IN USE. ENTRY BY CARD READER WILL RETRACT ELECTRIC STRIKE AND OPEN BOTH DOOR LEAFS. INSIDE WALL ACTUATOR WILL RETRACT ELECTRIC STRIKE AND OPEN BOTH DOOR LEAFS. 3 POSITION ROCKER SWITCH INSIDE PROCEDURE ROOM PROVIDES OPERATOR TO BE ON, OFF OR HELD OPEN. FREE EGRESS AT ALL TIMES.

HARDWARE GROUP NO. 07  
For use on Door #s: C2053A.1  
Provide each SGL door(s) with the following:

<table>
<thead>
<tr>
<th>QTY</th>
<th>DESCRIPTION</th>
<th>CATALOG NUMBER</th>
<th>FINISH</th>
<th>MFR</th>
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</thead>
<tbody>
<tr>
<td>3</td>
<td>HINGE</td>
<td>5BB1HW 4.5 X 4.5</td>
<td>652</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>STOREROOM LOCK</td>
<td>9K37D 14D</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td>1</td>
<td>ELECTRIC STRIKE</td>
<td>6211 FSE 12/16/24/28 VAC/VDC</td>
<td>630</td>
<td>VON</td>
</tr>
<tr>
<td>1</td>
<td>SURFACE CLOSER</td>
<td>4040XP EDA</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>1</td>
<td>KICK PLATE</td>
<td>8400 10&quot; X 2&quot; LDW B-CS</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>WALL STOP</td>
<td>WS406/407CCV</td>
<td>626</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>GASKETING</td>
<td>188SBK PSA</td>
<td>BK</td>
<td>ZER</td>
</tr>
<tr>
<td>1</td>
<td>MOTION SENSOR</td>
<td>SCANII 12/24 VDC</td>
<td>BLK</td>
<td>SCE</td>
</tr>
<tr>
<td>1</td>
<td>DOOR CONTACT</td>
<td>679-05</td>
<td>WHT</td>
<td>SCE</td>
</tr>
<tr>
<td>1</td>
<td>POWER SUPPLY</td>
<td>PS902 900-2RS 120/240 VAC</td>
<td>LGR</td>
<td>SCE</td>
</tr>
<tr>
<td>1</td>
<td>CARD READER - WORK OF DIVISION</td>
<td>28</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OPERATION: DOOR ALWAYS CLOSED AND LOCKED. ENTRY BY VALID CARD READ. FREE EGRESS AT ALL TIMES BY INSIDE LEVER.
HARDWARE GROUP NO. 08
For use on Door #s:
C2053M C2053N C2053Q
Provide each SGL door(s) with the following:

<table>
<thead>
<tr>
<th>QTY</th>
<th>DESCRIPTION</th>
<th>CATALOG NUMBER</th>
<th>FINISH</th>
<th>MFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>EA HINGE</td>
<td>5BB1HW 4.5 X 4.5</td>
<td>652</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>EA STOREROOM LOCK</td>
<td>9K37D 14D</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td>1</td>
<td>EA ELECTRIC STRIKE</td>
<td>6211 FSE 12/16/24/28 VAC/VDC</td>
<td>630</td>
<td>VON</td>
</tr>
<tr>
<td>1</td>
<td>EA OH STOP</td>
<td>100S</td>
<td>630</td>
<td>GLY</td>
</tr>
<tr>
<td>1</td>
<td>EA SURFACE CLOSER</td>
<td>4040XP EDA</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>1</td>
<td>EA KICK PLATE</td>
<td>8400 10&quot; X 2&quot; LDW B-CS</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>EA GASKETING</td>
<td>188SBK PSA</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>3</td>
<td>EA SILENCER</td>
<td>SR64</td>
<td>630</td>
<td>GLY</td>
</tr>
<tr>
<td>1</td>
<td>EA MOTION SENSOR</td>
<td>SCANII 12/24 VDC</td>
<td>BLK</td>
<td>SCD</td>
</tr>
<tr>
<td>1</td>
<td>EA DOOR CONTACT</td>
<td>679-05</td>
<td>WHT</td>
<td>SCE</td>
</tr>
<tr>
<td>1</td>
<td>EA POWER SUPPLY</td>
<td>PS902 900-2RS 120/240 VAC</td>
<td>LGR</td>
<td>SCE</td>
</tr>
</tbody>
</table>

OPERATION: DOOR ALWAYS CLOSED AND LOCKED. ENTRY BY VALID CARD READ. FREE EGRESS AT ALL TIMES BY INSIDE LEVER.

HARDWARE GROUP NO. 09
For use on Door #s:
C2053K.1 C2053K.2
Provide each SGL door(s) with the following:

HARDWARE PROVIDED BY DOOR MFR.

END OF SECTION 08 71 00
SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

1. Glass for windows, doors and interior borrowed lites.
2. Glazing sealants and accessories.

1.3 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of glass product; 12 inches square.

C. Glazing Accessory Samples: For sealants and colored spacers, in 12-inch lengths.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturers of insulating-glass units with sputter-coated, low-E coatings.

B. Product Certificates: For glass.

C. Product Test Reports: For insulating glass and glazing sealants, for tests performed by a qualified testing agency.

D. Preconstruction adhesion and compatibility test report.

E. Sample Warranties: For special warranties.
1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved by coated-glass manufacturer.

B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

1.9 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: Five years from date of Substantial Completion.
C. Manufacturer’s Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer’s written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Glass Product: Subject to compliance with requirements, provide product indicated in glass schedules or comparable product by one of the following:

1. Guardian Industries Corp.
2. PPG Industries, Inc.
3. Viracon, Inc.
4. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.

1. Obtain tinted glass from single source from single manufacturer.
2. Obtain reflective-coated glass from single source from single manufacturer.

C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer’s published test data, based on procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
2. For laminated-glass lites, properties are based on products of construction indicated.
3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.


B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.

1. Minimum Glass Thickness for Exterior Lites: 6 mm.
2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

D. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.

B. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
C. Silicone-Coated Spandrel Glass: ASTM C 1048, Type I, Condition C, Quality-Q3.

2.5 LAMINATED GLASS

A. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.
2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
3. Interlayer Color: Clear unless otherwise indicated.

2.6 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.

1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
2. Spacer: Aluminum with mill or clear anodic finish.

2.7 GLAZING SEALANTS

A. General:

1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.

2.8 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

2.9 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

   a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   2. Presence and functioning of weep systems.
   3. Minimum required face and edge clearances.
   4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.
   1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.5 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.
D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.6 MONOLITHIC GLASS SCHEDULE

A. Glass Type “G”: Clear annealed float glass.
   1. Minimum Thickness: 6 mm.

B. Glass Type “T”: Clear fully tempered float glass.
   1. Minimum Thickness: 6 mm.
   2. Safety glazing required.

3.7 GLASS SCHEDULE

B. CLEAR FLOAT GLASS
   1. Description: Type I, Class 1, Quality q3.
   2. Thickness: 1/4” unless otherwise noted.

C. CLEAR SAFETY GLASS
   1. Description: Type I, Class 1, Quality q3, Kind FT, Condition A.
   2. Thickness: 1/4” unless otherwise noted.

D. CLEAR INSULATING FLOAT GLASS
   1. Description: Type I, Class 1, Quality q3.
   2. Low Emissivity Coating: Magnetically sputtered on second surface.
   3. Thickness: 1/4” glass, 1/2” air space, 1” overall.

END OF SECTION 08 80 00
SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
      2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.
   B. Related Requirements:
      1. Section 09 21 23 "Gypsum Board Shaft Wall Assemblies" for fire rated wall assemblies.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
   B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS
   A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
B. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
   1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.

   1. Steel Studs and Runners:
      a. Minimum Base-Metal Thickness, unless otherwise indicated:
         1) Framing behind standard panels: 0.0269" inches
         2) Framing behind impact resistant panels: 0.0329" inches
         3) Framing behind tile backer panels: 0.0329 inches
      b. Depth: 3-5/8 inches unless otherwise indicated.

D. Slip-Type Head Joints: Where indicated, provide the following:
   1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

E. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   1. Minimum Base Metal Thickness: 0.027 inches
   2. Backing Plate: 4" width min, 20 guage. Provide at all locations where blocking is required for wall supported items.

G. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch-wide flanges.
   1. Depth: 1-1/2 inches
   2. Clip Angel: Not less than 1-1/2 inches by 1-1/2 inches, 0.068 inches thick, galvanized steel.

H. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
   1. Minimum Base-Metal Thickness: 0.033 inch .
   2. Depth: As indicated on Drawings.

I. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.018 inch , and depth required to fit insulation thickness indicated.
2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

B. Hanger Attachments to Concrete:
   1. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.

D. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Chicago Metallic Corporation; Drywall Grid System.
      c. USG Corporation; Drywall Suspension System.
      d. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.
   1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide one of the following:
   1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
   2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.

2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistant materials from damage.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and metal blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.

2. Multilayer Application: 16 inches o.c. unless otherwise indicated.

3. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.
B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

   a. Install two studs at each jamb unless otherwise indicated.
   b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
   c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

   a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

6. Curved Partitions:

   a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
   b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.

E. Direct Furring:

   1. Screw to wood framing.
   2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
F. Z-Furring Members:

1. Erect insulation, specified in Section 07 21 00 "Thermal Insulation," vertically and hold in place with Z-furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: 48 inches o.c.
2. Carrying Channels (Main Runners): 48 inches o.c.
3. Furring Channels (Furring Members): 16 inches o.c.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
   a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel roof deck.
6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support

F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 22 16
SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Interior gypsum board.
      2. Tile backing panels.
   B. Related Requirements:
      1. Section 09 22 16 "Non-Structural Metal Framing" for non-structural framing and
         suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Samples: For the following products:
      1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim
         accessory indicated.

1.4 DELIVERY, STORAGE AND HANDLING
   A. Store materials inside under cover and keep them dry and protected against weather,
      condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack
      panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS
   A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board
      manufacturer's written recommendations, whichever are more stringent.
   B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. American Gypsum.
2. CertainTeed Corp.
3. Georgia-Pacific Gypsum LLC.
5. USG Corporation.
6. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Gypsum Board, Type X: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch (15.9 mm).
2. Long Edges: Tapered.

C. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: 5/8 inch (15.9 mm), Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

D. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

E. Impact-Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to ASTM C 1629/C 1629M.
1. Core: **5/8 inch (15.9 mm), Type X**
2. Surface Abrasion: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements.
3. Indentation: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.
7. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

F. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
1. Core: 5/8 inch (15.9 mm), Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.
1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
2. Shapes:
   a. Cornerbead.
   b. LC-Bead: J-shaped; exposed long flange receives joint compound.
   c. L-Bead: L-shaped; exposed long flange receives joint compound.
   d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
   e. Expansion (control) joint.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Fry Reglet Corp.
   b. Drywall Molding End Closure – DMEC
2. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.


2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:
   1. Interior Gypsum Board: Paper.
   2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
   1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
   2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
      a. Use setting-type compound for installing paper-faced metal trim accessories.
   3. Fill Coat: For second coat, use setting-type, sandable topping compound.
   4. Finish Coat: For third coat, use setting-type, sandable topping compound.
   5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

D. Joint Compound for Tile Backing Panels:
   1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.6 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer’s written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
   1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

E. Acoustical Joint Sealant: Manufacturer’s standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Accumetric LLC; BOSS 824 Acoustical Sound Sealant.
   b. Grabber Construction Products; Acoustical Sealant GSC.
   d. USG Corporation; SHEETROCK Acoustical Sealant.
   e. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

F. Thermal Insulation: As specified in Section 07 21 00 “Thermal Insulation.”

G. Vapor Retarder: As specified in Section 07 21 00 “Thermal Insulation.”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
   1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
   2. Fit gypsum panels around ducts, pipes, and conduits.
   3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:
   1. Type X: As indicated on Drawings.
   2. Moisture- and Mold-Resistant Type: Walls to 48" AFF where floor elevation is below surrounding grade on any side of building.

B. Single-Layer Application:
1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.

2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
   a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
   b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.

2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.

3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.

4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer’s written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer’s written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

1. If control joints are not shown on the drawings they shall be located at a maximum of 30 feet o.c. Coordinate exact location with Architect prior to installation.
C. Interior Trim: Install in the following locations:
   1. Cornerbead: Use at outside corners unless otherwise indicated.
   2. LC-Bead: Use at exposed panel edges.
   3. L-Bead: Use where indicated.
   4. U-Bead: Use where indicated.

D. Aluminum Trim: Install in locations indicated on Drawings.

3.5 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840 and Gypsum Association GA-214-10.
   1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
   2. Level 5: All locations.
      a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."

E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.6 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splochy surface contamination and discoloration.
SECTION 09 51 13 - ACOUSTICAL PANEL CEILINGS

1. GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes:

1. Lay-in Acoustical panel ceilings.
2. Metal suspension systems.
3. Aluminum louver lenses.

1.3 SUBMITTALS

A. Product data for each type of product specified.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has successfully installed acoustical ceilings similar to those indicated for Project.

B. Surface Burning Characteristics: ASTM E 84 and ASTM E 1264 for Class A products. Flame spread of 25 or less and smoke developed of 450 or less.


D. Coordination of Work: Coordinate layout and installation of acoustical ceiling with other construction that penetrates ceilings or is supported by them.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver ceiling units in original, unopened packages. Allow units to reach room temperature before installation. Handle carefully to avoid chipping edges.
1.6 PROJECT CONDITIONS

A. Do not install acoustical ceilings until wet-work and work above ceiling is completed, and temperature and humidity will be continuously maintained.

1.7 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish ceiling tiles and suspension system components in quantity equal to 2 percent of amount installed.

2. PRODUCTS

2.1 ACOUSTICAL PANELS

A. The Drawings are based ceiling panel types from one manufacturer as listed below. Another approved manufacturer's system(s) which is/are similar and equivalent nature will be acceptable if specifically approved by Architect by Addendum during bidding period. The drawings are based on the following:

   a. APC-1 Armstrong World Industries, Inc., Ultima #1910, 24” x 24” x 3/4”, square lay-in for 15/16” grid. Color: White
   b. APC-2 Armstrong World Industries, Inc., OPTIMA Health Zone #3314, 24” x 24” x 1 ½” square lay-in for 15/16” grid. Color: White.

2. Other Approved Manufacturers:

   a. Armstrong World Industries, Inc.
   b. USG Interiors, Inc.

Or equal, if and as specifically approved by Architect by Addendum during bidding period. Products must be presented to Architect 48 hours prior to bid date.

2.2 METAL SUSPENSION SYSTEMS

A. Wide-Face, Capped, Double-Web Steel Suspension System: ASTM C 635. Roll-formed from pre-painted or zinc coated cold rolled steel sheet, 15/16 inch-wide, metal caps on flanges; intermediate-duty system.

B. Fire-Resistance-Rated, Wide-Face, Capped, Double-Web Steel Suspension System: ASTM C 635. Roll-formed from pre-painted or zinc-coated cold-rolled steel sheet, 15/16 inch-wide, metal caps on flanges; intermediate-duty system.


C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong World Industries, Inc.
2. Rockfon/Roxul Corporation (Chicago Metallic)
3. USG Interiors, Inc.
4. Or equal, if and as specifically approved by Architect by Addendum during bidding period. Products must be presented to Architect 48 hours prior to bid date.

D. Attachment Devices: Size for 5 times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.

E. Wire for Hangers and Ties: Size for 3 times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated. ASTM A 641, Class 1 zinc coating, soft temper. Minimum 0.106-inch diameter (12 gauge).

F. Edge Moldings and Trim: Manufacturer's standard aluminum moldings and trim.

G. When acoustic panels must be cut to install a recessed light or speaker or where it is necessary to surface apply a fire alarm device or thermostat or similar item, the panel should be reinforced by gluing a full-size piece of ½" type “X” gypsum drywall to the back surface of the panel.

3. EXECUTION

3.1 EXAMINATION

A. Examine substrates and structural framing to which ceiling system attaches or abuts for compliance with requirements specified.

3.2 PREPARATION

A. Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other sections.

B. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less-than-half-width units at borders, and comply with reflected ceiling plans.
3.3 INSTALLATION


B. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure. Splay hangers only where required to miss objects. Offset resulting horizontal forces by bracing, counter splaying, or other equally effective means.

C. Where width of ducts and other construction within ceiling plenum interfere with required spacing of hangers, install supplemental suspension members and hangers in form of trapezes or equivalent devices.

D. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts or other devices that are secure and appropriate for substrate. Do not attach hangers to steel roof deck or deck tabs.

E. Space hangers not more than 4'-0" o.c. along each member and provide hangers not more than 8 inches from ends.

F. Install edge moldings where necessary to conceal edges of acoustical units.

G. Install acoustical panels in coordination with suspension system, with edges concealed by support of suspension members. Scribe and cut panels to fit accurately at borders and at penetrations.

H. Install hold-down clips in areas indicated and in areas required by governing regulations, or for fire-resistance ratings; space as recommended by panel manufacturer, unless otherwise indicated or required.

3.4 CLEANING

A. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

B. If tiles are removed after initial installation to accommodate work by other trades, clean and reset all tiles that have been disturbed.

END OF SECTION 09 51 13
SECTION 09 65 16 – RESILIENT SHEET FLOORING

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Vinyl Sheet flooring.

1.3 SUBMITTALS
   A. Product Data: For each type of product.
   B. Shop Drawings: For each type of flooring. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
      1. Show details of special patterns.
   C. Samples: For each exposed product and for each color and texture specified in manufacturer’s standard size, but not less than 6-by-9-inch (150-by-230-mm) sections.
      1. For heat-welding bead, manufacturer’s standard-size Samples, but not less than 9 inches (230 mm) long, of each color required.
   D. Samples for Initial Selection: For each type of resilient sheet flooring indicated.
   E. Samples for Verification: In manufacturer’s standard size, but not less than 6-by-9-inch (150-by-230-mm) sections of each different color and pattern of resilient sheet flooring required.
      1. For heat-welding bead, manufacturer’s standard-size Samples, but not less than 9 inches (230 mm) long, of each color required.
   F. Welded-Seam Samples: For seamless-installation technique indicated and for each resilient sheet flooring product, color, and pattern required; with seam running lengthwise and in center of 6-by-9-inch (150-by-230-mm) Sample applied to a rigid backing and prepared by Installer for this Project.
   G. Product Schedule: See drawings and finishes schedule.
1.4 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For each type of resilient sheet flooring to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Resilient Sheet Flooring: Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, in roll form and in full roll width for each type, color, and pattern of flooring installed.

1.7 QUALITY ASSURANCE
   A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for resilient sheet flooring installation and seaming method indicated.

   1. Engage an installer who employs workers for this project who are trained or certified by resilient sheet flooring manufacturer for installation techniques required.

   B. Mock-ups: Build mock-ups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

   1. Build mock-ups for resilient sheet flooring including wall base condition and accessories.

       a. Size: Minimum 100 sq. ft. (9.3 sq. m) for each type, color and pattern in locations directed by Architect.

   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Store resilient sheet flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store rolls upright.
1.9 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 85 deg F (29 deg C), in spaces to receive resilient sheet flooring during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).

C. Close spaces to traffic during resilient sheet flooring installation.

D. Close spaces to traffic for 48 hours after resilient sheet flooring installation.

E. Install resilient sheet flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient sheet flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

1.1 RESILIENT SHEET FLOORING

A. Products: Subject to compliance with requirements, provide the following:

1. **RSF-1**: Teknoflor; Forestscapes #31097 Medium Walnut – Represented by Shannon Specialty Flooring 1005 S. 60th St. Milwaukee, WI 53214, (800) 522-9166
2. **RSF-2**: Tarkett/Johnsonite, 16077 Industrial Parkway, Middlefield, OH 44062, (800) 889-8916 – Represented by Taylor Grossenkemper, (913) 558-8531, Taylor.Grossenkemper@tarkett.com
   Product: Acczent Flourish, Colorway: Prosper Solstice #301

2.2 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient sheet flooring manufacturer for applications indicated.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
   1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient sheet flooring.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Prepare substrates according to resilient sheet flooring manufacturer’s written instructions to ensure adhesion of resilient sheet flooring.

B. Concrete Substrates: Prepare according to ASTM F 710.
   1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient sheet flooring manufacturer. Do not use solvents.

3. Alkalinity and Adhesion Testing: Perform tests recommended by resilient sheet flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 10 pH.

4. Moisture Testing: Proceed with installation only after substrates pass testing according to resilient sheet flooring manufacturer's written recommendations, but not less stringent than the following:
   a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
   b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient sheet flooring until it is the same temperature as the space where it is to be installed.
   1. At least 48 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient sheet flooring.

3.3 RESILIENT SHEET FLOORING INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient sheet flooring.

B. Unroll resilient sheet flooring and allow it to stabilize before cutting and fitting.

C. Lay out resilient sheet flooring as follows:
   1. Maintain uniformity of flooring direction.
   2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches (152 mm) away from parallel joints in flooring substrates.
   3. Match edges of flooring for color shading at seams.
   4. Avoid cross seams.

D. Scribe and cut resilient sheet flooring to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, and door frames.

E. Extend resilient sheet flooring into toe spaces, door reveals, closets, and similar openings.
F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on resilient sheet flooring as marked on substrates. Use chalk or other nonpermanent marking device.

G. Install resilient sheet flooring on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.

H. Adhere resilient sheet flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

I. Seamless Installation:
   1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and heat weld with welding bead to permanently fuse sections into a seamless flooring. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.
   2. Chemically Bonded Seams: Bond seams with chemical-bonding compound to permanently fuse sections into a seamless flooring. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on flooring surfaces.

   1. Install metal corners at inside and outside corners.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient sheet flooring.

B. Perform the following operations immediately after completing resilient sheet flooring installation:
   1. Remove adhesive and other blemishes from surfaces.
   2. Sweep and vacuum surfaces thoroughly.
   3. Damp-mop surfaces to remove marks and soil.

C. Protect resilient sheet flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, adhesive, and blemishes from flooring surfaces before applying liquid floor polish.
   1. Apply finish coats per manufacturers written instructions.
E. Cover resilient sheet flooring until Substantial Completion.

END OF SECTION 09 65 16
SECTION 09 72 00 - WALL COVERINGS

1. GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes:

1. Vinyl wall covering.

2. Pre-wallcovering primer. (Required under all wall covering)

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include data on physical characteristics, durability, fade resistance, and flame-resistance characteristics.

B. Shop Drawings: Show location and extent of each wall-covering type. Indicate pattern placement, seams and termination points.

C. Samples for Initial Selection: For each type of wall covering indicated.

D. Samples for Verification: Full width by [36-inch- (914-mm-)] long section of wall covering.

1. Sample from same print run or dye lot to be used for the Work, with specified applied. Show complete pattern repeat. Mark top and face of fabric.

E. Product Schedule: For wall coverings. Use same designations indicated on Drawings.

F. Qualification Data: For qualified testing agency.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for wall covering.

H. Maintenance Data: For wall coverings to include in maintenance manuals.
1.4 QUALITY ASSURANCE

A. Forest Certification: Fabricate products with wood veneer produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Surface-Burning Characteristics: As follows, per ASTM E 84:
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 50 or less.


C. Mock-ups: Build mock-ups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mock-ups for each type of wall covering on each substrate required. Comply with requirements in ASTM F 1141.
2. Approved mock-ups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver wall coverings to the project site in unbroken and undamaged original factory packaging and clearly labeled with the manufacturer’s identification label, quality or grade, and lot number.

B. Store materials in a clean, dry storage area with temperature maintained above 55°F (13°C) with normal humidity.

C. Store materials with original packaging to prevent damage.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Lighting: Do not install wall covering until a permanent level of lighting is provided on the surfaces to receive wall covering.
C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Wall-Covering Materials: For each type, full-size units equal to 5 percent of amount installed.

1.8 WARRANTY

A. All wall covering: Manufacturer's standard five-year warranty against manufacturing defects.

2. PRODUCTS

2.1 WALL COVERINGS

A. Wall Coverings: Subject to compliance with requirements, provide the following:

1. WC-1; Maharam 979 Third Avenue, STE 1701, New York, NY 10022, (212) 319-4789; Represented by Leslie Huckla, (913) 387-9668

   a. Product: Chambray #397140
   b. Color: #136 Reed
   c. Type: Type II
   d. Width: 54"
   e. Backing: Polyester/Cotton Osnaburg
   f. Flamespread: ASTM-E84 Adhered Flame 25, Smoke 45
   g. Installation Method, per manufacturer's written instructions.
   h. Repeat: Non-Match
   i. Weight: 20 oz. per ln/yd.
   j. Bolt size: 30 Linear Yards
   k. Sustainable attributes: Greenguard Gold, Non-Phthalate Vinyl, PFC-Free

2.2 ACCESSORIES

A. Provide all accessories indicated by manufacturers written installation instructions.
3. EXECUTION

3.1 PREPARATION

A. Acclimatize wall covering materials by removing them from packaging in the installation areas not less than 24 hours before installation. Follow all written instructions from manufacturer explicitly.

B. Follow manufacturer’s printed instructions for surface preparation.

C. Prepare substrates to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, and imperfections that would show through the finishes surface. Notify the contractor and architect in writing of any conditions detrimental to the proper and timely completion of the installation.

D. Painted Surfaces: Treat areas susceptible to pigment bleeding.

E. Prime new gypsum board with a recommended primer.

1. Primer shall be one of the following:
   a. Roman R35 Primer.
   b. Sherwin Williams PrepRite Prewallcovering primer B28W980.
   c. Or equal if and as specifically approved by Architect by Addendum during bidding period. Alternates must be submitted 48 hours in advance of bid time and date.

F. Check painted surfaces for pigment bleeding. Sand gloss, semi-gloss, and eggshell finishes with fine sandpaper.

3.2 INSTALLATION

A. Follow manufacturer’s printed instructions for installation.

B. Examine all materials for pattern, color, quantity, and quality, as specified for the correct location prior to cutting.

C. Install wall covering with no gaps or overlaps.

D. Remove air bubbles, wrinkles, blisters, and other defects.

E. Trim edges for color uniformity, pattern match, and tight closure at seams and edges. Butt seams.

F. Install wall covering over cork where required as recommended by manufacturer.
G. **Adhesives:** Adhesive must comply with wall covering manufacturer’s installation requirements, providing a mildew-resistant, nonstaining, and strippable attachment. Clay-based adhesives may be used if recommended by wall covering manufacturer.

2. Or equal if and as specifically approved by Architect by Addendum during bidding period.

3.3 **CLEANING**

A. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.

B. Use cleaning methods recommended by the wall covering manufacturer.

C. Replace strips which cannot be cleaned.

END OF SECTION 09 72 00
SECTION 09 91 23 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Comply with all UMHC standards as per written guidelines.

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on interior substrates.
   1. Gypsum board.
   2. Concrete Masonry Units
   3. Hollow Metal Frames

1.3 SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
   1. Submit Samples on rigid backing, 8 inches (200 mm) square.
   2. Step coats on Samples to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

C. Product List: For each product indicated, include the following:
   1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials from the same product run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.
1.5 QUALITY ASSURANCE

A. Material Quality: Provide the manufacturer’s best quality trade sale paint material of the various coating types specified.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the job site in the manufacturer’s original, unopened packages and containers bearing manufacturer’s name and label.

B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 PAINT, GENERAL

A. Material Compatibility:
   1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

B. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   1. Flat Paints and Coatings: 50 g/L.
   2. Non-flat Paints and Coatings: 150 g/L.
   3. Dry-Fog Coatings: 400 g/L.
   4. Primers, Sealers, and Undercoaters: 200 g/L.
C. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Hues: See finishes legend

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Gypsum Board: 12 percent.
   2. Plaster: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Plaster Substrates: Verify that plaster is fully cured.

E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.

F. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

G. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

B. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and re-prime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
C. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

D. Aluminum Substrates: Remove loose surface oxidation.

E. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

F. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.

G. Spray Textured Ceiling Substrates: Do not begin paint application until surfaces are dry.

H. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable in writing to topcoat manufacturers.
6. The term “exposed surfaces” includes areas visible when permanent or built-in fixtures are in place and all areas as specified herein. Extend paint finishes in these areas as required. If color is not designated, the Architect will select from standard colors.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance. Ensure that edges, corners, crevices, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces. Recoat primed and sealed surfaces where evidence of unsealed areas in first coat appears.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Allow sufficient time between successive coats to permit proper drying.
F. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.

G. Painting includes field painting exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment including all mechanical equipment and materials.

H. Painting is not required on prefinished items, finished metal surfaces, concealed surfaces, operating parts, and labels. Painting is required on all new items included in the work.

I. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.

J. Finish doors on tops, bottoms and side edges same as faces.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

E. Provide “wet paint” signs to protect newly painted finishes.
3.6 INTERIOR PAINT SCHEDULE

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Note: Refer to Finishes Legend for all Hue number/names.

3.7 INTERIOR PAINTING SYSTEMS

A. System GDW-21 for application on Interior Gypsum Drywall Ceilings:

1. Flat Latex Finish: 2 finish coats over primer.
2. Latex-Based Interior White Primer: Latex-based primer coating used on interior gypsum drywall under a flat latex paint.

   a. Devoe: "WonderPure" Primer recommended for substrate listed.
   b. DV: "Health-Kote" Low Odor Primer/Flat Finish, DF-1591.
   d. P & L: Pro-Hide Gold Interior Low Odor Latex Primer, Z9165.
   e. PPG Paints: "Pure Performance" Interior Latex Primer, 9-900 Series.

3. Flat Latex Paint: Latex-based paint for use as a flat finish over prime-coated gypsum drywall.

   a. Devoe: "WonderPure" Low Odor Interior Latex Flat.
   b. DV: "Health-Kote" Low Odor Interior Latex Flat, DF-1591.
   c. Kwal: "Envirokote" Flat Low Odor, 1210.
   e. P & L: Pro-Hide Gold Interior Low Odor Latex Flat, Z9100 Series.
   f. PPG Paints: "Pure Performance" Interior Flat Latex, 9-100 Series.
   g. S-W: ProMar 200 Zero VOC Flat, B30 Series.
   h. S-W: "Harmony" Interior Latex Flat, B5 Series.
B. **System GDW-31 for application on Interior Gypsum Drywall**

1. **Eggshell Latex Enamel Finish**: 2 finish coats over primer.
2. **Latex-Based Interior White Primer**: Latex-based primer coating used on interior gypsum drywall under a eggshell latex paint.
   b. DV: “Health-Kote” Low Odor Primer/Flat Finish, DF-1591.
   e. P & L: Pro-Hide Gold Interior Low Odor Latex Primer, Z9165.
   f. PPG Paints: “Pure Performance” Interior Latex Primer, 9-900 Series.

3. **Eggshell Latex Enamel**: Latex-based paint for use as an eggshell finish over prime-coated gypsum drywall.
   e. P & L: Pro-Hide Gold Interior Low Odor Latex Eggshell, Z9200 Series.
   f. PPG: “Pure Performance” Interior Eggshell Latex, 9-300 Series.
   h. S-W: “Harmony” Interior Latex Eggshell, B9 Series.

C. **System FM-31 for application on Interior Ferrous Metal**:

1. **Full-Gloss Enamel Finish**: 2 coats over primer with total dry film thickness not less than 2.5 mils.
2. **Synthetic, Rust-Inhibiting Primer**: Quick-drying, rust-inhibiting primer for priming ferrous metal on the interior under alkyd gloss enamels:
   a. Devoe: Bar-Ox Quick Dry Metal Primer, 14920 Red.
   b. ICI: Devguard Multi-Purpose Metal Primer, 4160.
   c. Iowa Paint: Meta Kote Rust Inhibitive Metal Primer White, 1064.
   d. Kwal: Rust Inhibiting Metal Primer, 9210.
   e. Moore: Ironclad Retardo Rust-Inhibitive Paint, 163.
   f. PPG: Speedhide Inhibitive Metal Primer, 6-208.
   g. S-W: Kem Kromik Universal Metal Primer, B50NZ6 / B50WZ1.
3. Interior Enamel Undercoat: Ready-mixed enamel for use as an undercoat over a primer on ferrous metal under an interior full-gloss alkyd enamel:
   e. Moore: Moore's Alkyd Enamel Underbody, 217.
   f. PPG: SpeedHide Alkyd Semi-Gloss Enamel, 6-1110 Series.
   g. S-W: Industrial Enamel, B-54Z Series.

4. Exterior Alkyd Gloss Enamel for use over a primer and undercoat on interior ferrous surfaces:
   a. Devoe: Mirrolac Interior/Exterior Alkyd Gloss Enamel, 70XX.
   c. Iowa Paint: Meta Kote Alkyd Urethane Gloss, 480 Series.
   e. Moore: Impervo High-Gloss Enamel, 133.
   f. PPG: SpeedHide Alkyd Semi-Gloss Enamel, 6-1110 Series.
   g. S-W: Industrial Enamel, B-54Z Series.

D. System CONC-1 (SCONC) for application on Interior High Traffic and Mechanical Floors:

1. Concrete Primer: Concrete primer for use over cured concrete.
   a. Application Rate per manufacturer’s instructions:
      1) ICI: PrePrime Penetrating Sealer, 167.
      3) Tnemec: Series 203 Primer.
      4) Or equal by others if and as specifically approved by Architect by Addendum during bidding period.

2. Coved Base: Apply a 4” rolled radius cove to all floor wall/curb transitions if applicable.
   a. Application Rate per manufacturer’s instructions:
      1) ICI: Devthane Self-Priming Epoxy, 235.
      2) PPG: Megaseal High Solids Mixed Primer, 99-6639 Series with Sumed Silica to make cove base.
      3) Tnemec: Series 237 Mortar.
      4) Or equal by others if and as specifically approved by Architect by Addendum during bidding period.
3. Intermediate Coat for use over primed concrete.
   a. Application Rate per manufacturer's instructions:
      1) ICI: BarRust Self-Priming Epoxy, 235.
      2) PPG: Megaseal Self-Leveling Epoxy, 99-6680 Series.
      3) Tnemec: Series 206.

4. Finish coat: 1 coat over intermediate coat and concrete primer. Color as selected by Architect from manufacturers standards:
   a. Application Rate per manufacturer's instructions:
      1) ICI: No 3rd coat required.
      2) PPG: Megaseal High Performance Urethane, 99-6730 Series.
      3) Tnemec: Series 291.
      4) Or equal by others if and as specifically approved by Architect by Addendum during bidding period.

E. System GDW-41 for application on Interior Gypsum Drywall:
   2. Latex-Based Interior White Primer: Latex-based primer coating used on interior gypsum drywall under a flat latex paint.
      a. Devoe: "WonderPure" Primer recommended for substrate listed.
      b. DV: "Health-Kote" Low Odor Primer/Flat Finish, DF-1591.
      e. P & L: Pro-Hide Gold Interior Low Odor Latex Primer, Z9165.
      f. PPG Paints: "Pure Performance" Interior Latex Primer, 9-900 Series.

   3. Semi-Gloss Latex Finish:
      e. P & L: Pro-Hide Gold Interior Low Odor Latex Semi-gloss, Z9300 Series.
F. System GDW-51 for application on Interior Gypsum Drywall:

1. PTE-X: Semi-Gloss Latex Epoxy Finish: Two (2) finish coats over primer.
2. Latex-Based Interior White Primer: Latex-based primer coating used on interior gypsum drywall under an epoxy finish:
   b. SW: “Harmony” Interior Latex Primer, B11W900, applied at 4 mils wet, 1.3 mils dry per coat.
   c. Or equal, if and as specifically approved by Architect by Addendum during bidding period.

3. PTE-X: Semi-Gloss Latex Epoxy Finish: See Finishes Legend for hue:
   a. PPG Paints: Pitt-Glaze WB 1 Water Based Pre-Catalyzed Epoxy (Semi-Gloss). Applied at 1.5 DFT.
   b. SW: Pro Industrial™ Water-Based Catalyzed Epoxy (Semi-Gloss), B70W211 / B60V25, applied at 2.5 – 3 mils dry per coat.
   c. Or equal, if and as specifically approved by Architect by Addendum during bidding period.

END OF SECTION 09 91 23
SECTION 10 21 23 – CUBICLE CURTAINS AND TRACK

PART 1. GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cubicle-curtain tracks and carriers.
2. Cubicle curtains

B. Related Requirements:

1. Section 06 10 00 “Rough Carpentry” for supplementary wood framing and blocking for mounting items requiring anchorage.
2. Section 09 22 16 “Non-Structural Metal Framing” for supplementary metal framing and blocking for mounting items requiring anchorage.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For each type of curtain fabric indicated, include durability, laundry temperature limits, fade resistance, applied curtain treatments, and fire-test response characteristics.

B. Shop Drawings: For curtains and tracks.

1. Show layout and types of cubicles, sizes of curtains, number of carriers, anchorage details, and conditions requiring accessories. Indicate dimensions taken from field measurements.
2. Include details of blocking for track support.

C. Samples: For each exposed product and for each color and texture specified, 10 inches (254 mm) in size.

D. Samples for Initial Selection: For each type of curtain material indicated.
E. Samples for Verification: For each type of product required, prepared on Samples of size indicated below:

1. Curtain Fabric: Not less than 10 inches (254 mm) square and showing complete pattern repeat, from dye lot used for the Work, with specified treatments applied. Mark top and face of material.
2. Mesh Top: Not less than 10 inches (254 mm) square.
3. Curtain Track: Not less than 10 inches (254 mm) long

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For curtains, tracks, and hardware to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Curtain Carriers and Track End Caps: Full-size units equal to 3 percent of amount installed for each size indicated, but not fewer than two units.

PART 2. PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Cubicle Curtains: Provide curtain fabrics with the following characteristics:

1. Laundering: Launderable to a water temperature of not less than 160 deg F (71 deg C).
2. Flame Resistance: Provide fabrics identical to those that have passed NFPA 701 when tested by a qualified testing agency acceptable to authorities having jurisdiction.
   a. Identify fabrics with appropriate markings of a qualified testing agency.

2.2 CUBICLE-CURTAIN SUPPORT SYSTEMS

A. Basis of Design: CS Cubicle Curtains, #6063 suspended-mounted track system.

B. Extruded Aluminum-Curtain Track: Not less than 1-1/4 inches wide by ¾ inch high (32 mm wide by 18 mm high).

1. Track Minimum Wall Thickness: 0.050 inch (1.27 mm).
2. Curved Track: Factory-fabricated, 12-inch- (305-mm-) radius bends.
C. PVC Curtain Track: Not less than 1-1/4 inches wide by 15/16 inch high (32 mm wide by 24 mm high).
   1. Curved Track: Factory-fabricated, 12-inch- (305-mm-) radius bends.

D. Curtain Track Accessories: Fabricate splices, end caps, connectors, end stops, coupling and joining sleeves, wall flanges, brackets, ceiling clips, and other accessories from same material and with same finish as track.
   1. Suspended-Track Support: Not less than 7/8-inch- (22.2-mm-) OD tube.
   2. End Stop: Removable with carrier hook.
   3. Switch Unit: Shuttle and coupling device for rerouting and securing cubicle curtain, with pull chain for switching track.

E. Curtain Roller Carriers: Two nylon rollers and nylon axle with nylon hook.

F. Curtain Glide Carriers: One-piece nylon glide with nylon hook.

G. Breakaway Curtain Carriers: One-piece nylon breakaway curtain carriers designed to allow curtains to detach from tracks with a pulling force of no more than 5 lbf (22.2 N).

H. Exposed Fasteners: Stainless steel.

I. Concealed Fasteners: Stainless steel.

2.3 CURTAINS

A. Basis of Design: On the Right Track, Inc. cubicle curtain as manufactured by CS Cubicle Curtains.

B. Fabric: Arc Com, 33 Ramland Rd. south, Orangeburg, NY 10962; Represented by Gay Miller, (816) 500-4719.
   1. Product: Dahlia-X.
   2. Colorway: AC-33282X-Fog #3 with Silver Antimicrobial Fiber.

C. Curtain Grommets: Two-piece, rolled-edge, rustproof, nickel-plated brass; spaced not more than 6 inches(152 mm) o.c.; machined into top hem.

D. Mesh Top: Not less than 19” high mesh top.

E. Snap Attachments: Provide manufacturer's standard nickel-plated brass snap attachments for modular panels.

F. Curtain Tieback: Nickel-plated brass chain; one at each curtain termination.
2.4 CURTAIN FABRICATION

A. Continuous Curtain Panels:

1. Width: Equal to track length from which curtain is hung plus 10 percent of added fullness, but not less than 12 inches (305 mm) of added fullness.
2. Length: Equal to floor-to-ceiling height, minus depth of track and carrier at top, and minus clearance above the finished floor of 12 inches (305 mm).
3. Retain "Top Hem" or "Mesh Top" Subparagraph below.
4. Top Hem: Not less than 1 inch (25.4 mm) and not more than 1-1/2 inches (38 mm) wide, triple thickness, reinforced with integral web, and double lockstitched.
5. Mesh Top: Top hem of mesh not less than 1 inch (25.4 mm) and not more than 1-1/2 inches (38 mm) wide, triple thickness, reinforced with integral web, and double lockstitched. Double lockstitch bottom of mesh directly to 1/2-inch (13-mm) triple thickness, top hem of curtain fabric.
6. Vertical Seams: Not less than 1/2 inch (13 mm) wide, double turned and double stitched.

PART 3. EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install tracks level and plumb, according to manufacturer's written instructions.

B. For tracks of up to 20 feet (6.0 m) in length, provide track fabricated from single, continuous length.


C. Suspended-Track Mounting: Install track with manufacturer's standard tubular aluminum suspended supports at intervals and with fasteners recommended by manufacturer. Fasten supports to structure. Provide supports at each splice and tangent point of each corner. Secure ends of track to wall with flanged fittings or brackets.

D. Track Accessories: Install splices, end caps, connectors, end stops, coupling and joining sleeves, and other accessories as required for a secure and operational installation.

1. Provide one locking switch unit for each pair of beds.
2. Provide one hinged loading unit for each pair of beds with locking switch unit.
E. Curtain Carriers: Provide curtain carriers adequate for 6-inch (152-mm) spacing along full length of curtain plus an additional carrier.

F. Cubicle Curtains: Hang curtains on each curtain track.

END OF SECTION 10 21 23
SECTION 10 26 00 - WALL AND DOOR PROTECTION

1. GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of wall surface protection systems:

1. Surface-Mount Corner Guards.
2. Abuse-resistant Crash Rails.
3. Abuse-resistant wall coverings.

1.3 SUBMITTALS

A. Product data for each wall surface protection system component and installation accessory.

B. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.

C. Shop Drawings: For each type of wall and door protection showing locations and extent.

1. Include plans, elevations, sections, and attachment details.

D. Samples for Initial Selection: For each type of impact-resistant wall-protection unit indicated, in each color and texture specified.

1. Include Samples of accent strips and accessories to verify color selection.

E. Samples for Verification: For each type of exposed finish on the following products, prepared on Samples of size indicated below:

F. Abuse-Resistant Wall Covering: 6 by 6 inches (150 by 150 mm) square.
1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.
   
   1. Include recommended methods and frequency of maintenance for maintaining best condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   
   1. Abuse-resistant wall coverings: Equal to 2 percent of each type, color, and texture installed.

1.6 QUALITY ASSURANCE

A. Fire Performance Characteristics: ASTM E 84. Flame spread of 25 or less and smoke developed of 450 or less.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
   
   1. Maintain room temperature within storage area at not less than 70 deg F (21 deg C) during the period plastic materials are stored.
   2. Keep plastic materials out of direct sunlight.
   3. Store plastic wall- and door-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F (21 deg C).

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   
   1. Maintain room temperature within storage area during installation at not less than 65 deg F (18 deg C) more than 75 deg F (24 deg C) during the period plastic materials are stored.
   2. After installation, maintain room temperature at not less than 60 deg F (16 deg C) nor more than 80 deg F (27 deg C).
B. Lighting: Do not install wall covering until a permanent level of lighting is provided on the surfaces to receive wall covering.

C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of wall- and door-protection units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
   b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.

2. Warranty Period: Five years from date of Substantial Completion.

2. PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by Manufacturer listed below. Other equivalent products may be accepted if and as specifically approved by Architect by Addendum during bidding period. (See Submittals.)

   1. The C/S Group (Acrovyn)
   2. Inpro Corporation
   3. Pawling Corporation

2.2 CORNER GUARDS

A. Rigid Plastic Material: ASTM D 256. Extruded, textured, chemical and stain-resistant, high-impact, polyvinyl chloride (PVC) or acrylic modified vinyl plastic.

   1. Surface-Mounted Corner Guards: Surface-mounted 2” x 2” guard with adjustable top and bottom end caps and surface mounted retainer made from recycled plastic with a sharp nose profile.

      a. **CG-1**, C/S Group (Acrovyn) 90 degree Surface-Mounted Corner Guards by The C/S Group, Model SSM-20N or equivalent product by other approved manufacturers.
      b. **CG-2**, C/S Group (Acrovyn) 180 degree Surface-Mounted End Wall Corner Guards by The C/S Group, Model SSM-25N, or equivalent product by other approved manufacturers.
2.3 ABUSE-RESISTANT WALL COVERINGS

A. Abuse-Resistant Sheet Wall Covering: Fabricated from semi-rigid, plastic sheet wall-covering material.

1. C/S Group (Acrovyn) 4000 High-Impact Wall Covering by the C/S Group.

   a. **SP-1** Color/Finish— Irish Cream, 997 (Velvet).

2. Size: 48 by 96 inches (1219 by 2438 mm) or 48 by 120 inches (1219 by 3048 mm) sheet.
3. Sheet Thickness: 0.060 inch.
4. Height: Wainscot, as indicated.
5. Caulk (between panels): Color-matched or clear caulk to match High-Impact Wall Covering HIWC-1 wall covering, Typ.
6. Trim Moldings for Top Edge of High Impact Wall Covering: Color to match High-Impact Wall Covering HIWC-1 wall covering, Typ.


2.4 ABUSE-RESISTANT CRASH RAILS

A. Provide Crash Guard/Hand Rail as follows. Provide corner guards complete with anchors as required to suite adjoining wall construction in which they are installed.

1. Surface Mounted Heavy-Duty Polymer Crash Rail/Hand rail:

   a. **CR-1**: Cloutman & Stingley 8301 State Line road, STE 101, Kansas City, MO 64116-1600 (816) 444-5090

      1) HR1: Acrovyn HRB20+SCR-80N - #997 Irish Cream

2.5 MATERIALS

A. Plastic Materials: Chemical- and stain-resistant, high-impact-resistant plastic with integral color throughout; extruded and sheet material as required, thickness as indicated.

B. Polycarbonate Plastic Sheet: ASTM D 6098, S-PC01, Class 1 or Class 2, abrasion resistant; with a minimum impact-resistance rating of 15 ft.-lbf/in. (800 J/m) of notch when tested according to ASTM D 256, Test Method A.
C. Adhesive: As recommended by protection product manufacturer.

2.6 FABRICATION

A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.

B. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.

C. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.
2.7 FINISHES

A. General: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

B. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

3. EXECUTION

3.1 EXAMINATION

A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.

   1. For wall and door protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Acclimatize wall covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

B. Follow manufacturer's printed instructions for surface preparation.

C. Complete finishing operations, including painting, before installing wall and door protection.

D. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

A. Installation Quality: Install wall and door protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
B. Mounting Heights: Install wall and door protection in locations and at mounting heights indicated on Drawings.

C. Abuse-Resistant Wall Covering: Install top and edge moldings, corners, and divider bars as required for a complete installation.

D. Adhesives: Adhesive must comply with wall covering manufacturer’s installation requirements, providing a mildew-resistant, non-staining, and strippable attachment.

3.4 CLEANING

A. Immediately upon completion of installation, clean wall surface protection systems using methods and materials recommended by manufacturer. Remove excess adhesive. Leave area of installation in clean, neat condition.

END OF SECTION 10 26 00
SECTION 10 44 13 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fire-protection cabinets for the following:

a. Portable fire extinguishers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.

B. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.5 COORDINATION

A. Coordinate sizes and locations of fire-protection cabinets with wall depths.

1.6 SEQUENCING

A. Apply decals on field-painted fire-protection cabinets after painting is complete.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

2.2 FIRE-PROTECTION CABINET

A. Cabinet Type: Suitable for standard 10 lb fire extinguisher.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. JL Industries, Inc.; a division of the Activar Construction Products Group.
   b. Larsens Manufacturing Company.
   c. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Cabinet Construction: Nonrated

1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch- (1.09-mm-) thick cold-rolled steel sheet lined with minimum 5/8-inch- (16-mm-) thick fire-barrier material. Provide factory-drilled mounting holes.

C. Cabinet Material: Stainless Steel.

A. Recessed Cabinet:

1. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
   a. Coordinate with all wall types where cabinets are to be installed and note on Shop Drawings for Architects review.

B. Cabinet Trim Material: Same material and finish as door.

C. Door Material: Stainless Steel.

D. Door Style: Vertical duo panel with frame.

E. Door Glazing: Tempered float glass (clear).

F. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide projecting door pull and friction latch.
FIRE PROTECTION CABINETS

2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

G. Accessories:
1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.

H. Materials:
1. Cold-Rolled Steel: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
   a. Finish: stainless steel
2. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.3 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
   1. Weld joints and grind smooth.
   2. Provide factory-drilled mounting holes.
   3. Prepare doors and frames to receive locks.
   4. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
   1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch (13 mm) thick.
   2. Fabricate door frames of one-piece construction with edges flanged.
   3. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.4 GENERAL FINISH REQUIREMENTS

B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for recessed and semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
   1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semirecessed fire-protection cabinets.
   2. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

C. Identification: Apply decals, vinyl lettering at locations indicated.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 13
SECTION 12 36 61 - SIMULATED STONE COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Solid-surface-material countertops and backsplashes.

1.3 ACTION SUBMITTALS

A. Product Data: For countertop materials and sinks.

B. Laboratory Test Reports for Credit IEQ 4: For adhesives, sealants and composite wood and agrifiber products, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

D. Samples for Initial Selection: For each type of material exposed to view.

E. Samples for Verification: For the following products:

1. Countertop material, 6 inches square.

1.4 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.
1.5  COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1  COUNTERTOP MATERIALS

A. Configuration: Provide countertops with the following front and backsplash style:

1. Front: Straight, slightly eased at top 1-1/2-inch laminated bullnose.
2. Backsplash: Straight, slightly eased at corner.

B. Countertops: 3/4-inch thick, solid surface material with front edge built up with same material.

C. Backsplashes: 3/4-inch thick, solid surface material.

D. Fabrication: Fabricate tops in one piece with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid-surface-material manufacturer’s written instructions for adhesives, sealers, fabrication, and finishing.

1. Fabricate with loose backsplashes for field assembly.

E. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

F. Adhesives: Adhesives shall not contain urea formaldehyde.

G. Adhesives: Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

H. SSM-1; Solid Surface Material: Homogeneous solid sheets of filled plastic resin complying with ANSI SS1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Or equal if and as specifically approved by Architect by Addendum during the bidding period. Submittals must be received by Architect 48 hours prior to bid date and time.

2. Type: Provide Standard Type unless Special Purpose Type is indicated.

3. Colors and Patterns: Corian, Concrete

4. Details: Provide all return aprons/edges as required for GWB wall conditions. No exposed L-shape edge will be acceptable.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install countertops level to a tolerance of 1/8 inch in 8 feet.

B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
   1. Install backsplashes and end-splashes to comply with manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
   2. Sinks: Install all sinks in strict accordance with manufacturers written instructions. Review all plumbing specifications.
   3. Color-match paintable silicone caulk all joints.
   4. Seal edges of cutouts in particleboard sub-tops by saturating with varnish.

END OF SECTION 12 36 61
SECTION 13 49 00 – RADIATION PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Lead sheet, strip, and plate.
2. Lead-lined concrete masonry units.
3. Lead glass.
4. Lead-lined, hollow-metal doors and door frames.
5. Lead-lined, observation-window frames.
6. Informational signs.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. See Section 08 34 49 “special function doors – RADIATION SHIELDING DOORS” for requirements for multi-panel shielded sliding door.

1.3 DEFINITIONS

A. Lead Equivalence: The thickness of lead that provides the same attenuation (reduction of radiation passing through) as the material in question under the specified conditions.

1. Lead equivalence specified for materials used in diagnostic x-ray rooms is as measured at 100 kV unless otherwise indicated.

1.4 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1. Review methods and procedures related to radiation protection including, but not limited to, the following:

a. Sequence and schedule of radiation protection work in relation to other work.
RADIATION PROTECTION

b. Supplementary lead shielding at duct, pipe, and conduit penetrations of radiation protection.
c. Methods of attaching other construction and equipment to lead-lined finishes.
d. Notification procedures for work that requires modifying radiation protection.
e. Requirements for field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show layout of radiation-protected areas. Indicate lead thickness or lead equivalence of components. Show components and installation conditions not fully dimensioned or detailed in product data.
   1. Show ducts, pipes, conduit, and other objects that penetrate radiation protection; include details of penetrations.
   2. Show details of neutron-shielding doors and frames, including anchorage to and coordination with other work. Show locations of electrical conduit and boxes for connecting door operators, door operator switches, and door interlock switches.
      a. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Product Schedule: For observation windows, doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For neutron-shielding doors to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.
B. Testing Agency Qualifications: Licensed by authorities having jurisdiction to perform radiation shielding surveys.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Lead-Lined, Hollow-Metal Doors and Frames: Comply with requirements in Section 081113 "Hollow Metal Doors and Frames" for delivery, storage, and handling.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install radiation protection until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Field Measurements: Verify actual dimensions of openings for by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide materials and workmanship, including joints and fasteners, that maintain continuity of radiation protection at all points and in all directions equivalent to materials specified in thicknesses and locations indicated.

1. Materials, thicknesses, and configurations indicated are based on radiation protection design prepared by Owner's radiation health physicist. This design is available to Contractor on request.

B. Lead-Lined Assemblies: Unless otherwise indicated, provide lead thickness in doors, door frames, window frames, penetration shielding, joint strips, film transfer cabinets, and other items located in lead-lined assemblies not less than that indicated for assemblies in which they are installed.

C. Lead Glazing: Unless otherwise indicated, provide lead equivalence not less than that indicated for assembly in which glazing is installed.

D. Fire-Rated and Smoke-Control Door and Frame Assemblies: Comply with Section 08 11 13 "Hollow Metal Doors and Frames"
2.2 MANUFACTURERS

A. Source Limitations: Obtain each type of radiation protection product from single source from single manufacturer unless otherwise indicated.

2.3 MATERIALS

   1. Subject to compliance with requirements, provide Sheet Lead or comparable product by one of the following:
      a. Radiation Protection Products.
      b. Mayco Industries
      c. Ray-Bar Engineering Corporation

B. Lead-Lined Concrete Masonry Units: Fabricated from two solid concrete units, complying with ASTM C 90 or ASTM C 129, separated vertically by a single sheet of lead permanently bonded or anchored between the two halves. Size lead sheets to provide a 1-inch (25-mm) overlap with adjacent units or provide supplemental lead to ensure uninterrupted protection.
   1. Furnish special shapes as needed to maintain bond without cutting units.
   2. Furnish lead wool for filling voids or joints.

C. Masonry Mortar: Comply with Section 04 20 00 “Unit Masonry.”


E. Grout: ASTM C 476, with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.
   1. For grouting frames of neutron-shielding doors, use coarse grout made with aggregate having a density not less than that used for concrete walls in which frames are installed.

F. Lead Glass: Lead-barium, polished glass containing not less than 60 percent heavy metal oxides, including not less than 48 percent lead oxide by weight.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Radiation Protection Products, Inc; leaded glass or comparable product by one of the following:
      a. A&L Shielding, Inc.
      b. Accurate Radiation Shielding, Inc.
      c. Amerope Enterprises, Inc.
      d. El Dorado Metals, Inc.
      e. Hot Cell Services Corporation.
      f. Mars Metal Company.
   a. Outer Ply: Clear float glass.
   b. Interlayer: Clear polyvinyl butyral.
   c. Inner Ply: Lead glass; thickness as needed to provide lead equivalence indicated

G. Glazing Compounds, Gaskets, and Accessories: Comply with requirements in Section 08 80 00 "Glazing."

H. Accessories and Fasteners: Manufacturer's standard fasteners and accessories as required for installation, maintaining same lead equivalence as rest of system.

I. Asphalt Coating: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

J. Asphalt Felt: ASTM D 226/D 226M.

2.4 LEAD-LINED, HOLLOW-METAL DOORS (HMD-1)

A. General: Steel doors complying with NAAMM-HMMA 861, except with a single continuous sheet of lead of thickness not less than that required for partition in which door is installed extending from top to bottom and edge to edge, installed either between back-to-back stiffeners or between stiffeners and stop face of door.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. A&L Shielding, Inc.
   b. Deronde Products.
   c. Door Components, Inc.
   d. El Dorado Metals, Inc.
   e. Karpen Steel Custom Doors & Frames.
   f. Mars Metal Company.
   g. New Shield, Inc.
   h. Ray-Bar Engineering Corp.
   i. Republic Doors and Frames.

2. Line inverted channels at top and bottom of doors with lead sheet of same thickness used in door and close with filler channels to provide flush top and bottom edges.
3. Shield cutouts for locksets with lead sheet of same thickness used in door. Lap lining of cutouts with door lining 1 inch (25 mm).
4. Prepare doors to receive observation windows; cut and trim openings through doors in factory. Furnish removable stops for glazed openings.
5. Furnish lead-lined astragals for pairs of doors.
6. Factory fit doors to suit frame-opening sizes indicated with [1/16-inch (1.5-mm)] clearance at heads and jambs and minimum clearance at bottom.
7. Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating
   a. Color and Gloss: As selected by Architect from manufacturer's full range.

2.5 LEAD-LINED, HOLLOW-METAL DOOR FRAMES AND WINDOW FRAMES

A. General: Steel door frames complying with NAAMM-HMMA 861, lined with lead sheet of thickness not less than that required for doors and walls where frames are used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. A&L Shielding, Inc.
   b. Aaccurate Radiation Shielding, Inc.
   c. Deronde Products.
   d. Door Components, Inc.
   e. El Dorado Metals, Inc.
   f. Fluke Biomedical.
   g. Karpen Steel Custom Doors & Frames.
   h. Mars Metal Company.
   i. Mayco Industries.
   j. NELCO, Inc.
   k. New Shield, Inc.
   l. Pioneer Industries.
   m. Pitts Little Corporation.
   n. Ray-Bar Engineering Corp.
   o. Republic Doors and Frames.

2. Furnish with additional reinforcements and internal supports to adequately carry the weight of lead-lined doors. Install reinforcements and supports before installing lead lining.
3. Form lead sheet to match frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Fabricate lead lining wide enough to maintain an effective lap with lead of adjacent shielding.
4. Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating
   a. Color and Gloss: As selected by Architect from manufacturer's full range.
2.6 INFORMATIONAL SIGNS

A. Informational Signs: Comply with Section 10 14 23 "Panel Signage."
   1. Color: As selected by Architect from manufacturer's full range of colors.
   2. Provide copy indicated or as directed.
   3. Indicate lead equivalence in millimeters and heights of radiation protection in inches.

B. Rooms Where the Level of Protection Is Uniform Throughout: Provide one sign for each room indicating lead equivalence of partitions, ceilings, floors, doors, and other portions of radiation protection enclosure. Indicate height of radiation protection above floor or indicate that partitions are radiation protected to full height.

C. Rooms Where the Level of Protection Is Not Uniform Throughout: Provide one sign for each room with different lead equivalences in different locations. Indicate, in tabular form, lead equivalence of each wall, partition, ceiling, floor, door, and window. Indicate height of radiation protection above floor or indicate that partitions are radiation protected to full height. Indicate where lead equivalence changes or is not continuous.

D. Rooms Where Some Partitions Are without Radiation Protection: Provide one sign for each partition that contains radiation protection and indicate its lead equivalence. Indicate height of radiation protection above floor or indicate that partitions are radiation protected to full height.

E. Rooms Where Only the Door Has Radiation Protection: Provide one sign for each door indicating its lead equivalence.

2.7 DOOR AND DOOR FRAME FABRICATION

A. Hardware Preparation: Factory prepare doors and frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Section 08 71 00 "Door Hardware."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates in areas to receive radiation protection, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of radiation protection.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION OF LEAD-LINED CONCRETE MASONRY UNITS

A. Lay units in running bond, using methods recommended in writing by concrete masonry unit manufacturer.

B. Cut units, as needed, without disturbing bond between lead and concrete, and without reducing required lapping margin or shielding qualities.

C. Blocks Designed to Have Lead Laps at Joints: Lay units with tight lead laps without soldering or burning.

D. Blocks Designed to Have Lead Bars in Joints: Lay units with lead bars, of thickness not less than that required in block, in each horizontal and vertical joint. Position bars directly adjacent to lead lining with bars overlapping lead lining at least twice the thickness of lead lining, but not less than 1/2 inch (13 mm).

E. Mortar Joints: Lay units with 1/2-inch (13-mm) solidly filled mortar joints. Keep lead laps free of intervening mortar. Cut joints flush with face of units.

F. Wraparound Metal Frames: Extend units into frame openings with lead lining projecting into rabbets of frames to effectively lap with lead frames or frame linings at least 1 inch (25 mm).

G. Pipe and Conduit Chases: Where pipe and conduit chases occur within blocks, faces can be removed from one side to permit installation. Where necessary to remove lead lining for pipe and conduit installation, install continuous lead sheet and overlap adjoining lead protection at least 1 inch (25 mm). Fill voids around pipe and conduit chases with mortar, finished flush with face of partition. Do not locate pipe and conduit chases directly opposite each other in same partition.

3.3 INSTALLATION OF LEAD-LINED DOORS AND DOOR FRAMES

A. Install lead-lined steel doors and door frames according to Section 08 11 13 "Hollow Metal Doors and Frames."

1. Apply a coat of asphalt mastic or paint to lead lining in door frames where lead comes in contact with masonry or grout.

B. Install lead-lined wood doors according to Section 08 14 16 "Flush Wood Doors."

C. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with door manufacturer’s written instructions.
D. Frames: Comply with HMMA 840 unless otherwise indicated. Except for frames located in existing walls or partitions, place frames before constructing walls. Set frames accurately in position, plumb, and brace securely until permanent anchors are set.

1. Provide three anchors per jamb, located adjacent to hinge on hinge jamb and at corresponding heights on strike jamb.
2. In masonry construction, use wire or T-strap anchors and apply a coat of asphalt mastic or paint to lead lining where lead comes in contact with masonry or grout.
3. In metal stud construction, use wall anchors attached to studs with screws.
4. In wood stud construction, use strap anchors attached to studs with screws.

E. Lap lead lining of frames over lining in walls at least 1 inch (25 mm).

F. Lead Lining of Frames: Line inside of frames with lead of thickness not less than that required in doors and walls where frames are used. Form lead to match frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Lap lining over lining in walls at least 1 inch (25 mm).

G. Install doors in frames level and plumb, aligned with frames and with uniform clearance at each edge.

H. Line astragals with lead sheet.

I. Hardware: Line covers, escutcheons, and plates to provide effective shielding at cutouts and penetrations of frames and doors. See Section 08 71 00 "Door Hardware" for other installation requirements.

J. Touch up damaged finishes with compatible coating after sanding smooth.

K. Operation: Rehang or replace doors that do not swing or operate freely. Check and readjust operating hardware items, leaving doors and frames undamaged and in proper operating condition.

3.4 INSTALLATION OF LEAD-LINED WINDOWS

A. Install observation windows according to manufacturer’s written installation instructions.

1. Apply a coat of asphalt mastic or paint to lead lining in frames where lead comes in contact with masonry or grout.

B. Install windows level, plumb, square, true to line, and anchored securely in place to structural support.

C. Install leaded side of frame on radiation side of wall. Lap lead lining of frames over lining in walls at least 1 inch (25 mm).
D. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with manufacturer's written instructions.

3.5 INSTALLATION OF PENETRATING ITEMS

A. At penetrations of lead linings, provide lead shields to maintain continuity of protection.

B. Provide lead linings, sleeves, shields, and other protection in thickness not less than that required in assembly being penetrated.

C. Secure shields at penetrations using adhesive or wire ties but not penetrating fasteners unless indicated on Drawings.

D. Film Transfer Cabinets: Where film transfer cabinets occur in lead-lined partitions, line wall flange with lead sheet of same thickness as required for partition where it is located.

E. Outlet Boxes and Conduit: Cover or line with lead sheet lapped over adjacent lead lining at least 1 inch (25 mm). Wrap conduit with lead sheet for a distance of not less than 10 inches (250 mm) from box.

F. Duct Openings: Unless otherwise indicated, line or wrap ducts with lead sheet for distance from partition/ceiling equal to three times the largest opening dimension. Lap lead sheet with adjacent lead lining at least 1 inch (25 mm).

G. Piping: Unless otherwise indicated, wrap piping with lead sheet for a distance of not less than 10 inches (250 mm) from point of penetration.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections after radiology equipment has been installed and placed in operating condition.

B. Correct deficiencies in or remove and replace radiation protection that inspection reports indicate does not comply with specified requirements.

C. Prepare test and inspection reports.

3.7 PROTECTION

A. Lock radiation-protected rooms once doors and locks are installed, and limit access to only those persons performing work in the rooms.

END OF SECTION 13 49 00
SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Pipes, fittings, and specialties.
      2. Sprinklers.
      3. Iron butterfly valves with indicators.
      4. Trim and drain valves.

1.3 DEFINITIONS
   A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.
   B. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
   C. SBR: Styrene-butadiene rubber.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
   B. Shop Drawings: For wet-pipe sprinkler systems.
      1. Include plans, elevations, sections, and attachment details.
   C. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer, licensed in the State of Missouri, responsible for their preparation. Shop drawings and hydraulic calculations shall be submitted to MUHC for review and approval.
1.5 INFORMATIONAL SUBMITTALS

A. Design Data:

1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

B. Welding certificates.

C. Field Test Reports:

1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor’s Material and Test Certificate for Aboveground Piping."

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer’s responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:


B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.

1. Available fire pump flow test records indicate the following conditions:

   a. Rated flow: 1,250 gpm.
   b. Rated pressure: 120 psig.
   c. If standard coverage sprinklers are provided and same pipe sizes used as existing, no hydraulic calculations are required. Hydraulic calculations shall be required if extended coverage sprinklers are used, or if pipe sizes differ from existing.

2. Sprinkler system design shall be approved by authorities having jurisdiction.

   a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
   b. Sprinkler Occupancy Hazard Classifications:

      1) Equipment Rooms: Ordinary Hazard, Group 1.
      2) General Storage Areas, Including Clean and Soiled Utility Rooms: Ordinary Hazard, Group 1.
      3) Office, Treatment, and Public Areas: Light Hazard.
      4) Medical Supply Rooms: Ordinary Hazard, Group 1.

3. Minimum Density for Automatic-Sprinkler Piping Design:

   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
   b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
   c. Calculation area reductions using quick response sprinklers shall be permitted in accordance with NFPA 13.

4. Maximum Protection Area per Sprinkler: According to UL listing.

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
B. Schedule 40, Black-Steel Pipe: ASTM A 135/A 135M; ASTM A 795/A 795M, Type E; or ASME B36.10M wrought steel, with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.

C. Malleable- or Ductile-Iron Unions: UL 860.

D. Cast-Iron Flanges: ASME 16.1, Class 125.

E. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
   1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick; ASME B16.21, nonmetallic and asbestos free; or EPDM rubber gasket.
      b. Class 150 and Class 300, Ductile-Iron or Steel, Raised-Face Flanges: Ring-type gaskets.
   2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.


G. Grooved-Joint, Steel-Pipe Appurtenances:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Anvil International.
      b. Corcoran Piping System Co.
      c. National Fittings, Inc.
      d. Shurjoint-Apollo Piping Products USA Inc.
      e. Smith-Cooper International.
      f. Tyco by Johnson Controls Company.
   4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
2. Reliable Automatic Sprinkler Co., Inc. (The).
3. Tyco by Johnson Controls Company.
4. Victaulic Company.
5. Viking Group, Inc.

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

D. Automatic Sprinklers with Heat-Responsive Element:
   1. Nonresidential Applications: UL 199.
   2. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

E. Sprinkler Finishes: Brass or bronze with flat white concealed cover plate.

F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed sprinklers are specified with sprinklers.

2.4 GENERAL REQUIREMENTS FOR VALVES

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" and shall bear UL mark, or:

B. FM Global Approved: Valves shall be listed in its "Approval Guide."

C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.

D. ASME Compliance:
   1. ASME B16.1 for flanges on iron valves.
   2. ASME B1.20.1 for threads for threaded-end valves.
   3. ASME B31.9 for building services piping valves.

E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

F. NFPA Compliance: Comply with NFPA 13 for valves.

G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.

H. Valve Sizes: Same as upstream piping unless otherwise indicated.

I. Valve Actuator Types:
1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.5 IRON BUTTERFLY VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. ALEUM USA.
4. Kennedy Valve Company; a division of McWane, Inc.
5. NIBCO INC.
6. Tyco by Johnson Controls Company.
7. Victaulic Company.

B. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.

2.6 TRIM AND DRAIN VALVES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

2. Clow Valve Company; a subsidiary of McWane, Inc.
3. Hammond Valve.
4. Kennedy Valve Company; a division of McWane, Inc.
5. Mueller Co.
6. NIBCO INC.
7. Victaulic Company.
8. WATTS.

B. Ball Valves:

1. Description:
a. Pressure Rating: 175 psig minimum.
b. Body Design: Two piece.
c. Body Material: Forged brass or bronze.
d. Port size: Full or standard.
e. Seats: PTFE.
f. Stem: Bronze or stainless steel.
g. Ball: Chrome-plated brass.
h. Actuator: Handlever.
i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

C. Globe Valves:

1. Description:

a. Pressure Rating: 175 psig minimum.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc Holder and Nut: Bronze.
f. Disc Seat: Nitrile.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

F. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.

G. Examine roughing-in for sprinkler system to verify actual locations of piping connections before fire-department connection installation.
3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install sprinkler piping with drains for complete system drainage.

G. Install hangers and supports for sprinkler system piping according to NFPA 13.

H. Fill sprinkler system piping with water.

I. Install sleeves for piping penetrations of concrete or block walls, ceilings, and floors. Comply with requirements for sleeves specified in NFPA 13. Sleeves are not required if holes are core drilled.


3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system’s pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to “Quality Assurance” Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install valves in horizontal piping with stem at or above the pipe center.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements for valve tags and schedules and signs on surfaces concealing valves in the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.
3.5 SPRINKLER INSTALLATION
   A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.

3.6 IDENTIFICATION
   A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

3.7 FIELD QUALITY CONTROL
   A. Perform the following tests and inspections:
      1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
      2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
      4. Coordinate with fire-alarm tests. Operate as required.
   B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
   C. Prepare test and inspection reports.

3.8 CLEANING
   A. Clean dirt and debris from sprinklers.
   B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.9 DEMONSTRATION
   A. Train Owner's maintenance personnel to adjust, operate, and maintain valves and equipment.

3.10 PIPING SCHEDULE
   A. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
      1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
      2. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
B. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger, shall be one of the following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.

3.11 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms with Suspended Ceilings: Concealed sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.

END OF SECTION 21 13 13
SECTION 22 05 00 - BASIC PLUMBING REQUIREMENTS

1. GENERAL

1.1 SECTION INCLUDES

A. This section describes Basic Plumbing Requirements required to provide for a complete installation of all mechanical systems for this project. This section shall apply to all other Division 22 specification sections as well as all work shown on the drawings.

B. It is the intent of the Plumbing Division of the Specifications that all plumbing work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations operate as designed.

C. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Owner’s representative.

D. The Contractor shall note that, in some cases, piping as shown on the Drawings provide general location and routing information only. The Contractor shall be responsible for providing interference-free systems with proper clearance to facilities and equipment.

E. Where the word “provide” is used, it shall mean “furnish and install” unless otherwise noted or specified.

F. Note that the words “mechanical” and “plumbing” are used interchangeably throughout the Division 22 and 23 specification sections.

1.2 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section and all other sections of Division 22.

1.3 DESCRIPTION OF WORK

A. The work included under this section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete mechanical systems required by these specifications and/or shown on the drawings of the contract.

B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, piping fixtures, etc. The Contractor shall follow the drawings in laying out work and verify clearances for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of outlets or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.
1.4 PERMITS

A. All permits, fees, licenses, etc. required for this project shall be obtained by the Contractor.

1.5 QUALITY ASSURANCE

A. Installers shall have at least 5 years of successful installation experience on projects with mechanical installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for satisfactory operation, unless noted otherwise in other mechanical sections.

B. Manufacturer of equipment and materials must be regularly engaged in the manufacture of the specified equipment and material with similar construction and capacities and whose products have been in satisfactory use in similar service for not less than five (5) years, unless noted otherwise in other Mechanical Sections.

C. Qualify welding processes and operators for structural steel according to AWS D1.1. "Structural Welding Code - Steel.

D. Quality welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

E. Comply with provisions of ASME B31 Series "Code for Pressure Piping", including all addenda.

F. Contractor signed welder certificate(s) shall be submitted. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current. A record shall be maintained on the job site showing the date and results of qualification tests for each welder employed on the job. One certified copy of the qualification test for each welder so employed shall be furnished to the Owner's representative.

G. For all the refrigerant work/service required by this project, all refrigerant technicians shall be EPA/ASHRAE 34 certified for corresponding classification type I, II, III and/or IV.

1.6 REFERENCES

A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall conform to the following as applicable:

1. Safety and Health Regulations for Construction.
2. Occupational Safety and Health Standards, National Consensus Standards and Established Federal Standards.
4. ACCA - Air Conditioning Contractors of America.
5. ACGIH - American Conference of Governmental Industrial Hygienists.
6. ADC - Air Diffusion Council.
8. AIHA - American Industrial Hygiene Association.
14. ASME - The American Society of Mechanical Engineers.
17. CABO – Council of American Building Officials.
18. CAGI - Compressed Air and Gas Institute.
19. CTI - Cooling Tower Institute.
21. ETL - Engineering Tests Laboratory.
23. HI - Hydraulic Institute.
24. HYD I - Hydronics Institute.
25. IAPMO – International Association of Plumbing and Mechanical Officials.
26. ICBO - International Conference of Building Officials.
29. NEC - National Electrical Code.
30. NEMA - National Electrical Manufacturers Association.
32. NSF - National Sanitation Foundation.
33. SAE - Society of Automatic Engineers.
34. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
35. TEMA - Tubular Exchanger Manufacturers Association.
36. UL - Underwriters Laboratories, Inc.
38. International Mechanical Code.
39. Other governing, state, and local codes that apply.

1.7 SUBMITTALS

A. General: Follow the procedures specified in Division 1 Sections "General Conditions" and "Special Conditions".

B. The Architect/Engineer’s review of submittals, including any corrections or comments made on the shop drawings during the review process, do not relieve Contractor from compliance with requirements of the Contract Documents. The review is only a review of general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. The Contractor is responsible for confirming and correlating all quantities and dimensions; selecting fabrication process and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner. The Contractor shall not be relieved from responsibility for errors or omissions in the shop drawings, product data or samples by the Architect/Engineer’s review of those drawings.
C. No portion of the work requiring submission of a shop drawing, product data or sample shall be commenced until the submittal has been reviewed by the Architect/Engineer. All such portions of the work shall be in accordance with reviewed submittals and the associated manufacturer recommendations.

D. Shop drawings shall include the minimum following information as applies. Additional specific information required is outlined in other Plumbing Sections.

1. Certified performance and data with system operating conditions indicated. All coil, fan, and pump performance data shall be computer generated.
2. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicating, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
3. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loading, required clearances, and methods of assembly of components.
4. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to electrical equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of electrical equipment and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
5. Maintenance Data: Submit maintenance data and parts list for each mechanical equipment, control and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

E. Coordination drawings

1. Drawings:

   a. Provide coordination in determining adequate clearance and space requirements for fire protection equipment, mechanical equipment, electrical equipment, and other items/equipment in the project. The Architect/Engineer reserves the right to determine space priority of equipment in the event of interference between pieces of equipment, piping, conduit, ducts and equipment of the trades. The Architect/Engineer will only review conflicts and give an opinion but will not perform as a coordinator.

   b. Provide coordination drawings indicating structural components, reflected ceiling layout, fire protection items, mechanical items, electrical items, and other systems. Indicate on the coordination drawings where components will be installed and how the service access area to such items shall be maintained. Illustrate items requiring access for maintenance or adjustment.

   c. The Contractor will not be allowed any time extensions for participation in the coordination drawing process. The Contractor will not be allowed any contract cost extra for any additional fittings, rerouting or changes of duct size to equivalent sizes to those shown on the drawings that may be determined necessary through the coordination drawing process.
d. Deviations from the contract documents that are necessary for overall system installation and coordination shall be brought to the attention of the Architect/Engineer. Such necessary changes in the contract scope discovered through the coordination drawing process will be covered by the requirements of the “change order” process.

e. Access panels shall occur only in gypsum wallboard or plaster ceilings where indicated on the drawings or as needed to provide access to equipment, dampers, or valves. Access to fire suppression and other items shall be through accessible acoustical ceiling areas. Additional access panels will not be allowed without written approval from the Architect/Engineer at the coordination drawing stage and only after alternatives are reviewed. Layout changes shall be made to avoid additional access panels. If additional access panels are required, they shall be provided at no additional cost to the Owner.

f. Soffit penetrations and light alcoves shall be fully coordinated with hanging devices, studs, fire/smoke ratings, and structural support requirements.

2. The Contractor and subcontractors responsible for items of work located in or above ceilings shall participate in the coordination drawing process. Participation is mandatory. If the Contractor or subcontractor fails to participate in the coordination drawing process, the Owner reserves the right to do the following:

a. Stop construction progress payments for work performed by the Contractor. Payments will be reinstated only after the Contractor or subcontractor resumes participation in the coordination drawing process.

b. Require the relocation and resizing of components as necessary to ensure components will be installed as intended. In the event the Contractor did not participate in the coordination process, the Contractor will not be entitled to contract cost increases or time extensions due to Owner-initiated changes in the work.

c. The Contractor shall be held responsible for unnecessary rework that is attributable to failure to participate in the coordination process.

3. Drawings shall be prepared at 1/4 inch = 1 foot, 0 inches (minimum).

a. Coordination participants shall provide equipment installation and clearance requirements. This information shall be indicated on the coordination drawings.

b. Coordination drawings shall indicate the following major system components (including insulation, hub or connection widths with verification of turning radius):

1) Roof drain leaders
2) Large waste piping
3) Sprinkler mains
4) Equipment located above the ceiling
5) Heating hot water piping
6) Chilled water piping
7) Conduit runs 2 inches and larger
8) Cable tray
9) Bus duct
10) Recessed light fixtures
11) Building wiring or cable trays
12) Ceiling heights as shown in contract documents and thickness of system
13) Soffits (including framing of supports)
14) Access points and clearances required
15) Access panels
16) Valves
17) Dampers
18) Coils
19) Ductwork
20) Fire-rated wall, partition, and floor penetrations
21) Steam and condensate piping
22) Space allotted for future utilities
23) Equipment in mechanical and electrical spaces

c. Information shall be delineated to indicate distances from column centerlines, pipe/equipment size, and distance from finished floor to bottom of pipe/equipment and hangers.

4. The coordination drawings shall be submitted to the Architect/Engineer and Owner's representative for review. The submitted coordination drawings shall indicate which contractors participated in the process and where conflicts appear to occur even after the priority ranking of utility routing has been utilized. In the event that conflicts require input from the Architect/Engineer, recommended solutions will be provided with the coordination drawings for review by the Architect/Engineer. The Architect/Engineer will review and return an opinion to the contractors for implementation. All contractors shall agree to the final coordinated layout by signing off on the coordination drawings before any construction can begin.

5. Maintain an updated set of coordination drawings at the job site reflecting changes, modifications and adjustments. Changes shall be reflected and sets or new sheets reissued to the Architect/Engineer and the Owner for review on a monthly basis with changes "clouded" and brought to the attention of the Architect/Engineer and the Owner.

6. When a change order request is issued, the affected subcontractors shall review the coordination drawings and bring to the attention of the Contractor and the Architect/Engineer revisions necessary to the work of others not directly affected by the change order.

7. Contractors that fail to cooperate in the coordination drawing effort shall be responsible for all costs incurred for adjustments to the work made necessary to accommodate installations. Provide adequate clearance and access through accessible ceilings. Conflicts that result after the coordination drawings are signed off will be the responsibility of the Contractor or subcontractor who did not properly identify their work or installed the work improperly.

F. Provide separate shop drawing submittals for all items listed in Shop Drawing and Submittal Log in Division 1.

1.8 SUBSTITUTES

A. Refer to the General Conditions and Special Conditions sections of this Specification for general substitution requirements and information.
1.9 WARRANTY

A. Refer to the General Conditions section of this Specification for general warranty requirements and information. Additional warranty requirements are specified in subsequent Plumbing Sections.

1.10 CLOSE OUT AND OPERATION INSTRUCTIONS

A. Operate each system and item of equipment in a test run of appropriate duration, but no less than 7 days, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance.

B. Any system placed in temporary operation for testing or for the convenience of the Contractor during construction shall be properly maintained and operated by the Contractor.

C. All systems shall be protected against freezing, flooding, corrosion or other forms of damage prior to acceptance by the Owner.

D. Material or equipment damaged, shown to be defective or not in accordance with the Specifications shall be repaired or replaced to the satisfaction of the Owner's representative.

E. All tests shall be made after notification to and in the presence of the Owner's representative.

F. Before starting up any system, each piece of equipment comprising any part of the system shall be checked for proper lubrication and any other condition which may cause damage to the equipment or endanger personnel.

G. After systems have been demonstrated to be satisfactory for 7 consecutive days and ready for permanent operation, all permanent pipe line strainers shall be cleaned, valve and packings properly adjusted, lubrication checked and replenished if required. Temporary piping, etc. shall be removed and openings restored in a permanent manner acceptable to the Owner's representative.

H. Conduct a walk-through instruction seminar for the Owner's personnel pertaining to the continued operation and maintenance of mechanical equipment and systems. Explain the identification system, maintenance requirements, operational diagrams, temperature control provisions, sequencing requirements, security, safety, efficiency and similar features of the systems. Walk through must be documented as to those attending and subjects covered. Walk through document(s) shall be signed and dated by the contractor's representative and the owner's representative.
I. At the time of substantial project completion, turn over the prime responsibility for operation of the plumbing equipment and systems to the Owner's operating personnel. Until the time of final acceptance, provide full time operating personnel, who are completely familiar with the work, to consult with and continue training the Owner's personnel.

1. If any systems are operated prior to substantial completion, the contractor shall perform all necessary preventative maintenance according to all manufacturer recommendations.

1.11 AS-BUILT DOCUMENTS

A. Prepare as-built documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in above, indicate the following installed conditions:

1. The Plumbing Contractor shall provide the Owner with as-built drawings for ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units and indicate all devices requiring periodic maintenance or repair, such as control power transformers, LACS panels/routers, field controllers, duct static pressure sensors, piping pressure sensors, etc.

2. All plumbing systems as described in the Specifications and/or shown on the drawings.

3. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 22 Section "Plumbing Identification." Indicate actual inverts and horizontal locations of underground piping.

4. Equipment/material locations (exposed and concealed), dimensioned from prominent building lines.

1.12 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.

2. PRODUCTS (NOT APPLICABLE).
3. EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Store and handle material and equipment in compliance with manufacturers’ recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

C. Use proper lifting equipment where size/weight requires handling by such means.

D. Comply with manufacturer’s rigging and moving instructions for unloading material and equipment, and moving them to final location.

E. Equipment requiring disassembly for access purposes shall be disassembled and reassembled as required for movement into the final location following manufacturer’s written instructions.

F. Deliver material and equipment as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

G. Contractor shall schedule deliveries so as to minimize space and time requirements for storage of materials and equipment on site.

3.2 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 2 through 26 for rough-in requirements.

3.3 COORDINATION

A. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

B. Coordinate the plumbing work with work of the different trades so that:

1. Interferences between mechanical, electrical, architectural, and structural work, including existing services, will be avoided.

2. Within the limits indicated on the drawings, the maximum practicable space for operation, maintenance repair, removal and testing of mechanical and other equipment will be provided.
3. Pipes, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes, ducts, and similar items shall be located so that they will not interfere with the intended use of other equipment.

C. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.

D. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.

3.4 PLUMBING INSTALLATIONS

A. All dimensions and clearances affecting the installation of work shall be verified in the field in relation to established datum, to building openings and to the work of other trades.

B. The location of all equipment and systems shall be coordinated to preclude interferences with other construction.

C. Should interferences occur which will necessitate deviations from layout or dimensions shown on the Drawings, the Architect/Engineer and the Owner’s representative shall be notified and any changes approved before proceeding with the work.

D. Arrange for chases, slots, and openings in other building components during progress of construction to allow for mechanical installations.

E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum possible headroom.

F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

G. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.

H. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

I. Install plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
K. Welding, sweating, or brazing operations

1. All cutting, welding, brazing, or sweating operations carried on in the vicinity of, or accessible to, combustible material shall be adequately protected to make certain that a spark or hot slag does not reach the combustible material and start a fire.

2. When it is necessary to do cutting, welding, brazing, or sweating close to wood construction, in pipe shafts, or other locations where combustible materials can not be removed or adequately protected, employ fireproof blankets and proper fire extinguishers. Position another individual nearby to guard against sparks and fire.

3. Whenever combustible material has been exposed to molten metal or hot slag from welding or cutting operations, or spatter from electric arc operations, a guard shall be kept at the place of work for at least one hour after completion to verify that smoldering fires have not been started.

4. Whenever welding or cutting operations are carried on in a vertical shaft or where floor openings exist, a fire guard shall be employed to examine all floors below the point of the welding or cutting operation. The fire guard shall be kept on duty for at least one hour after completion to verify that smoldering fires have not been started.

5. Before any work involving cutting, welding, brazing, or sweating operations is started, consult with the Architect/Engineer as to particular safety precautions to be employed on the work.

6. Obtain proper hot work permits as required.

3.5 ACCESSIBILITY

A. All work shall be installed so as to be accessible for operation, maintenance and repair with particular attention given to locating valves, controls and equipment requiring periodic lubrication, cleaning, adjusting or servicing of any kind.

3.6 LUBRICATION AND TOOLS

A. Provide a fresh charge of lubricant in accordance with manufacturer’s recommendations to all equipment requiring lubrication prior to start-up and maintain lubrication as required until acceptance by Owner.

B. Provide for each piece of equipment any special tools and a list of such tools required for the operation or adjustment of the equipment and turn over to the Owner’s representative prior to final acceptance of the equipment.

3.7 PIPING SYSTEMS PRESSURE TESTING

A. The following personnel in the order listed shall be considered acceptable witnesses of all piping pressure testing:

1. Owner’s Representative
2. Mechanical Engineer / Architect
3. General Contractor’s Foreman

B. Removal of pressure charge and associated drain down shall also be witnessed.
C. Mechanical contractor shall provide a minimum of 24-hour notice to at least one of the above listed parties before commencing any piping systems pressure test.

D. Pressure gauge requirements: Provide recently calibrated gauge with 4” face and a range such that test pressure is between 50% and 100% of gauge range. For example, a gauge with a 15 psig range is acceptable for a 10 psig pressure test, whereas a gauge with a 30 psig range is unacceptable in this application. Gauge resolution shall be suitable for type of testing, system size and test media. Gauge shall have been recently calibrated. Test duration shall be 1 hour.

E. All piping pressurizing equipment (i.e., air compressor) shall be disconnected before test is commenced and shall remain disconnected for the entire duration of the test.

F. Entire system shall be properly vented before test is commenced.

G. For specific piping pressure testing requirements and procedures, see applicable piping systems specification sections.

H. Submit completed "Pipe Pressure Test Log" provided at the end of this Section for each pressure test before final project closeout. Test log shall also be included in operation and maintenance manuals.

NOTE: USE MULTIPLE FORMS IF NECESSARY

3.8 EXTENT OF WORK

A. Access Panels

1. Furnish and install panels for access to valves and dampers and similar items where no other means of access, such as readily removable, sectional ceiling is shown or specified.

B. Cutting and Patching

1. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:

2. Contractor shall coordinate all cutting and patching of holes, in existing building and new construction which are required for the passage of mechanical work.

3. Under no circumstances shall any structural members, load-bearing walls or footings be cut without first obtaining written permission from the Engineer.

4. Cut, channel, chase and core drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
5. Patching of concrete openings shall be filled with grout and finished smooth with the adjacent surface.
6. All below-grade openings for pipe shall be sealed with interlocking synthetic rubber line assembly, Link-Seal by Thunderline Corporation or equal.
7. Repair cut surfaces to match adjacent surfaces.
8. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
   a. Uncover work to provide for installation of ill-timed work.
   b. Remove and replace defective work.
   c. Remove and replace work not conforming to requirements of the Contract Documents.
   d. Remove samples of installed Work as specified for testing.
   e. Install equipment and materials in existing structures.
   f. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. Excavation and Backfilling

1. Contractor shall perform all excavation and backfilling necessary to install the required mechanical work. Coordinate the work with other excavating and backfilling work in the same area.
2. Except as indicated otherwise, comply with the applicable sections in Division 2 of these specifications, excavation filling and backfilling (for structures) to 5' outside the building line.
3. Trenching: Trench width shall be no more than required for shoring, bracing and performance of the work. All necessary shoring and bracing shall be installed to insure worker safety, proper installation of mechanical work, and protection of adjacent structures. Provide all dewatering as required. Depth shall not exceed that required to achieve the specified depth of cover and overdig will be permitted for bedding material only. All trenches shall be open cut from the surface.
4. Bedding: All work shall be properly bedded whether on virgin soil or on granular bedding as specified. All granular bedding shall be laid on undisturbed soil. PVC and copper piping shall have a 4" crushed stone bed conforming to specification for granular material in Division 2. If rock is encountered, excavate to a point 4" below installed bottom elevation of piping and provide bedding as called for above.
5. Haunching: Haunching shall be brought up on both sides of the pipe for a distance of 1/3 the pipe diameter and shall be of the same material used for bedding.
6. Backfill: Backfilling shall not begin until installation has been tested for leaks.
7. Placement: Place all granular material in lifts of 12" maximum compacted to 100% of maximum dry density as determined as ASTM D698. Place soil in 6" lifts compacted to 95% of maximum density as determined by ASTM D698. Do not place any backfill until excavations have been cleaned of all water, debris and loose or soft soil.
8. Protection: At least 72 hours prior to excavating, for each phase, Contractor shall contact the Owner's Representative to arrange for utility locates in the construction area.
9. Contractor shall provide temporary supports for all underground utilities crossing an excavation.
10. Provide all required barricades, fencing, signs, lights, etc. as necessary for the protection of the workers and of the general public.
11. Excess Material: All excess earth and other material resulting from the excavation shall be removed from site daily by the Contractor.
12. Landscape work, pavement, flooring and similar exposed finish work that is disturbed or damaged by excavation shall be repaired and restored to their original condition by the Contractor.

D. Painting

1. Contractor is to field paint plumbing equipment and materials in specified areas as noted on the plumbing plans, plumbing schedules and in the specifications.
2. In concealed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted with one coat of zinc rich paint.
3. In exposed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted in accordance with Section 099100.

E. The responsibility of work specified under Division 22 and 26 is clarified under, Section 220513, "Electrical Requirements for Plumbing Equipment. Contractor is to coordinate all electrical requirements prior to ordering powered plumbing equipment.

END OF SECTION 22 05 00
**PIPE PRESSURE TEST LOG**

**PROJECT:**

**BUILDING:**

**GENERAL CONTRACTOR:**

**CLARK ENERSEN PROJECT NUMBER:**

**MECHANICAL CONTRACTOR:**

**TEST INFORMATION**

<table>
<thead>
<tr>
<th>TEST DATE</th>
<th>PIPI NG SY S TEM</th>
<th>AREA TESTED</th>
<th>TEST MEDIA (WATER OR AIR)</th>
<th>TEST DURATION (MINUTES)</th>
<th>PRESSURE GAGE NUMBER</th>
<th>INITIAL (PSIG)</th>
<th>FINAL (PSIG)</th>
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**ADDITIONAL COMMENTS:**

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**PRESSURE GAGE INFORMATION**

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**NOTE:** USE MULTIPLE FORMS IF NECESSARY
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SECTION 22 05 13 - ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

1. GENERAL

1.1 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

A. Quality assurance.
   1. Electrical components and materials shall be UL labeled and listed.

B. References.
   1. The design, manufacture, testing and method of installation of all equipment and materials furnished under the requirements of this specification section shall conform to the following:
      b. NEMA Standard ICS 2 – Industrial Control Devices, Controllers, and Assemblies.
      c. NEMA Standard 250 – Enclosures for Electrical Equipment.
      d. NEMA Standard KS 1 – Enclosed Switches.

C. Submittals.
   1. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, or as required by the individual equipment specification sections.

D. Operation and maintenance manuals.

E. Project record documents.

F. Delivery, storage, and holding

G. Related sections.
   1. Separate electrical components and materials required for field installation and electrical connections are specified in Division 26.
1.2 SUMMARY

A. This section specifies the basic requirements for electrical components which are an integral part of packaged plumbing equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged plumbing equipment. In addition, this section covers necessary coordination issues between plumbing and electrical disciplines. All plumbing and electrical construction documents must be completely reviewed by the Plumbing and Electrical Contractors prior to the submission of bids. Any discrepancies in the documents should be brought to the Architect/Engineer's attention at that time. Failure to properly coordinate or review documents in advance of submission of bids will not be valid cause for changes to the overall Contract amount.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for plumbing equipment are scheduled on the Drawings.

2. PRODUCTS

2.1 SAFETY SWITCHES

A. See specification section 26 05 01 – Basic Electrical Materials and Methods.

3. EXECUTION

3.1 CONTRACTOR COORDINATION

A. General contractor is responsible for coordination of all subcontractors and associated scopes of work.

END OF SECTION 22 05 13
SECTION 22 05 19 – PLUMBING METERS AND GAUGES

1. GENERAL

1.1 SECTION INCLUDES

A. Pressure gauges and pressure gauge taps.

B. Thermometers and thermometer wells.

C. Piping pressure and temperature test plugs.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References

C. Submittals

D. Operation and maintenance manuals.

E. Project record documents

   1. Accurately record actual locations of instrumentation.

F. Delivery, storage, and handling

2. PRODUCTS

2.1 PRESSURE GAUGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection, liquid-filled.

B. Case: Drawn steel or brass, glass lens, 4-1/2-inches diameter.

C. Connector: Brass, 1/4-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1 percent of range span.
F. Range: Conform to the following:

1. Vacuum: 30 inches Hg to 15 psi.
2. All fluids: 2 times operating pressure.

2.2 PRESSURE GAUGE ACCESSORIES

A. Syphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.3 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

B. Scale range: Temperature ranges for services listed as follows:

1. Hot Water: 30 to 240 deg with 2-degree scale divisions (0 to 115 deg C with 1-degree scale divisions).
2. Cold and Tepid Water: 0 to 100 deg F with 2-degree scale divisions (minus 18 to 38 deg C with 1-degree scale divisions).

2.4 GLASS THERMOMETERS

A. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9 inches long.

B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

C. Tube: Red reading, magnifying lens, with non-mercury fluid.

D. Scale: Satin-faced, nonreflective aluminum, with permanently etched markings.

E. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

2.5 THERMOMETER WELLS

A. Thermometer Wells: Brass or stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.
2.6 PIPING PRESSURE AND TEMPERATURE TEST PLUGS

A. Test Plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and 2 self-sealing valve-type core inserts, suitable for inserting a 1/8-inch O.D. probe assembly from a dial-type thermometer or pressure gage. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: Conform to the following for fluid and temperature range:

3. EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 THERMOMETERS

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

B. Install as shown on plans and elsewhere as indicated.

C. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.3 PRESSURE GAUGES

A. Install pressure gauges in piping tee with pressure gauge valve, located on pipe at most readable position.

B. Install as shown on plans, and elsewhere as indicated.

C. Pressure Gauge Ball Valves: Install in piping tee with snubber. Install syphon in lieu of snubber for steam pressure gages.

3.4 TEST PLUGS

A. Test Plugs: Install where indicated, located on pipe at most readable position. Secure cap.

3.5 ADJUSTING AND CLEANING

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

END OF SECTION 22 05 19
SECTION 22 05 29 – PLUMBING HANGERS AND SUPPORTS

1. **GENERAL**

1.1 **SECTION INCLUDES**

A. Pipe and equipment hangers, supports, anchors, saddles and shields.

B. Sleeves and seals.

C. Mechanical sleeve seals.

D. Flashing and sealing equipment and pipe stacks.

E. Sealants, firestop insulation, putty and compounds.

1.2 **REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:**

A. References

B. Submittals

C. Delivery, storage and handling

2. **PRODUCTS**

2.1 **PIPE HANGERS AND SUPPORTS**

A. Plumbing Piping:

1. Conform to International Plumbing Code, International Fuel Gas Code, ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89 as applicable.

B. Pure Water Piping and Laboratory Waste and Vent Piping:

1. Conform to manufacturer’s recommendations as applicable.

C. Hangers and Supports:

1. Hangers for Hot and Cold Pipe Sizes 1/2 to 1-1/2 Inch, Carbon steel, adjustable swivel, band type.

2. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.

3. Hangers for Hot Pipe Sizes 2 to 4 Inches; Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
7. Wall Support for Hot Pipe Sizes 6 Inches (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
12. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Hangers for insulated pipe shall be enlarged to compensate for insulation thickness so that hangers support insulation. See Section 22 07 19.
16. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
17. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
18. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
19. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
20. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
21. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
22. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
23. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
24. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
25. Side-Beam Brackets (MSS Type 34): For sides of steel beams.
26. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
27. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
28. See Section 22 05 48 for vibration isolation hangers and supports.

2.2 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
2.3 INSERTS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Internally Threaded Screw Anchors: Internally threaded, self-tapping screw anchors, Power Fasteners Snake or approved equivalent.
   
   1. Tested in accordance with ACI 355.2 and ICC-ES AC193 for use in structural concrete under the design provisions of ACI318 (Strength Design method using Appendix D)

2.4 FLASHING

A. Metal Flashing: 26 gage galvanized steel.

B. Metal Counterflashing: 22 gage galvanized steel.

C. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

D. Floor Drain and Floor Sink Flashing: 40 mil thick chlorinated polyethylene (CPE), equivalent to Chloraloy.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 SLEEVES

A. Sleeves for Pipes Through Rated Floors and Walls: Schedule 40 steel pipe.

B. Sleeves for Pipes Through Non-Rated Floors: Schedule 40 steep pipe, extended 2" above floor.

C. Sleeves for Pipes Through Non-Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage galvanized steel, extended 2" above floor. See drawings for further detail.

2.6 SEALANTS, FIRESTOP INSULATION, PUTTY, AND COMPOUNDS

A. Refer to Section 07 84 13 for firestopping materials and methods. Refer to drawings for additional details.

B. Sealants:
   
   1. Non fire/smoke rated partitions: Acrylic or silicone based caulking.
   2. Fire/smoke rated partitions: Silicone based caulking, UL listed.
C. **All fire-rated sealants and firestops shall be installed by a certified firestop contractor. Reference front-end specifications for further information.**

### 2.7 MECHANICAL SEALS

A. **Mechanical Seals:** Modular mechanical type, consisting of interlocking low durometer EPDM synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with type 316 stainless steel bolts and reinforced plastic polymer pressure plates which cause rubber sealing elements to expand when tightened, providing a watertight and gas-tight seal and electrical insulation. Provide Advance Products & Systems Model Innerlynx, Link-Seal LS-316, or approved equivalent.

1. A sleeve shall be provided for each mechanical seal.
   a. **Thermoplastic sleeves:** Sleeve shall have smooth walls and shall be made of molded non-metallic high density polyethylene (HDPE) with an integral solid water stop, Advance Products & Systems Model PWS, Century-line Model CS, or approved equivalent.
   b. **Steel sleeves:** Sleeve shall have smooth walls, shall be made of Schedule 40 steel with an integral welded solid water stop, and shall have corrosion-resistant coating, Advance Products & Systems Model GWS, Century-line Model WS, or equivalent.

### 3. EXECUTION

#### 3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

#### 3.2 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

#### 3.3 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.
B. Support fire protection systems piping independently from other piping systems. Fire main piping may be trapezed with other piping systems. Coordinate trapeze hangers with the Sprinkler Contractor.

C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

H. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

I. Support riser piping independently of connected horizontal piping.

J. Provide copper plated hangers and supports for non-insulated copper pipe.

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Prime coat steel hangers and supports in the mechanical room and other exposed areas. Refer to the Architectural reflected ceiling plans for location of exposed ceilings. Hangers and supports located in attic space, crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Adjust hangers to distribute loads equally on attachments and to achieve specified pipe slopes.

N. Space hangers for pure water and laboratory waste and vent systems to avoid pipe sags. Use manufacturer-recommended V-groove channel if necessary to maintain sag-free installation.

O. Saddles, Shields and Inserts

1. Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
2. Install protective shields MSS Type 40 on cold piping that has vapor barrier. Shields shall span an arc of 180 degrees (360 degrees on trapeze hangers with U-bolt clamps) and shall have dimensions in inches not less than the following:

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<td>0.060</td>
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<td>16 through 24</td>
<td>24</td>
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3. Pipes 8 inches and larger shall have wood inserts.
4. Insert materials shall be at least as long as the protective shield.
5. Provide manufacturer-recommended saddles, inserts, and/or shields where cellular foam insulation is used. The removal of sections of cellular foam insulation for the purpose of pipe support is not acceptable.

3.4 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to control movement to compensators.

D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.5 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls and floors.

B. Flash floor drains in floors with topping over finished areas with CPE membrane, a minimum of 12 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

C. Seal floor, shower, mop sink, etc. drains watertight to adjacent materials.

D. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.
E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 SLEEVES

A. Provide pipe and duct sleeves at all fire/smoke rated partitions, exterior wall penetrations and wall penetrations into exposed areas. Pipe and duct sleeves are not required for penetrations through non-rated concealed partitions.

B. At the Contractor’s option, pipe sleeves may be omitted if the wall or floor is core drilled, except in areas potentially exposed to wet conditions (such as mechanical rooms, loading dock, generator room, penthouse, kitchen, etc.).

C. Set sleeves in position in formwork. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Sleeves through floors shall be ground flush with finish floor level. In areas potentially exposed to wet conditions (such as mechanical rooms, loading dock, generator room, penthouse, kitchen, etc.), sleeve shall extend a minimum of 2" above finish floor.

F. Where piping penetrates non-rated ceilings or walls, close off space between pipe or duct and adjacent work with urethane rod stock and caulk air tight.

G. Seal pipe penetrations through non-rated floors.

1. Where piping is not located in a rated shaft and it penetrates a single non-rated floor, close off space between pipe and adjacent work with urethane rod stock and caulk air tight.

2. Where piping is not located in a rated shaft and it penetrates multiple non-rated floors, close off space between pipe and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound.

H. Where piping penetrates rated floor, ceiling, or wall, close off space between pipe or duct with appropriate fire rated sealant, insulation, putty or compound. Refer to the Drawings for fire/smoke rated wall locations and the appropriate ratings.

I. Install chrome plated steel escutcheons on piping at finished surfaces.

J. Waste, vent and storm pipe penetrations through the concrete floor slab shall be encased in the poured concrete slab.

K. PVC pipe casing around the cold and hot water and gas piping shall be encased in poured concrete when penetrating the floor slab. Seal the opening between the piping and PVC casing with putty or rigid polyisocyanurate insulation plug and seal with caulking.
L. Provide mechanical seals and sleeves through exterior wall and floor penetrations and 3 hour or higher fire rated partitions.

3.7 HANGER SCHEDULES


B. Reference manufacturer’s recommendations for pure water piping and laboratory waste and vent piping.

END OF SECTION 22 05 29
SECTION 22 05 53 – PLUMBING IDENTIFICATION

1. GENERAL

1.1 SECTION INCLUDES

A. Nameplates.
B. Tags.
C. Pipe Markers.
D. Ceiling Tacks/Stickers.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

A. Commissioning requirements.
   1. See section 01 91 13 – General Commissioning Requirements for all commissioning requirements.
B. References
C. Related Sections
D. Submittals
E. Quality Assurance

1.3 PROJECT RECORD DOCUMENTS

A. Record actual locations of tagged valves.

2. PRODUCTS

2.1 NAMEPLATES

A. Equipment Mark Nameplates: Laminated three-layer plastic with engraved black letters (matching equipment mark indicated on drawings) on light contrasting background color, with minimum 3/4 inch high letters.
B. Equipment Nameplates: Factory-applied permanent nameplate indicating the manufacturer’s name, model, serial number, temperature and pressure design, and any other data necessary to conform with specified requirements. On equipment installed outdoors, nameplate shall be stamped steel or engrave plastic.

2.2 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter or square.

B. Chart: Typewritten list that is plastic laminated and mounted in mechanical room. Valve list is to coordinate with mechanical piping schematics if provided on plans.

C. Pipe Schematics: Valve numbers are to be labeled on Engineer schematic drawings, plastic laminated and schematic shall be mounted in mechanical room.

2.3 PIPE MARKERS


B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings; minimum information indicating flow direction arrow and identification of fluid being conveyed.

2.4 CEILING TACKS/STICKERS

A. Description: ½” self adhesive color coded stickers.

B. Color code as follows:

1. Yellow - HVAC equipment
2. Red - Fire dampers/smoke dampers, sprinkler/standpipe system valves
3. Green - Plumbing valves
4. Blue - Heating/cooling valves

3. EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
B. Install tags with corrosion resistant chain.

C. Install plastic tape pipe and duct markers in accordance with manufacturer's instructions. Directional arrow tape shall be overlapped to ensure proper adhesion and no peeling of tape in future.

D. Identify air handling units, exhaust fans, chillers, pumps, heat generating, heat rejecting, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

E. Identify pressure reducing valves, backflow preventers, valves, and meters with tags.

F. Identify control panels and major control components outside panels with plastic nameplates.

G. Identify valves in main and branch piping with tags.

H. Tag automatic controls, instruments, and relays. Key to control schematic.

I. Identify piping, concealed or exposed, with plastic tape pipe markers. For pipes ¾” and smaller, identify piping with tags. Identify service, flow direction, and pressure when applicable, i.e. low pressure steam, high pressure steam. Install in clear view from floor and align with axis of piping. Locate identification not to exceed 15 feet on straight runs including risers and drops, more often in congested areas, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction. Provide a minimum one label per pipe per room. Where pipes are racked, install pipe markers on each pipe in the same location to aid in differentiating each pipe in the rack.

J. Provide ceiling stickers or machine generated labels to locate valves, dampers, or HVAC equipment above T-bar type panel ceilings. Locate ceiling sticker on the ceiling grid closest to equipment. Label each sticker with the device located above the ceiling, i.e. VBR-33.

END OF SECTION 22 05 53
SECTION 22 07 19 – PLUMBING PIPING INSULATION

1. GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.
B. Jackets and accessories.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

A. References
B. Submittals
C. Delivery, Storage and Handling

1.3 QUALITY ASSURANCE

A. See Section 22 05 00.
B. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255, and UL 723.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
B. Maintain temperature during and after installation for minimum period of 24 hours.

2. PRODUCTS

2.1 GLASS FIBER

A. Insulation: ASTM C547; rigid molded, noncombustible.

1. 'K' ('ksi') value: ASTM C335, 0.24 at 75 degrees F.
2. Minimum Service Temperature: -20 degrees F.
3. Maximum Service Temperature: 300 degrees F.
4. Maximum Moisture Absorption: 0.2 percent by volume.
B. Vapor Barrier Jacket

1. ASTM C921, White kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
3. Secure with self sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

C. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch centers.

D. Vapor Barrier Lap Adhesive: compatible with insulation.

E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

F. Fibrous Glass Fabric: Cloth, untreated; 9 oz/sq yd weight with 1.0 lb/cu ft density blanket.

G. Indoor Vapor Barrier Finish: Vinyl emulsion type acrylic, compatible with insulation, white color.

2.2 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. ‘K’ (ksi) Value: ASTM C177 or C518; 0.27 at 75 degrees F.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 220 degrees F.
4. Maximum Moisture Absorption: ASTM D1056; 1.0 percent (pipe) by volume, 1.0 percent (sheet) by volume.
5. Moisture Vapor Transmission: ASTM E96; 0.20 perm inches.
7. Maximum Smoke Developed: ASTM E84; 50.

B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.3 JACKETS

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. PVC Plastic: High-impact-resistant; UV-resistant PVC complying with ASTM D 1784, Class 16354-C; One piece molded type fitting covers and sheet material, white color.

1. Minimum Service Temperature: -40 degrees F.
2. Maximum Service Temperature: 150 degrees F.
3. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
5. Maximum Smoke Developed: ASTM E84; 50.
7. Connections: Brush on welding adhesive or pressure sensitive color matching vinyl tape.

C. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   1. Thickness: 0.040 inch.
   2. Finish: Smooth.
   4. Fittings: Factory-fabricated fitting covers of same material, finish, and thickness as jacket.
      a. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
   5. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

3. EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
B. For elastomeric insulation systems, use inserts by the same manufacturer of the insulating system being installed (i.e. for Armaflex, use Amafix.)
C. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
D. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
E. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
F. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.
G. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

H. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

I. Where piping passes through fire walls indicated on the contract drawings, contractor shall install firestopping per firestop manufacturers instructions.

J. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

K. Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

L. Repair damaged sections of existing mechanical insulation, damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

M. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

N. Wood blocking shall not be used.

O. On exposed piping, locate insulation and cover seams in least visible locations.

P. Inserts and Shields:

1. Refer to Section 22 05 29 for additional information.
2. Application: Piping 1 inch diameter or larger.
3. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
4. Insert Location: Between support shield and piping and under the finish jacket.
5. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
6. Insert Material: ASTM C640 cork, hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
7. Provide inserts and/or shields per manufacturer recommendations for cellular foam insulation applications in order to maintain continuous insulation throughout the pipe system. The removal of sections of cellular foam insulation to accommodate pipe supports is not acceptable. Manufacturer products specifically designed for supporting insulation and maintaining the integrity of the insulation system at pipe hanger locations, such Armaflex Armafix Insulation Pipe Hangers, are acceptable.

Q. Finish insulation at supports, protrusions, and interruptions.

R. For pipe exposed in finished areas, finish with white PVC jacket and PVC fitting covers.
S. For piping exposed in mechanical rooms below 8 feet above finished floor, finish with aluminum jacket and aluminum fitting covers.

T. All valves in insulated systems shall have valve stem extensions. Insulation installer shall notify the contractor and Owner if valves without stem extensions are encountered. All valves without stem extensions in areas where stem extensions are required shall be replaced.

3.3 TOLERANCE

A. Substituted insulation materials, where allowed, shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.4 GLASS FIBER INSULATION SCHEDULE

A. Plumbing Systems

<table>
<thead>
<tr>
<th>PIPING SYSTEM</th>
<th>PIPE SIZE:</th>
<th>THICKNESS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Water and Hot Water Recirc Systems</td>
<td>1-1/4&quot; &amp; smaller</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Hot Water and Hot Water Recirc Systems</td>
<td>1-1/2&quot; &amp; larger</td>
<td>1-1/2&quot;</td>
</tr>
</tbody>
</table>

3.5 CELLULAR FOAM INSULATION SCHEDULE

A. Plumbing Systems

<table>
<thead>
<tr>
<th>PIPING SYSTEM</th>
<th>PIPE SIZE:</th>
<th>THICKNESS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Water Systems</td>
<td>All sizes</td>
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</tr>
<tr>
<td>Tempered Water Systems</td>
<td>All sizes</td>
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</tr>
<tr>
<td>Tepid Water to Emergency Fixtures</td>
<td>All sizes</td>
<td>None</td>
</tr>
<tr>
<td>Cold (&lt;65°F) Condensate Drain Piping</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Drain Piping Serving OA Plenum</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Branch Drain Piping Serving Floor Sinks</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Roof Drain Bodies</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Roof Drainage Systems Above Grade</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Plumbing Vents Within 20' of Exterior</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Fire Sprinkler System Main Drain and</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Inspector’s Test Valve Drain Within 20' of Building Exterior</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
</tbody>
</table>

END OF SECTION 22 07 19
SECTION 220800 – PLUMBING SYSTEMS COMMISSIONING

PART 1  GENERAL

1.1  DESCRIPTION

A. The purpose of this section is to specify the Contractor’s responsibilities and participation in the commissioning process relative to Division 22.

B. Commissioning testing shall be performed by this division Contractor and documented by the Commissioning Authority. Commissioning is primarily the responsibility of the Commissioning Authority, with start-up, testing and support for commissioning the responsibility of the Contractors. The commissioning process does not relieve the Contractor from participation in the process or diminish the role and obligations to complete all portions of work in a satisfactory and fully operational manner.

C. Work of Division 22 includes:

   1. Testing and start-up of the plumbing equipment.
   3. Providing qualified personnel to assist in commissioning tests, including seasonal testing.
   4. Completion and endorsement of Pre-functional Construction Checklists provided by the Commissioning Authority to assure that Division 22 equipment and systems are fully operational and ready for functional testing.
   5. Providing equipment, materials and labor necessary to correct deficiencies found during the commissioning process which fulfill contract and warranty requirements.
   6. Providing operation and maintenance information and as-built drawings to the Commissioning Authority for review, verification and organization, prior to distribution.
   7. Provide a detailed start up plan for CxA’s review, comment and recommendation.
   8. Provide at the end of the job the following items for inclusion in the systems manual.
      a. Control drawings, sequences of control
      b. A table of all set points
      c. Schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown
      d. A list of all manufacture recommended preventive maintenance procedures for all equipment and systems.
   9. Use Burns & McDonnell (BMcD)’s on-line and window based Commissioning application to fill out Construction Checklist and to track issues resolutions. Attendance a one BMcD training class is required for all contractors. This training will take place at the construction Cx kick off.
   10. Providing assistance to the Commissioning Authority to develop, edit and document system operation descriptions.
   11. Providing training for the systems specified in this Division with coordination of Owner by the Commissioning Authority.
1.2 RELATED WORK

A. All installation, testing and start-up procedures and documentation requirements specified within Division 22.

B. Section 019113 – Commissioning

C. Commissioning Functional Test Procedures that required participation of the Division 22 Contractors.

D. Cooperate with the Commissioning Authority in the following manner:
   1. All testing and start-up procedures and documentation requirements specified within Division 1 and Division 22 and related portions of this project.
   2. Allow sufficient time before final completion dates so mechanical systems start-up, test and balance, and commissioning can be accomplished.
   3. Provide labor and material to make corrections when required without undue delay.
   4. Put all plumbing equipment into full operation and continue the operation of the same during each working day of the testing, balancing and commissioning.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

A. Standard test equipment for commissioning will be provided by the Contractor.

B. Division 22 Contractor shall provide standard and specialized test equipment as necessary to test and start up the plumbing systems.

C. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment through the installing contractor. Manufacturer shall provide the test equipment, demonstrate its use and assist the Commissioning Authority in the commissioning process.

D. The Contractor shall provide all equipment, software and all test programming support as necessary to start up, calibrate, debug and verify proper function of the control/facility management system. This equipment and software shall be provided for use by the test, adjust and balance contractor and the Commissioning Authority.

PART 3 EXECUTION

3.1 WORK PRIOR TO COMMISSIONING

A. Complete all phases of work so the systems can be energized, started, tested and otherwise commissioned. Division 22 has primary start-up responsibilities with obligations to complete systems, including all sub-systems, so they are functional. This includes the complete installation of all equipment materials, raceways, wire,
terminations, controls, etc., per the Contract Documents and related directives, clarifications, change orders, etc.

B. A Commissioning Plan will be developed by the Commissioning Authority. Upon request of the Commissioning Authority, the Contractor shall provide assistance and consultation. The Commissioning Plan will be developed prior to completion of the installation. The Contractor is obligated to assist the Commissioning Authority in preparing the Commissioning Plan by providing all necessary information pertaining to the actual equipment and installation. If Contractor-initiated system changes have been made that alter the commissioning process, the Commissioning Authority will notify the Architect and the Contractor may be obligated to compensate the Commissioning Authority to test the revised product or confirm the suitability/unsuitability of the substitution or revision.

C. Specific pre-commissioning responsibilities of Division 22 are as follows:

1. Normal start-up services required bringing each system into a fully operational state. This includes motor rotational check cleaning, lug tightening, control sequences of operation, etc. The Commissioning Authority will not begin the commissioning process until each system is complete, including normal contractor start-up and debugging.
2. The Contractor shall perform pre-functional construction checklists on the systems to be commissioned to verify that all aspects of the work are complete in compliance with the plans and Specifications. Contractor start-up forms may be substituted for the pre-functional test forms with prior approval by the Commissioning Authority.
3. Factory start-up services will be provided for key equipment and systems specified in Division 22. Factory start-up activities to be documented and submitted. The Contractor shall coordinate this work with the manufacturer and the Commissioning Authority.
4. Notify Construction Manager and Commissioning Authority when systems are ready for functional testing.

D. Commissioning is intended to begin upon completion of a system. Commissioning may proceed prior to the completion of systems and/or sub-systems, if expediting this work is in the best interests of the Owner. Commissioning activities and schedule will be coordinated with the Contractor. Start of commissioning before system completion will not relieve the Contractor from completing those systems as per the schedule.

3.2 PARTICIPATION IN COMMISSIONING

A. Commissioning testing shall be performed by this division Contractor and documented by the Commissioning Authority. Provide skilled technicians to start up and debug all systems within this division of work. These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc., will be requested by the Commissioning Authority and coordinated by the Contractor. Contractor will ensure the qualified technician(s) are available and present during the agreed-upon schedules and of sufficient duration to complete the necessary tests, adjustments and/or problem resolutions.
B. System problems and discrepancies may require additional technician time, Commissioning Authority time, redesign and/or reconstruction of systems and system components. The additional technician time shall be made available for the subsequent commissioning periods until the required system performance is obtained.

C. The Commissioning Authority reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment, system and/or sub-system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment and an attitude/willingness to work with the Commissioning Authority to get the job done. A liaison or intermediary between the Commissioning Authority and qualified factory representatives does not constitute the availability of a qualified technician for purpose of this work.

D. The test, adjust and balance subcontractor shall provide a draft report with final test measurements to the Commissioning Authority and shall provide qualified technicians and instruments needed for balancing to demonstrate a sample up to 100% of measurements until specified results are achieved.

3.3 WORK TO RESOLVE DEFICIENCIES

A. In some systems, maladjustments, misapplied equipment, and/or deficient performance under varying loads will result in a system that does not meet the original design intent. Correction of work will be completed under direction of the Architect, with input from the Contractor, equipment supplier and Commissioning Authority. Whereas all members will have input and the opportunity to discuss, debate and work out problems, the Architect/Engineer of Record will have final jurisdiction on the necessary work to be done to achieve performance.

3.4 ADDITIONAL COMMISSIONING

A. Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The Contractor, suppliers and Commissioning Authority shall include a reasonable reserve to complete this work as part of their standard contractual obligations.

B. The cost of compensation of the Commissioning Authority for repeat testing or troubleshooting due to systems that do not meet specified performance shall be borne by the Contactor.

C. Corrective work shall be completed in a timely fashion to permit the timely completion of the commissioning process. Experimentation to render system performance will be permitted. If the Commissioning Authority deems the experimentation work to be ineffective or untimely to the commissioning process, the Commissioning Authority will notify the Architect/Engineer of Record indicating the nature of the problem, expected steps to be taken and the deadline for completion of activities. If the deadline passes without resolution of the problem, the Owner reserves the right to obtain supplementary services and equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner will be the Contractor’s responsibility.
3.5 SYSTEMS TO BE COMMISSIONED

A. Refer to specification section 019113:

3.6 TRAINING

A. This Contractor will be required to participate in the training of the Owner’s engineering and maintenance staff for each system and the related components. Training may be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids, or in the field with the specific equipment. The type of training will be per the Owner’s option.

B. The Contractor will be responsible for the generic training as well as instructing the Owner’s staff on the system peculiarities specific to this project.

3.7 SYSTEMS DOCUMENTATION

A. Maintain as-built red-lines on the job site as required in Division 1. Given the size and complexity of this project, red-lining of the drawings at completion of construction based on memory of key personnel is not satisfactory. Continuous and regular red-lining and/or posting of drawings is considered essential and mandatory.

B. In addition to the stated requirements for operation and maintenance data, provide one (1) copy of equipment technical literature, operation and maintenance literature and shop drawings to the Commissioning Authority as soon as they are available. This requirement is for review of these documents prior to distribution of multiple copies for the Owner’s final use.

C. Schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown

D. A list of all manufacture recommended preventive maintenance procedures for all equipment and systems.

E. END OF SECTION
SECTION 22 10 00 - PLUMBING PIPING

1. GENERAL

1.1 SECTION INCLUDES

A. Pipe and pipe fittings.
B. Valves.
C. Sanitary waste and vent piping system.
D. Domestic water piping system
E. Laboratory water piping system

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.
   1. Valves: Manufacturer’s name and pressure rating marked on valve body.
B. References
C. Submittals
D. Operation and maintenance manuals.
E. Project record documents
   1. Record actual locations of valves.
F. Delivery, storage, and handling

1.3 REGULATORY REQUIREMENTS

A. Perform Work in accordance with International Plumbing Code.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.
1.5 EXTRA MATERIALS

A. Provide two repacking kits for each size valve.

2. PRODUCTS

2.1 SANITARY WASTE AND VENT PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A888 and CISPI 301, hubless, service weight for piping.
   
   1. Fittings: Cast iron, ASTM A888 and CISPI 301, service weight.
   2. Joints: Neoprene gaskets and heavy-duty stainless steel 4-band or 6-band clamp-and-shield assemblies.

2.2 DOMESTIC AND LABORATORY WATER PIPING, ABOVE GRADE

A. Copper Tubing: ASTM B88, Type L, hard drawn.

   2. Joints: ASTM B32, solder, Grade 95TA, for piping 1-1/2” and smaller. AWS A5.8, BCuP-5 (15% silver bearing material) silver braze, for piping 2” and larger.
2.3 FLANGES, UNIONS, AND COUPLINGS

A. Pipe Size 2 Inches and Under:
   1. Ferrous pipe: 150 psig malleable iron threaded unions.
   2. Copper tube and pipe: 150 psig bronze unions with soldered joints.

B. Pipe Size Over 2 Inches:
   1. Ferrous pipe: 150 psig forged steel slip-on flanges; 1/16 inch thick preformed neoprene gaskets.
   2. Copper tube and pipe: 150 psig slip-on bronze flanges; 1/16 inch thick preformed neoprene gaskets.

2.4 DIELECTRIC CONNECTIONS:

   A. Dielectric Connections: Where connecting ferrous and non-ferrous piping materials, use full-port ball valve with bronze construction or dielectric couplings to separate piping materials.

2.5 SWING CHECK VALVES

   A. Up to and including 2 Inches: Bronze swing disc, 125 psig working pressure.

   B. Over 2 Inches: Cast iron body, bronze trim, swing disc, renewable disc and seat, flanged ends.

2.6 BALL VALVES

   A. Up to and including 4 inches: Bronze two piece body, chrome plated steel full-port ball, teflon seats and stuffing box ring, lever handle.

2.7 BUTTERFLY VALVES

   A. 3 Inches and larger:
      1. Standard: MSS SP-67, Type I.
      2. Body Design: Lug type suitable for bidirectional dead-end service rated at 200 psig without use of downstream flange.
      4. Seat: EPDM
      5. Stem: One or two piece stainless steel.
      6. Disc: Neoprene coated ductile iron or aluminum bronze.
2.8 STRAINERS

A. Size 2 inch and Under: Screwed bronze body for 250 psig working pressure, Y pattern with 20-mesh stainless steel perforated screen.

B. Size 2-1/2 inch and larger: Flanged cast iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

2.9 CALIBRATED BALANCE VALVES

A. Pre-Set Balance Feature. Valves to be designed to allow Installing Contractor to pre-set balance points for proportional system balance prior to system start-up in accordance with scheduled flow rates.

B. Valve Design and Construction. All valves shall have a calibrated orifice or venturi section, two ¼" threaded pressure tap ports with integral seals, and memory stop to retain the set position. Valves should be rated for 125 psig working pressure and 250 Deg. F maximum operating temperature.

C. Valves shall be selected based on flowrate, not on pipe size dimensions.

D. Preformed Insulation. All valves to be provided with molded insulation to permit access for balance and read-out.

2.10 DRAIN VALVES

A. Equipped with hose adaptor fitting and cap.

3. EXECUTION

3.1 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient.

D. Install piping to conserve building space and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Vent pipes shall extend minimum 12” above finish roof line or as required by code.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Provide access where valves and fittings are not exposed.

J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

K. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting.

L. Install bell and spigot pipe with bell end upstream.

M. Install valves with stems upright or horizontal, not inverted.

N. Extend chains on valves with chainwheel operators down to maximum 5-feet above finished floor.

O. Install strainers in horizontal pipe or in vertical pipe such that flow is downward. Do not install strainers in vertical pipe with flow upward.

P. Install copper tubing under building slab according to CDA’s “Copper Tube Handbook.” Install ball valve directly upstream of each floor slab penetration.

Q. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105.

R. Install ball valve at all laboratory water connections to fume hoods and other laboratory/vivarium equipment.

S. Install natural gas shutoff valves at each required piece of equipment. Provide gas regulators as necessary to accommodate equipment pressure requirements. Coordinate with equipment vendor.
T. For PP and PVDF piping, installation shall only be performed by factory trained and certified installers in accordance with the manufacturer’s written procedures. Each installer shall complete the manufacturer's certification course, including written test examinations and submittal of test fusion welds to the factory for evaluation and file. Installation practices, including support spacing and expansion considerations, shall be in accordance with the manufacturer’s certification course and written recommendations.

1. The manufacturer shall also provide training and certification for Owner’s personnel at a time separate from the contractor training. Coordinate exact time with Owner.
2. Upon completion of the project, the contractor shall send electrofusion controller/heater back to factory for calibration and necessary repairs prior to delivering to the Owner. Contractor shall be responsible for any expense accrued due to the recertification and repair of the electrofusion controller/heater. Contractor shall also provide all associated components required to maintain the piping system.

U. Provide dewatering as necessary to accommodate the electrofusion joint-making process for all underground laboratory waste piping.

3.4 APPLICATION
A. Install unions downstream of valves and at equipment or apparatus connections.
B. Install valves for shut-off and to isolate equipment, part of systems, and vertical risers.
C. Install ball valves for throttling, bypass, or manual flow control services.
D. Provide flow control valves in water recirculating systems where indicated. Balance flow to maintain hot water at all plumbing fixtures.
E. Support storm piping at roof drains independent of drain.

3.5 ERECTION TOLERANCES
A. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum or as indicated on drawings. Maintain gradients.
B. Slope water piping and arrange to drain at low points.

3.6 PLUMBING PIPING PRESSURE TESTING
A. Test for leaks and defects all new plumbing piping systems and parts of existing systems, which have been altered, extended or repaired. Submit copy of Pipe Pressure Test Log provided in section 22 05 00 for each section of piping tested. Refer to International Plumbing Code for general pipe pressure testing requirements (i.e., test pressure gauges, inspections, etc.).
B. Leave uncovered and unconcealed all new, altered, extended, or replaced piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.

C. Repair all leaks and defects using new materials and retest all plumbing systems until satisfactory results are obtained.

D. Laboratory Waste and Vent Piping Systems.

   1. Test in accordance with manufacturer recommendations. Note that the use of air or other compressed gases will not be allowed for pressure testing of plastic laboratory waste and vent piping.

3.7 DISINFECTION OF WATER PIPING SYSTEMS

   1. After water systems have been pressure tested and flushed, each system (including distribution system to building) shall be cleaned and disinfected per AWWA C651. Note that procedures shall require two (2) consecutive sets of acceptable samples taken at least 24 hours apart.

   2. Take samples no sooner than 24 hours after flushing, from outlets and from water entry per AWWA 651, and analyze in accordance with AWWA C651.

   3. Samples shall be subject to bacteriological testing by a recognized 3rd party testing agency. Send test reports to Owner for review. If unsatisfactory bacteriological results are found, the system shall be disinfected and retested again until satisfactory results are obtained.

3.8 SERVICE CONNECTIONS

   A. Before commencing work check invert elevations required for connection to existing mains and branch piping, confirm inverts and ensure that these can be properly connected with slope for drainage.
1. GENERAL

1.1 SECTION INCLUDES

A. Automatic flow balance valves.

B. Installation requirements of other plumbing specialties scheduled in Plumbing Fixture Schedule.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

A. References.

B. Submittals.

C. Project record documents
   1. Record actual locations of plumbing specialties.

D. Operation and maintenance data.

E. Qualifications

F. Delivery, storage and handling.

2. PRODUCTS

2.1 AUTOMATIC FLOW BALANCE VALVES

A. Externally adjustable balance valve with removable differential pressure cartridge and external locking handle. Flow cartridge must be removable from valve without removing the valve from piping. Valve equipped with two capped ¼” readout valves. NPT end connections. Brass body with stainless steel spring, HNBR diaphragm and EPDM o-rings. MWP of 300 psig, temperature range of 14 to 250 degrees F., +/- 5% accuracy. Valves shall be identified with flow rate, pressure operating range, and coil designation.

B. Manufacturer: Bell and Gossett Ultraset or equivalent.

2.2 OTHER SPECIALTIES

A. Refer to Plumbing Specialties Schedule for required product information.
3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Pipe relief from backflow preventers to nearest drain.

C. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to either building exterior or floor drain (coordinate with plans). Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.

D. Provide final certification for all testable backflow preventers, after installation, by certified cross connection device tester. Submit copy of successful test to owner representative.

END OF SECTION 22 11 19
SECTION 22 40 00 - PLUMBING FIXTURES

1. GENERAL

1.1 SECTION INCLUDES

A. Cleanouts.
B. Water hammer arresters.
C. Installation requirements of plumbing fixtures scheduled in Plumbing Fixture Schedule.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

A. Commissioning requirements.
   1. See section 01 91 13 – General Commissioning Requirements for all commissioning requirements.
B. References
C. Submittals
D. Quality Assurance
E. Delivery, Storage and Handling

1.3 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings and instructed by the manufacturer.
B. Confirm that millwork is constructed with adequate provision for the installation of countertop lavatories and sinks.

2. PRODUCTS

2.1 CLEANOUTS

A. Exterior Surfaced Areas: Round or Square cast nickel bronze access frame and non-skid cover.
B. Interior Finished Floor Areas: cast iron body and frame, medium duty nickel bronze top to accommodate the following floor finishes as required:

1. Exposed rim type with recess to receive terrazzo or resilient floor finish.
2. Exposed finish type with standard mill finish.
3. Exposed flush type with standard scored or abrasive finish.
4. Concealed undercarpet flush type with mill finish and carpet marker.

C. Interior Finished Wall Areas: Line type with cast iron body and round gasket cover and round stainless steel access cover secured with machine screw.

D. Interior Unfinished Accessible Areas: Caulked or threaded type.

2.2 WATER HAMMER ARRESTERS

A. Standard: ASSE 1010 or PDI-WH 201.

B. Type: Diaphragm type.

C. Size: Size per manufacturer recommendations.

2.3 OTHER PLUMBING FIXTURES

A. Refer to Plumbing Fixture Schedule for all required product information.

3. EXECUTION

3.1 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

B. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install each fixture with trap with 2 slip joints, easily removable for servicing and cleaning.

C. Provide chrome plated rigid or flexible supplies to fixtures with stops, reducers, and escutcheons.

D. Install components level and plumb.

E. Install and secure fixtures in place with scheduled wall supports or wall carriers and bolts.

F. Seal fixtures to wall and floor surfaces with sealant, color to match fixture.

3.4 LAVATORY AND SINK INSTALLATION

A. Install lavatories and sinks level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories and sinks.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1. Coordinate exact locations with drawings.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.

E. Seal joints between lavatories/sinks, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks.

G. Install water-supply piping with stop on each supply to each faucet.

   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with lavatory/sink.
   2. Install stops in locations where they can be easily reached for operation.

3.5 CLEANOUT INSTALLATION
A. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

B. Encase exterior cleanouts in concrete flush with grade.

3.6 WATER HAMMER ARRESTOR INSTALLATION

A. Install water hammer arrestors complete with accessible isolation valve according to PDI-WH 201 and as shown on drawings.

3.7 FLOOR DRAIN INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

B. Position floor drains for easy access and maintenance.

C. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

1. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
2. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
3. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

D. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

3.8 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.9 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.
3. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

C. Adjust water pressure at flushometer valves to produce proper flow.

D. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.10 CLEANING

A. Directly prior to project turnover, clean plumbing fixtures and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets, urinals, and fittings.

C. Do not allow use of plumbing fixtures for use during construction unless approved in writing by Owner.

END OF SECTION 22 40 00
SECTION 22 61 13 – SPECIALTY GAS PIPING

1. GENERAL

1.1 SECTION INCLUDES

A. Equipment, accessories, pipe, and pipe fittings for:
   1. Specialty gas system (e.g. compressed air, vacuum, etc.)

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

A. Quality assurance.
   1. Perform work in accordance with NFPA 99.
   2. Brazing Qualifications: Must meet the brazing qualification standard outlined in NFPA 99.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents.

F. Delivery, storage, and handling.

1.3 REGULATORY REQUIREMENTS

A. Conform to NFPA 99 for Level 1 gas systems and applicable codes for laboratory gas systems.

B. Provide certificate of compliance from authority having jurisdiction indicating approval of systems.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., or other testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.
2. PRODUCTS

2.1 PIPE AND FITTINGS

A. Specialty Gases

1. Copper Medical Gas Tube: ASTM B 819 Type L, hard drawn, rated for OXY or OXY/MED. Tubing shall be cleaned for oxygen service by the manufacturer and delivered with capped ends.
3. Joints: AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze, without flux to NFPA 99 Level 1 system standards and ASSE series 6000 installation procedure, including clean, dry nitrogen purge.
4. Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

2.2 VALVES

A. Factory Preparation for Laboratory Gas Service: Disassemble, clean, degrease, seal, and pack for shipping.

B. Ball Valves:

1. Bronze body, three piece, double-seal ball valves with replaceable neoprene or teflon seat and stem seals, for minimum 600 psi cold working pressure, flange or union mounting, labeled for intended service.

C. Check Valves:

1. Description: In-line pattern, bronze.
2. Pressure Rating: 300 psig minimum.

2.3 PIPING ACCESSORIES

A. Hangers and Supports: MSS SP-58 with types as required by MSS SP-69.

B. Pressure Gauges:

1. ANSI B40.1, white dials and black lettering with restrictor.
2. Manufactured and labeled expressly for intended service; UL labeled.
2.4 AIR PRESSURE REGULATORS

A. Main Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250 psig inlet pressure. Pilot-operated.

B. Line Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200 psig inlet pressure. Diaphragm-operated.

2.5 AIR FILTER ASSEMBLIES

A. See schedule for further information.

3. EXECUTION

3.1 INSTALLATION

A. Connect condensate drains to nearest floor drain.

B. Install valved drip connections at low points of piping system.

C. Install take offs to outlets from top of main, with shut off valve after take off. Slope take off piping to outlets.

D. Install couplings, female quick connectors, and pressure gauges where outlets are indicated.

E. Identify piping system and components. Refer to Section 22 05 53.

F. Pre-Installation Cleaning: Disassemble positive pressure gas systems pipe, fittings, valves, and components, except those supplied cleaned and prepared for intended service, and thoroughly wash in hot solution of sodium carbonate or trisodium phosphate mixed 1 lb to 3 gal of water. After washing, rinse with water, dry and cap until installation.

G. Braze joints in pipe and tubing. Avoid leaving excess flux inside of pipe and fittings. During brazing of pipe connections, purge interior of pipe continuously with nitrogen.

H. Effect changes in size with reducing fittings. Make changes in direction of required turns or offsets with fittings or tubing shaped by bending tools. Make bends free of flattening, buckling or thinning of tube wall.

I. Cut pipe and tubing accurately and install without springing or forcing.

J. Grade piping down in direction of flow.
K. Provide pipe sleeves where pipes and tubing pass through walls, floors, roofs, and partitions. Finish flush at both ends. Extend 2 inches above finished floors. Pack space between pipe or tubing and sleeve, and calk.

L. Support gas piping with pipe hooks or hangers suitable for size of pipe, spaced:
   1. 1/2 inch pipe or tubing or less: 72 inches.
   2. 3/4 inch or one inch pipe or tubing: 96 inches.
   3. 1-1/4 inches or larger (horizontal): 120 inches.
   4. Vertical pipe or tubing: Every floor level.

M. Except where indicated or in flush wall mounted cabinets, install manual shut off valves with stem vertical and accessible for operation and maintenance.

N. Install ball valve at all connections to equipment.

O. Bases and Site preparation
   1. Contractor shall furnish 4 inch high concrete housekeeping pads under all medical air vacuum pumps.
   2. Contractor shall furnish inertia bases in lieu of housekeeping pads where the equipment installed is not factory isolated by the manufacturer.
   3. Cast anchor bolts into bases.

3.2 FIELD QUALITY CONTROL

A. Piping Leak Test: Cap and fill piping system with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate the test source and let stand for four hours to equalize temperature. Refill system, if necessary, to test pressure; hold for two hours with no drop in system pressure.

B. Repair or replace compressed piping as required to eliminate leaks, and retest to demonstrate compliance.

END OF SECTION 22 61 13
1. GENERAL

1.1 SECTION INCLUDES

A. This section describes Basic Mechanical Requirements required to provide for a complete installation of all mechanical systems for this project. This section shall apply to all other Division 23 specification sections as well as all work shown on the drawings.

B. It is the intent of the Mechanical Division of the Specifications that all mechanical work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations operate as designed.

C. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Owner’s representative.

D. The Contractor shall note that, in some cases, piping as shown on the Drawings provide general location and routing information only. The Contractor shall be responsible for providing interference-free systems with proper clearance to facilities and equipment.

E. Where the word “provide” is used, it shall mean “furnish and install” unless otherwise noted or specified.

F. Note that the words “mechanical” and “plumbing” are used interchangeably throughout the Division 22 and 23 specification sections.

1.2 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section and all other sections of Division 23.

1.3 DESCRIPTION OF WORK

A. The work included under this section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete mechanical systems required by these specifications and/or shown on the drawings of the contract.

B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, piping fixtures, etc. The Contractor shall follow the drawings in laying out work and verify clearances for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of outlets or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.
1.4 QUALITY ASSURANCE

A. Installers shall have at least 5 years of successful installation experience on projects with mechanical installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for satisfactory operation, unless noted otherwise in other mechanical sections.

B. Manufacturer of equipment and materials must be regularly engaged in the manufacture of the specified equipment and material with similar construction and capacities and whose products have been in satisfactory use in similar service for not less than five (5) years, unless noted otherwise in other Mechanical Sections.

C. Qualify welding processes and operators for structural steel according to AWS D1.1. "Structural Welding Code - Steel.

D. Quality welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

E. Comply with provisions of ASME B31 Series "Code for Pressure Piping", including all addenda.

F. Contractor signed welder certificate(s) shall be submitted. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current. A record shall be maintained on the job site showing the date and results of qualification tests for each welder employed on the job. One certified copy of the qualification test for each welder so employed shall be furnished to the Owner’s representative.

G. For all the refrigerant work/service required by this project, all refrigerant technicians shall be EPA/ASHRAE 34 certified for corresponding classification type I, II, III and/or IV.

1.5 REFERENCES

A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall conform to the following as applicable:

1. Safety and Health Regulations for Construction.
2. Occupational Safety and Health Standards, National Consensus Standards and Established Federal Standards.
4. ACCA - Air Conditioning Contractors of America.
5. ACGIH - American Conference of Governmental Industrial Hygienists.
6. ADC - Air Diffusion Council.
8. AIHA - American Industrial Hygiene Association.
14. ASME - The American Society of Mechanical Engineers.
16. CAGI - Compressed Air and Gas Institute.
17. CTI - Cooling Tower Institute.
18. EJMA - Expansion Joint Manufacturers Association.
19. ETL - Engineering Tests Laboratory.
22. HYD I - Hydronics Institute.
23. ICBO - International Conference of Building Officials.
25. NEBB - National Environmental Balancing Bureau.
27. NEMA - National Electrical Manufacturers Association.
29. NSF - National Sanitation Foundation.
30. SAE - Society of Automatic Engineers.
31. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
32. TEMA - Tubular Exchanger Manufacturers Association.
33. UL - Underwriters Laboratories, Inc.
34. International Plumbing Code.
35. International Mechanical Code.
36. Other governing, state, and local codes that apply.

1.6 SUBMITTALS

A. General: Follow the procedures specified in Division 1 Sections “General Conditions” and “Special Conditions”.

B. The Architect/Engineer’s review of submittals, including any corrections or comments made on the shop drawings during the review process, do not relieve Contractor from compliance with requirements of the Contract Documents. The review is only a review of general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. The Contractor is responsible for confirming and correlating all quantities and dimensions; selecting fabrication process and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner. The Contractor shall not be relieved from responsibility for errors or omissions in the shop drawings, product data or samples by the Architect/Engineer’s review of those drawings.

C. No portion of the work requiring submission of a shop drawing, product data or sample shall be commenced until the submittal has been reviewed by the Architect/Engineer. All such portions of the work shall be in accordance with reviewed submittals and the associated manufacturer recommendations.

D. Shop drawings shall include the minimum following information as applies. Additional specific information required is outlined in other Plumbing Sections.

1. Certified performance and data with system operating conditions indicated. All coil, fan, and pump performance data shall be computer generated.
2. **Product Data:** Submit manufacturer's technical product data, including rated capacities of selected model clearly indicating, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.

3. **Shop Drawings:** Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loading, required clearances, and methods of assembly of components.

4. **Wiring Diagrams:** Submit manufacturer's electrical requirements for power supply wiring to electrical equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of electrical equipment and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

5. **Maintenance Data:** Submit maintenance data and parts list for each mechanical equipment, control and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

### E. Coordination drawings

1. **Drawings:**
   
   a. Provide coordination in determining adequate clearance and space requirements for fire protection equipment, mechanical equipment, electrical equipment, and other items/equipment in the project. The Architect/Engineer reserves the right to determine space priority of equipment in the event of interference between pieces of equipment, piping, conduit, ducts and equipment of the trades. The Architect/Engineer will only review conflicts and give an opinion but will not perform as a coordinator.
   
   b. Provide coordination drawings indicating structural components, reflected ceiling layout, fire protection items, mechanical items, electrical items, and other systems. Indicate on the coordination drawings where components will be installed and how the service access area to such items shall be maintained. Illustrate items requiring access for maintenance or adjustment.
   
   c. The Contractor will not be allowed any time extensions for participation in the coordination drawing process. The Contractor will not be allowed any contract cost extra for any additional fittings, rerouting or changes of duct size to equivalent sizes to those shown on the drawings that may be determined necessary through the coordination drawing process.
   
   d. Deviations from the contract documents that are necessary for overall system installation and coordination shall be brought to the attention of the Architect/Engineer. Such necessary changes in the contract scope discovered through the coordination drawing process will be covered by the requirements of the "change order" process.
   
   e. Access panels shall occur only in gypsum wallboard or plaster ceilings where indicated on the drawings or as needed to provide access to equipment, dampers, or valves. Access to fire suppression and other items shall be through accessible acoustical ceiling areas. Additional access panels will not be allowed without written approval from the Architect/Engineer at the coordination drawing stage and only after alternatives are reviewed. Layout changes shall be made to avoid additional access panels. If additional access panels are required, they shall be provided at no additional cost to the Owner.
   
   f. Soffit penetrations and light alcoves shall be fully coordinated with hanging devices, studs, fire/smoke ratings, and structural support requirements.
2. The Contractor and subcontractors responsible for items of work located in or above ceilings shall participate in the coordination drawing process. Participation is mandatory. If the Contractor or subcontractor fails to participate in the coordination drawing process, the Owner reserves the right to do the following:

a. Stop construction progress payments for work performed by the Contractor. Payments will be reinstated only after the Contractor or subcontractor resumes participation in the coordination drawing process.

b. Require the relocation and resizing of components as necessary to ensure components will be installed as intended. In the event the Contractor did not participate in the coordination process, the Contractor will not be entitled to contract cost increases or time extensions due to Owner-initiated changes in the work.

c. The Contractor shall be held responsible for unnecessary rework that is attributable to failure to participate in the coordination process.

3. Drawings shall be prepared at 1/4 inch = 1 foot, 0 inches (minimum).

a. Coordination participants shall provide equipment installation and clearance requirements. This information shall be indicated on the coordination drawings.

b. Coordination drawings shall indicate the following major system components (including insulation, hub or connection widths with verification of turning radius):

   1) Roof drain leaders
   2) Large waste piping
   3) Sprinkler mains
   4) Equipment located above the ceiling
   5) Heating hot water piping
   6) Chilled water piping
   7) Conduit runs 2 inches and larger
   8) Cable tray
   9) Bus duct
  10) Recessed light fixtures
  11) Building wiring or cable trays
  12) Ceiling heights as shown in contract documents and thickness of system
  13) Soffits (including framing of supports)
  14) Access points and clearances required
  15) Access panels
  16) Valves
  17) Dampers
  18) Coils
  19) Ductwork
  20) Fire-rated wall, partition, and floor penetrations
  21) Steam and condensate piping
  22) Space allotted for future utilities
  23) Equipment in mechanical and electrical spaces

c. Information shall be delineated to indicate distances from column centerlines, pipe/equipment size, and distance from finished floor to bottom of pipe/equipment and hangers.
4. The coordination drawings shall be submitted to the Architect/Engineer and Owner’s representative for review. The submitted coordination drawings shall indicate which contractors participated in the process and where conflicts appear to occur even after the priority ranking of utility routing has been utilized. In the event that conflicts require input from the Architect/Engineer, recommended solutions will be provided with the coordination drawings for review by the Architect/Engineer. The Architect/Engineer will review and return an opinion to the contractors for implementation. All contractors shall agree to the final coordinated layout by signing off on the coordination drawings before any construction can begin.

5. Maintain an updated set of coordination drawings at the job site reflecting changes, modifications and adjustments. Changes shall be reflected and sets or new sheets reissued to the Architect/Engineer and the Owner for review on a monthly basis with changes “clouded” and brought to the attention of the Architect/Engineer and the Owner.

6. When a change order request is issued, the affected subcontractors shall review the coordination drawings and bring to the attention of the Contractor and the Architect/Engineer revisions necessary to the work of others not directly affected by the change order.

7. Contractors that fail to cooperate in the coordination drawing effort shall be responsible for all costs incurred for adjustments to the work made necessary to accommodate installations. Provide adequate clearance and access through accessible ceilings. Conflicts that result after the coordination drawings are signed off will be the responsibility of the Contractor or subcontractor who did not properly identify their work or installed the work improperly.

F. Provide separate shop drawing submittals for all items listed in Shop Drawing and Submittal Log in Division 1.

1.7 SUBSTITUTES

A. Refer to the General Conditions and Special Conditions sections of this Specification for general substitution requirements and information.

1.8 WARRANTY

A. Refer to the General Conditions section of this Specification for general warranty requirements and information. Additional warranty requirements are specified in subsequent Mechanical Sections.

1.9 CLOSE OUT AND OPERATION INSTRUCTIONS

A. Operate each system and item of equipment in a test run of appropriate duration, but no less than 7 days, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance.

B. Any system placed in temporary operation for testing or for the convenience of the Contractor during construction shall be properly maintained and operated by the Contractor.

C. All systems shall be protected against freezing, flooding, corrosion or other forms of damage prior to acceptance by the Owner.
D. Material or equipment damaged, shown to be defective or not in accordance with the Specifications shall be repaired or replaced to the satisfaction of the Owner’s representative.

E. All tests shall be made after notification to and in the presence of the Owner’s representative.

F. Before starting up any system, each piece of equipment comprising any part of the system shall be checked for proper lubrication and any other condition which may cause damage to the equipment or endanger personnel.

G. After systems have been demonstrated to be satisfactory for 7 consecutive days and ready for permanent operation, all permanent pipe line strainers shall be cleaned, valve and packings properly adjusted, lubrication checked and replenished if required. Temporary piping, etc. shall be removed and openings restored in a permanent manner acceptable to the Owner’s representative.

H. Conduct a walk-through instruction seminar for the Owner’s personnel pertaining to the continued operation and maintenance of mechanical equipment and systems. Explain the identification system, maintenance requirements, operational diagrams, temperature control provisions, sequencing requirements, security, safety, efficiency and similar features of the systems. Walk through must be documented as to those attending and subjects covered. Walk through document(s) shall be signed and dated by the contractor's representative and the owner's representative.

1. Provide instruction seminar, minimum 4 hours each, for each of the following items: Air Handling Units, Exhaust Fans, and Heat Recovery Housing.

I. At the time of substantial project completion, turn over the prime responsibility for operation of the mechanical equipment and systems to the Owner’s operating personnel. Until the time of final acceptance, provide full time operating personnel, who are completely familiar with the work, to consult with and continue training the Owner’s personnel.

1. If any systems are operated prior to substantial completion, the contractor shall perform all necessary preventative maintenance according to all manufacturer recommendations.

1.10 RECORD DOCUMENTS

A. Prepare as-built documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in above, indicate the following installed conditions:

1. The Mechanical Contractor shall provide the Owner with as-built drawings for ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units and indicate all devices requiring periodic maintenance or repair, such as control power transformers, LACS panels/routers, field controllers, duct static pressure sensors, piping pressure sensors, etc.

2. All mechanical systems as described in the Specifications and/or shown on the drawings.
3. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 23 Section "Mechanical Identification." Indicate actual inverts and horizontal locations of underground piping.

4. Equipment/material locations (exposed and concealed), dimensioned from prominent building lines.

1.11 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.

2. PRODUCTS (NOT APPLICABLE)

3. EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Store and handle material and equipment in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

C. Use proper lifting equipment where size/weight requires handling by such means.

D. Comply with manufacturer's rigging and moving instructions for unloading material and equipment, and moving them to final location.

E. Equipment requiring disassembly for access purposes shall be disassembled and reassembled as required for movement into the final location following manufacturer's written instructions.

F. Deliver material and equipment as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.
3.2 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 2 through 26 for rough-in requirements.

3.3 COORDINATION

A. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

B. Coordinate the mechanical work with work of the different trades so that:

1. Interferences between mechanical, electrical, architectural, and structural work, including existing services, will be avoided.
2. Within the limits indicated on the drawings, the maximum practicable space for operation, maintenance repair, removal and testing of mechanical and other equipment will be provided.
3. Pipes, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes, ducts, and similar items shall be located so that they will not interfere with the intended use of other equipment.

C. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.

D. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.

3.4 MECHANICAL INSTALLATIONS

A. All dimensions and clearances affecting the installation of work shall be verified in the field in relation to established datum, to building openings and to the work of other trades.

B. The location of all equipment and systems shall be coordinated to preclude interferences with other construction.

C. Should interferences occur which will necessitate deviations from layout or dimensions shown on the Drawings, the Architect/Engineer and the Owner’s representative shall be notified and any changes approved before proceeding with the work.

D. Arrange for chases, slots, and openings in other building components during progress of construction to allow for mechanical installations.
E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum possible headroom.

F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

G. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.

H. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

I. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

K. Welding, sweating, or brazing operations
   1. All cutting, welding, brazing, or sweating operations carried on in the vicinity of, or accessible to, combustible material shall be adequately protected to make certain that a spark or hot slag does not reach the combustible material and start a fire.
   2. When it is necessary to do cutting, welding, brazing, or sweating close to wood construction, in pipe shafts, or other locations where combustible materials can not be removed or adequately protected, employ fireproof blankets and proper fire extinguishers. Position another individual nearby to guard against sparks and fire.
   3. Whenever combustible material has been exposed to molten metal or hot slag from welding or cutting operations, or spatter from electric arc operations, a guard shall be kept at the place of work for at least one hour after completion to verify that smoldering fires have not been started.
   4. Whenever welding or cutting operations are carried on in a vertical shaft or where floor openings exist, a fire guard shall be employed to examine all floors below the point of the welding or cutting operation. The fire guard shall be kept on duty for at least one hour after completion to verify that smoldering fires have not been started.
   5. Before any work involving cutting, welding, brazing, or sweating operations is started, consult with the Architect/Engineer as to particular safety precautions to be employed on the work.

3.5 ACCESSIBILITY

A. All work shall be installed so as to be accessible for operation, maintenance and repair with particular attention given to locating valves, controls and equipment requiring periodic lubrication, cleaning, adjusting or servicing of any kind.
3.6 LUBRICATION AND TOOLS

A. Provide a fresh charge of lubricant in accordance with manufacturer’s recommendations to all equipment requiring lubrication prior to start-up and maintain lubrication as required until acceptance by Owner.

B. Provide for each piece of equipment any special tools and a list of such tools required for the operation or adjustment of the equipment and turn over to the Owner’s representative prior to final acceptance of the equipment.

3.7 PIPING SYSTEMS PRESSURE TESTING

A. The following personnel in the order listed shall be considered acceptable witnesses of all piping pressure testing:

1. Owner’s Representative
2. Mechanical Engineer / Architect
3. General Contractor’s Foreman

B. Removal of pressure charge and associated drain down shall also be witnessed.

C. Mechanical contractor shall provide a minimum of 24-hour notice to at least one of the above listed parties before commencing any piping systems pressure test.

D. Pressure gauge requirements: Provide recently calibrated gauge with 4” face and a range such that test pressure is between 50% and 100% of gauge range. For example, a gauge with a 15 psig range is acceptable for a 10 psig pressure test, whereas a gauge with a 30 psig range is unacceptable in this application. Gauge resolution shall be suitable for type of testing, system size and test media. Gauge shall have been recently calibrated.

E. All piping pressurizing equipment (i.e., air compressor) shall be disconnected before test is commenced and shall remain disconnected for the entire duration of the test.

F. Entire system shall be properly vented before test is commenced.

G. For specific piping pressure testing requirements and procedures, see applicable piping systems specification sections.

H. Submit completed “Pipe Pressure Test Log” provided at the end of this Section for each pressure test before final project closeout. Test log shall also be included in operation and maintenance manuals.

NOTE: USE MULTIPLE FORMS IF NECESSARY
3.8 EXTENT OF WORK

A. Access Panels

1. Furnish and install panels for access to valves and dampers and similar items where no other means of access, such as readily removable, sectional ceiling is shown or specified.

B. Cutting and Patching

1. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:

2. Contractor shall coordinate all cutting and patching of holes, in existing building and new construction which are required for the passage of mechanical work.
3. Under no circumstances shall any structural members, load-bearing walls or footings be cut without first obtaining written permission from the Engineer.
4. Cut, channel, chase and core drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
5. Patching of concrete openings shall be filled with grout and finished smooth with the adjacent surface.
6. All below-grade openings for pipe shall be sealed with interlocking synthetic rubber line assembly, Link-Seal by Thunderline Corporation or equal.
7. Repair cut surfaces to match adjacent surfaces.
8. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
   a. Uncover work to provide for installation of ill-timed work.
   b. Remove and replace defective work.
   c. Remove and replace work not conforming to requirements of the Contract Documents.
   d. Remove samples of installed Work as specified for testing.
   e. Install equipment and materials in existing structures.
   f. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. Concrete Bases

1. Minimum 4" high concrete housekeeping pads shall be provided under floor mounted mechanical equipment.
2. Construct concrete equipment bases a minimum 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000 psi, 28-day compressive strength concrete, reinforcement and forms as specified in Division 3 Section "Cast-In-Place Concrete."
D. Painting

1. Contractor is to field paint HVAC equipment and materials in specified areas as noted on the HVAC plans, HVAC schedules and in the specifications.
2. In concealed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted with one coat of zinc rich paint.
3. In exposed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted in accordance with Section 099100.

E. The responsibility of work specified under Division 23 and 26 is clarified under, Section 230513, "Electrical Requirements for Mechanical Equipment. Contractor is to coordinate all electrical requirements prior to ordering powered mechanical equipment.

END OF SECTION 23 05 00
SECTION 23 05 13 - ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

1. GENERAL

1.1 SECTION INCLUDES

A. Electrical Requirements for:

1. Motors
2. Starters, Electrical Devices, and Wiring
4. Motor Connections
5. Capacitors
6. Safety Switches

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

1. Electrical components and materials shall be UL labeled and listed.

B. References.

1. The design, manufacture, testing and method of installation of all equipment and materials furnished under the requirements of this specification section shall conform to the following:

   a. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
   b. AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
   c. ANSI/IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.
   d. ANSI/NEMA Standard MG 1 – Motors and Generators.
   e. ANSI/NFPA 70 - National Electrical Code.
   f. NEMA Standard ICS 2 – Industrial Control Devices, Controllers, and Assemblies.
   g. NEMA Standard 250 – Enclosures for Electrical Equipment.
   h. NEMA Standard KS 1 – Enclosed Switches.

C. Submittals.

1. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, or as required by the individual equipment specification sections.

D. Operation and maintenance manuals.

E. Project record documents.
F. Delivery, storage, and holding

G. Related sections.

1. Separate electrical components and materials required for field installation and electrical connections are specified in Division 26.

1.3 SUMMARY

A. This section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment. In addition, this section covers necessary coordination issues between mechanical and electrical disciplines. All mechanical and electrical construction documents must be completely reviewed by the Mechanical and Electrical Contractors prior to the submission of bids. Any discrepancies in the documents should be brought to the Architect/Engineer’s attention at that time. Failure to properly coordinate or review documents in advance of submission of bids will not be valid cause for changes to the overall Contract amount.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

2. PRODUCTS

2.1 MOTORS

A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Minimum service factors shall be as follows:

<table>
<thead>
<tr>
<th>Horsepower</th>
<th>3600 RPM:</th>
<th>1800 RPM:</th>
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<tbody>
<tr>
<td>1/6 – 1/3</td>
<td>1.35</td>
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<tr>
<td>1/2</td>
<td>1.25</td>
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<tr>
<td>1 – 1.25</td>
<td>1.25</td>
<td>1.15</td>
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<tr>
<td>1.5 - 150</td>
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3. Two-speed poly-phase motors shall have two separate windings served by a single point electrical connection to the two speed starter. Two speed starters shall be located at the motor location unless otherwise noted.
5. Starting capability: Frequency of starts as indicated by automatic control system, and not less than five (5) evenly timed starts per hour for manually controlled motors.
   a. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit each specific application.
   b. Bearings: Ball or roller bearings with inner and outer shaft seals; re-greasable; designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor; for fractional horsepower, light duty motors, sleeve type bearings are permitted.
   c. Enclosure Type: Unless otherwise noted, use open drip-proof motors where satisfactorily housed or remotely located during operation; guarded drip-proof motors where exposed to contact by employees or building occupants; weather protected Type I for outdoor use, Type II where not housed.
   d. Explosion proof motors shall be provided as indicated on plans and schedules.
   e. Overload protection: Built-in thermal overload protection (in accordance with NEC requirements) and, where indicated, an internal sensing device suitable for signaling and stopping the motor at the starter.

7. Noise rating: "Quiet"
8. Efficiency: "Premium efficiency" motors, as defined in NEMA MG 1, most recent edition.
9. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
10. All three-phase motors shall be inverter duty type.
11. Motors Used With Variable Frequency Drives: Ratings, characteristics, and features coordinated with and approved by drive manufacturer. Motor shall be designed and labeled for use with variable frequency drives. Motor shall be designed with critical vibration frequencies outside the operating range of the drive output and shall be suitable for use throughout speed range without overheating.
   a. Provide AEGIS SGR, or approved equivalent, shaft grounding ring/system to divert adverse shaft currents away from the motor bearings. Use AEGIS Colloidal Silver Shaft Coating (PN CS015), or approved equivalent, prior to ring installation. Install coating and ring per manufacturer recommendations.

12. Motors less than 1 hp: Motor shall be an electronic commutation (EC) motor specifically designed for HVAC applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal. Motor shall be a minimum of 85% efficient at all speeds.
2.2 SHEAVES

A. All sheaves shall conform to NEMA Standard MG1-14.42, which lists minimum diameters and maximum overhangs. Locate motors to minimize overhang.

B. When replacing sheaves, use sheaves of at least the originally supplied sizes.

C. Contractor shall be responsible for replacement sheaves required to achieve specified performance. Coordinate with testing and balancing of the equipment.

2.3 STARTERS, ELECTRICAL DEVICES, AND WIRING

A. Motor-Starter Characteristics: Motor starters shall be compatible with the equipment they serve. In general, motor starter characteristics shall meet the requirements of Division 26 specification sections and as outlined as follows:

B. Motor Connections

1. Provide connections to motors in accordance with the requirements listed in the electrical specifications.
2. See Division 26 for the use of lugs for motor connections.

C. Capacitors

1. Capacitor features shall include:
   
   a. Individual unit cells.
   b. All welded steel housing.
   c. Each capacitor shall be internally fused.
   d. Non-flammable synthetic liquid impregnate.
   e. Craft tissue insulation.
   f. Aluminum foil electrodes

2. KVAR size shall be determined by the Contractor/Supplier and shall correct motor power factor to 95 percent or better and shall be installed on all motors 10 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load. Power factor correction is not required for motors used in conjunction with variable frequency drives.

D. FULL VOLTAGE NON-REVERSING MAGNETIC STARTERS

1. See specification section 26 29 13 – Motor Controllers for requirements.

E. FULL VOLTAGE NON-REVERSING COMBINATION STARTERS

1. See specification section 26 29 13 – Motor Controllers for requirements.
F. MANUAL MOTOR STARTERS

G. See specification section 26 29 13 – Motor Controllers for requirements.

H. CAPACITORS

1. Capacitor features shall include:
   a. Individual unit cells.
   b. All welded steel housing.
   c. Each capacitor shall be internally fused.
   d. Non-flammable synthetic liquid impregnate.
   e. Craft tissue insulation.
   f. Aluminum foil electrodes

2. KVAR size shall be determined by the Contractor/Supplier and shall correct motor power factor to 95 percent or better and shall be installed on all motors 10 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load. Power factor correction is not required for motors used in conjunction with variable frequency drives.

2.4 SAFETY SWITCHES

A. See specification section 26 05 01 – Basic Electrical Materials and Methods.

3. EXECUTION

3.1 INSTALLATION

A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer’s recommendations. Align shafts to manufacturer’s requirements or within 0.002 inch per inch diameter of coupling hub.

C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer’s instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer’s recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

3.2 CONTRACTOR COORDINATION
A. General contractor is responsible for coordination of all subcontractors and associated scopes of work.

END OF SECTION 23 05 13
SECTION 23 05 19 – HVAC METERS AND GAGES

1. GENERAL

1.1 SECTION INCLUDES

A. Pressure gages and pressure gage taps.
B. Thermometers and thermometer wells.
C. Piping pressure and temperature test plugs.
D. Static pressure and filter gages.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.
B. References
C. Submittals
D. Operation and maintenance manuals.
E. Project record documents
   1. Accurately record actual locations of instrumentation.
F. Delivery, storage, and handling

2. PRODUCTS

2.1 PRESSURE GAUGES

B. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection, liquid-filled.
C. Case: Drawn steel or brass, glass lens, 4-1/2 inches diameter.
D. Connector: Brass, 1/4-inch NPS.
E. Scale: White coated aluminum, with permanently etched markings.

F. Accuracy: Plus or minus 1 percent of range span.

G. Range: Conform to the following:

   1. Vacuum: 30 inches Hg to 15 psi.
   2. All fluids: 2 times operating pressure.

2.2 PRESSURE GAUGE ACCESSORIES

A. Syphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.3 GLASS THERMOMETERS


B. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9 inches long.

C. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Tube: Red reading, magnifying lens, with non-mercury fluid.

E. Scale: Satin-faced, nonreflective aluminum, with permanently etched markings.

F. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

G. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

H. Scale range: Temperature ranges for services listed as follows:

   1. Heating Water: 30 to 250 deg with 2-degree scale.
   2. Chilled Water: 0 to 100 deg F with 2-degree scale divisions.
   3. Steam and Condensate: 50 to 400 deg F with 2-degree scale divisions.
2.4 THERMOMETER WELLS

A. Thermometer Wells: Brass or stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.5 PIPING PRESSURE AND TEMPERATURE TEST PLUGS

A. Test Plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and 2 self-sealing valve-type core inserts, suitable for inserting a 1/8-inch O.D. probe assembly from a dial-type thermometer or pressure gage. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: Conform to the following for fluid and temperature range:


2.6 STATIC PRESSURE GAUGES

A. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.

B. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

C. Construction: Bronze or stainless-steel body, with sight glass and ball indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 150 psig.

E. Minimum Temperature Rating: 200 deg F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

3. EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer's instructions.
3.2 PRESSURE GAUGES

A. Install pressure gauges in piping tee with pressure gauge valve, located on pipe at most readable position.

B. Install as shown on plans, and elsewhere as indicated.

C. Pressure Gauge Ball Valves: Install in piping tee with snubber. Install syphon in lieu of snubber for steam pressure gages.

3.3 THERMOMETERS

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

B. Install as shown on plans and elsewhere as indicated.

C. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.4 TEST PLUGS

A. Test Plugs: Install where indicated, located on pipe at most readable position. Secure cap.

3.5 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.

END OF SECTION 23 05 19
SECTION 23 05 29 – HVAC HANGERS AND SUPPORTS

1. GENERAL

1.1 SECTION INCLUDES

A. Pipe, ductwork, and equipment hangers, supports, anchors, saddles and shields.

B. Mechanical flashing.

C. Mechanical sleeves and seals.

D. Flashing and sealing equipment and pipe stacks.

E. Sealants, firestop insulation, putty and compounds.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents.

F. Delivery, storage, and handling.

2. PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Hydronic Piping:

1. Conform to International Mechanical Code, ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89 as applicable.

B. Refrigerant Piping

1. Conform to International Mechanical Code, ASME B31.1, ASTM F708, MSS SP58, MSS SP69, MSS SP89, as applicable.
C. Hangers and Supports:

1. Hangers for Hot and Cold Pipe Sizes 1/2 to 1-1/2 Inch, Carbon steel, adjustable swivel, band type.
2. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
3. Hangers for Hot Pipe Sizes 2 to 4 Inches; Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
7. Wall Support for Hot Pipe Sizes 6 Inches (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
12. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Roof Support for Hot and Cold Pipe: See PIPE STANDS section below.
16. Hangers for insulated pipe shall be enlarged to compensate for insulation thickness so that hangers support insulation. See Section 23 07 19.
17. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
18. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
19. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
20. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
21. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
22. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
23. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
24. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
25. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
26. Side-Beam Brackets (MSS Type 34): For sides of steel beams.
27. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
28. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
29. See Section 23 05 48 for vibration isolation hangers and supports if applicable.
2.2 DUCTWORK HANGERS AND SUPPORTS

A. Ductmate Clutcher not allowed.

B. Strap and Rod Sizes: Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:

2.3 ACCESSORIES

A. Hanger Rods: ASTM A36 steel or galvanized threaded both ends, threaded one end, or continuous threaded.
   1. Ductwork: Use double nuts and lock washers on threaded rod supports.

2.4 INSERTS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Internally Threaded Screw Anchors: Internally threaded, self tapping screw anchors, Power Fasteners Snake or approved equivalent.
   1. Tested in accordance with ACI 355.2 and ICC-ES AC193 for use in structural concrete under the design provisions of ACI318 (Strength Design method using Appendix D)

2.5 FLASHING

A. Metal Flashing: 26 gage galvanized steel.
B. Metal Counterflashing: 22 gage galvanized steel.

C. Lead Flashing:
   1. Waterproofing: 5 lb/sq ft sheet lead
   2. Soundproofing: 1 lb/sq ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet buty; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.6 SLEEVES

A. Sleeves for Pipes Through Rated Floors and Walls: Schedule 40 steel pipe.

B. Sleeves for Pipes Through Non-Rated Floors: Schedule 40 steep pipe, extended 2" above floor.

C. Sleeves for Pipes Through Non-Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage galvanized steel, extended 2" above floor. See drawings for further detail.

D. Sleeves for Round Ductwork: Galvanized steel, or as shown on drawings.

E. Sleeves for Rectangular Ductwork: Galvanized steel, or as shown on drawings.

2.7 SEALANTS, FIRESTOP INSULATION, PUTTY, AND COMPOUNDS

A. Refer to Section 07 84 13 for firestopping materials and methods. Refer to drawings for additional details.

B. Sealants:
   1. Non fire/smoke rated partitions: Acrylic or silicone based caulking.
   2. Fire/smoke rated partitions: Silicone based caulking, UL listed.

C. All fire-rated sealants and firestops shall be installed by a certified firestop contractor. Reference front-end specifications for further information.

2.8 MECHANICAL SEALS

A. Mechanical Seals: Modular mechanical type, consisting of interlocking low durometer EPDM synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with type 316 stainless steel bolts and reinforced plastic polymer pressure plates which cause rubber sealing elements to expand when tightened, providing a watertight and gas-tight seal and electrical insulation. Provide Advance Products & Systems Model Innerlynx, Link-Seal LS-316, or approved equivalent.
1. Provide high-temperature silicone links rated for 400 Deg. F for steam and condensate applications.

2. A sleeve shall be provided for each mechanical seal.
   a. Thermoplastic sleeves: Sleeve shall have smooth walls and shall be made of molded non-metallic high density polyethylene (HDPE) with an integral solid water stop, Advance Products & Systems Model PWS, Century-line Model CS, or approved equivalent.
   b. Steel sleeves: Sleeve shall have smooth walls, shall be made of Schedule 40 steel with an integral welded solid water stop, and shall have corrosion-resistant coating, Advance Products & Systems Model GWS, Century-line Model WS, or equivalent.

3. **EXECUTION**
   
3.1 **INSTALLATION**
   
A. Install in accordance with manufacturer's instructions.

3.2 **INSERTS**
   
A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.3 **PIPE HANGERS AND SUPPORTS**
   
A. Support horizontal piping as scheduled.

B. Support fire protection systems piping independently from other piping systems. Fire main piping may be trapezed with other piping systems. Coordinate trapeze hangers with the Sprinkler Contractor.

   1. Reference sections 21 05 29 and 22 05 29 for additional information regarding fire protection and plumbing piping supports and hangers.

C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

H. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

I. Support riser piping independently of connected horizontal piping.

J. Provide copper plated hangers and supports for non-insulated copper pipe.

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Prime coat steel hangers and supports in the mechanical room and other exposed areas. Refer to the Architectural reflected ceiling plans for location of exposed ceilings. Hangers and supports located in attic space, crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Adjust hangers to distribute loads equally on attachments and to achieve specified pipe slopes.

N. Saddles, Shields and Inserts

1. Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

2. Install protective shields MSS Type 40 on cold piping that has vapor barrier. Shields shall span an arc of 180 degrees (360 degrees on trapeze hangers with U-bolt clamps) and shall have dimensions in inches not less than the following:

<table>
<thead>
<tr>
<th>NPS</th>
<th>LENGTH</th>
<th>THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 through 3-1/2</td>
<td>12</td>
<td>0.048</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>0.060</td>
</tr>
<tr>
<td>5 &amp; 6</td>
<td>18</td>
<td>0.060</td>
</tr>
<tr>
<td>8 through 14</td>
<td>24</td>
<td>0.075</td>
</tr>
<tr>
<td>16 through 24</td>
<td>24</td>
<td>0.105</td>
</tr>
</tbody>
</table>

3. Pipes 8 inches and larger shall have wood inserts.

4. Insert materials shall be at least as long as the protective shield.

5. Provide manufacturer-recommended saddles, inserts, and/or shields where cellular foam insulation is used. The removal of sections of cellular foam insulation for the purpose of pipe support is not acceptable.
3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to control movement to compensators.

D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.6 FLASHING
A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls and floors.

B. Flash drains in floors with topping over finished area with lead, inches clear on sides with minimum 36 x 36 inch sheet size. Fasten to drain clamp device.

C. Seal floor, shower, mop sink, etc. drains watertight to adjacent materials.

D. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 SLEEVES

A. Provide pipe and duct sleeves at all fire/smoke rated partitions, exterior wall penetrations and wall penetrations into exposed areas. Pipe and duct sleeves are not required for penetrations through non-rated concealed partitions.

B. At the Contractor's option, pipe sleeves may be omitted if the wall or floor is core drilled.

C. Set sleeves in position in formwork. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Sleeves through floors shall be grinded flush with finish floor level.

F. Where piping or ductwork penetrate non-rated ceilings or walls, close off space between pipe or duct and adjacent work with urethane rod stock and caulk air tight.

G. Seal pipe and duct penetrations through non-rated floors.

1. Where piping is not located in a rated shaft and it penetrates a single non-rated floor, close off space between pipe and adjacent work with urethane rod stock and caulk air tight.

2. Where piping is not located in a rated shaft and it penetrates multiple non-rated floors, close off space between pipe and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound.

3. Where ductwork is not located in a rated shaft and it penetrates a single non-rated floor, close off space between duct and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound.

4. Where ductwork is not located in a rated shaft and it penetrates multiple non-rated floors, close off space between duct and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound. Install fire damper in duct at each floor level. Ductwork containing fume exhaust air shall not be provided with fire dampers.
H. Where piping or ductwork penetrate rated floor, ceiling, or wall, close off space between pipe or duct with appropriate fire rated sealant, insulation, putty or compound. Refer to the Drawings for fire/smoke rated wall locations and the appropriate ratings.

I. Provide on ductwork close fitting metal collar or escutcheon covers on the side of penetration that are exposed to view.

J. Install chrome plated steel escutcheons on piping at finished surfaces.

K. Waste, vent and storm pipe penetrations through the concrete floor slab shall be encased in the poured concrete slab.

L. Provide mechanical seals and sleeves through exterior wall and floor penetrations and 3 hour or higher fire rated partitions.

3.8 EQUIPMENT ROOF SUPPORTS

A. Provide a minimum of two equipment roof supports for each roof-mounted equipment item that does not have integral equipment rails that would extend the bottom of the equipment a minimum of 24” above the roof insulation. Coordinate location of roof supports with equipment manufacturer.

B. Provide all necessary sealants and flashing required for a waterproof installation. Coordinate with roof manufacturer and other trades.

3.9 HANGER SCHEDULES

A. Reference International Plumbing Code and International Mechanical Code where applicable.

END OF SECTION 23 05 29
SECTION 23 05 48 – HVAC VIBRATION CONTROLS

1. GENERAL

1.1 Coordinate requirements of this specification with all other specifications and trades. Requirements of this specification take precedence over other specification sections. For example, the requirements of this section with regard to pipe supports in mechanical rooms take precedence above the requirements of Section 23 05 29.

1.2 This specification pertains to the furnishing and installation of vibration isolation devices for rotating or reciprocating mechanical equipment and piping and conduit systems attached thereto, and electrical transformers and attached switchgear and conduit systems.

1.3 This work shall include all material and labor required for installation of the resilient mounting and suspension systems, adjusting each mounting system, and measurement of isolator system performance when so requested by the Architect. Specific mounting arrangements for each item of mechanical and electrical equipment shall be as described herein and as indicated by schedules and details on the drawings.

1.4 All vibration isolation equipment except for resilient pipe connectors, including steel framing and reinforcing for concrete inertia bases and including steel rail bases, shall be furnished by Mason Industries or Kinetics Noise Control. A single manufacturer for all vibration isolation equipment in Sections 22 05 48, 23 05 48, and 26 05 48 will be required except as specifically approved in writing by the Architect or by his specific approval of shop drawings or as specified herein. For resilient pipe connectors refer to provisions of this specification that follow.

1.5 SECTION INCLUDES

A. Vibration isolation systems.

1.6 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING GUIDELINES

A. References

B. Submittals

C. Delivery, storage and handling
1.7 ADDITIONAL REQUIREMENTS

A. The Contractor and the vibration isolation manufacturer or his regularly designated and factory authorized representative shall perform the following tasks in addition to the supply and installation of isolation equipment:

1. Obtain from the Architect the approved manufacturer's name, model number, and other necessary identifying data for each item of mechanical and electrical equipment to be resiliently mounted. Coordinate all resilient mounting systems with the exact equipment to be furnished in regard to physical size, isolator locations, weight, rotating speed, etc. Direct contact and cooperation between the vibration isolation device fabricator and the equipment manufacturer will be required.

2. Obtain all necessary data in regard to piping systems which are to be resiliency supported so that proper isolators can be selected. Select piping system isolators for proper coordination with the physical arrangement of pipe lines and with the physical characteristics of the building.

3. Submit shop drawings as required by other portions of this specification. These drawings shall include specification information as follows:

   a. Manufacturer's model number for each isolator, the machine or pipeline to which it is to be applied, and the number of isolators to be furnished for each machine or pipeline.
   
   b. For steel spring mounts or hangers - Free height, deflected height, solid height, isolator loading, and diameter of spring coil.
   
   c. For elastomer or glass fiber isolators - Free height, deflected height, and isolator loading.

   d. Dimensional and weight data for concrete inertia bases, steel and rail bases, and details of isolator attachment.

4. Provide on-the-job supervision as required during installation of resiliently mounted equipment and piping to assure that all vibration isolators are installed in strict accordance with normally accepted practices for critical environments.

5. Replace at no extra cost to the Owner any isolators which do not produce the required deflection, are improperly loaded above or below their correct operating height, or which in any way do not produce the required isolation.

6. Cooperate with all other Contractors engaged in this project so that the installation of vibration isolation devices will proceed in a manner that is in the best interests of the Owner.

7. Notify the Architect of any project conditions which affect vibration isolation system installation or performance and which are found to be different from conditions indicated by the drawings or described by the specifications. Should vibration isolation system installation proceed without such notifications any remedial work required to achieve proper isolator performance shall be accomplished by the Contractor at no additional cost to the Owner.

8. Be alert for possible "short-circuiting" of vibration isolation systems by piping supports, electrical connections, temperature control connections, drain lines, building construction, etc., and notify the involved contractor as to these problems or potential problems. Where such situations cannot be easily resolved, notify the Architect so that preventive or remedial action can take place on a timely basis. Any remedial measures required shall be undertaken by the contractor responsible at no additional cost to the Owner.
9. This specification does not include provisions for seismic restraints that might be required by isolations systems due to the geographic location of the project, building codes, or other considerations.

2. PRODUCTS

2.1 VIBRATION ISOLATION SYSTEMS:

1. General:

   a. The vibration isolation systems described herein and identified by type letter designations shall be applied to specific classifications of mechanical and electrical equipment as indicated by Section C of this document.

   b. The minimum static deflection of the isolators for each classification of mechanical or electrical equipment shall be as indicated by Section C of this document or as otherwise indicated herein.

2. Type A Isolation:

   a. The equipment shall be rigidly mounted on a large reinforced concrete inertia base which has length and width dimensions approximately 20% greater than the supported equipment. The inertia base and equipment shall be supported by steel spring vibration isolators. Brackets for the spring isolators shall be located off the sides of the inertia base or integral with the perimeter of the inertia base with the tops of the springs near the vertical center of gravity of the equipment and inertia block; or if the center of gravity is higher than the top of the inertia base, the tops of the springs shall be at the top of the inertia base. The spring isolators shall rest on curbs or pedestals if necessary. There shall be a 2 inch minimum space between the bottom of the inertia base and the top of the housekeeping pad or floor slab when a housekeeping pad is not indicated to be employed.

   b. Concrete inertia bases shall be formed by a welded steel channel frame which incorporates prelocated equipment anchor bolts, and reinforcing bars in each direction welded in place. Concrete shall be standard 150-160 lb/cu.ft. structural concrete. The base thickness shall be determined by the weight requirements but it shall be a minimum of 8% of the longest span between isolators or 6 inches, whichever is greater. For centrifugal and axial fans and centrifugal pumps the inertia base shall have a minimum weight equal to that of the isolated equipment. For reciprocating equipment the inertia base shall have a minimum weight equal to twice the weight of the equipment.
c. Springs shall be of the free standing unhoused type. Horizontal spring stiffness shall not be less than 0.8 of vertical stiffness. Springs shall be selected for reasonably uniform deflection taking into consideration any difference in machine weight at each supporting point, but deflection of each spring shall not be less than that specified for each classification of mechanical equipment. The spring deflection from the point of rated deflection to the point at which the spring is solid shall not be less than 1/2 of the rated static deflection. The yield point of the steel used in the springs shall be sufficiently great so that the springs may be compressed to shorted turns without danger of spring failure. At least two layers of ribbed waffle pattern neoprene pads or equivalent glass fiber pads shall be installed under the base plate of each spring isolator. Springs shall have leveling bolts and proper means for bolting to the machines. To prevent corrosion, springs for outdoor installation shall be galvanized or otherwise coated as approved by the Architect.

3. Type B Isolation:
   a. The equipment shall be rigidly mounted on wide flange or channel structural steel members which shall run perpendicular to any support channels or similar members which are an integral portion of the equipment, or which shall be fabricated to form a complete frame for machine mounting. Height saving spring mounting brackets shall be welded to the ends of the structural steel saddle members or to the sides of structural steel frames to attach free standing steel spring isolators. Unless otherwise approved, the depth of the structural steel saddle members or the perimeter members of mounting frames shall be at least one-tenth of the longest frame dimension.
   b. Steel spring isolators shall be as specified for Type A isolation.
   c. Minimum clearance between the steel base and the housekeeping pad or floor shall be 2 inches.

4. Type C Isolation:
   a. The equipment shall be rigidly mounted in a steel frame which is sufficiently stiff so that it may be supported on resilient isolators without distortion of the frame or misalignment of the equipment. If the equipment has an integral frame which is suitably rigid, the resilient isolators may be secured directly to the integral equipment frame or base.
   b. Isolators shall be selected on the basis of the required static deflection as scheduled or otherwise indicated, and as follows:

   1) Required deflection 0.25 to 0.4 inches - double deflection neoprene-in-shear isolators.

   2) Required deflection 0.5 inches and greater - steel spring isolators as specified for the Type A mounting.

   c. Isolators shall be selected for reasonably uniform deflection taking into consideration any difference in machine weight at each supporting point, but deflection shall not be less than that specified for each classification of equipment.

   d. Minimum clearance between the equipment base and the housekeeping pad or floor shall be 2 inches.
5. Type D Isolation:
   a. The equipment shall be mounted on resilient "pads". These pads shall be multiple layers of waffle or ribbed neoprene, neoprene and cork sandwich, or precompressed glass fiber with height and stiffness as required to provide the static deflection as scheduled or specified and as required to properly support the load.
   b. Pads shall be loaded in accordance with the manufacturer's recommendations and sized to achieve this recommended loading. The equipment weight at each supporting point shall be considered in selecting pad dimensions along with the recommended loading.

6. Type E Isolation:
   a. The equipment shall be suspended with steel spring vibration isolators which are complete with neoprene-in-shear isolators for high frequency noise control. The neoprene-in-shear isolators shall provide static deflection of 0.20 inches minimum. In addition, elastomer washers shall be furnished as necessary to prevent metal-to-metal contact.
   b. Hanger rod misalignment of up to 15 degrees relative to vertical shall not cause "short-circuiting" of the isolation components due to metal-to-metal contact.
   c. Spring hangers shall utilize free standing springs which are unhoused except for the required partial and open housing assembly. Spring hangers shall be selected for reasonably uniform deflection taking into consideration any difference in machine weight at each supporting point, but deflection of each hanger shall not be less than that specified for each classification of mechanical equipment. The spring deflection from the point of rated deflection to the point at which the spring is solid shall not be less than one-half of the rated static deflection. The yield point of the steel used in the springs shall be sufficiently great so that the springs may be compressed to shorted turns without danger of spring failure.
   d. Resilient hangers shall be installed as near as possible to the supporting overhead structure. The machine suspension points shall be in a rigid and heavy portion of the building structure. Suspension of machines from lightweight floor slabs shall be avoided, particularly at the center of structural spans.
   e. Suspension rods shall be attached to rigid members of the machine structure. When such attachment points do not exist, a heavy steel framework shall be furnished to support the machine with suspension rods attached to this framework.

7. Type F Isolation:
   a. The equipment shall be suspended with double deflection neoprene-in-shear hangers which are complete with elastomer washers as required to prevent metal-to-metal contact.
   b. Hangers shall be installed as near as possible to the supporting overhead structure. Suspension points shall be on a rigid portion of both the overhead structure and equipment framework.
8. Type G Isolation:
   a. This mounting shall be the same as the Type E mounting except that the suspended machine shall be supported by a concrete inertia base. Suspension rods shall be attached to the concrete base.

9. Type K Isolation (Curb Mounted Roof-top Air Conditioning Machines):
   a. The roof-top air conditioning machine shall be mounted on a free standing steel spring isolated rectangular rail (curb) system. The isolation system shall be suitable for outdoor unprotected locations and it shall include a soft and flexible elastomer air and water seal which shall not short circuit the spring isolators. The isolation system shall not allow lateral movement greater than 5/8 inch for wind loads up to 100 miles per hour. Suitable systems of this type are Kinetics Noise Control Type ESR and Mason Industries Type RSC.

10. Type L Isolation (Water Chillers and Similar Equipment):
    a. Same as Type C except that steel spring isolators shall employ vertical limit stops with provisions to prevent short circuiting of the limit stops when the springs are loaded normally.

3. EXECUTION

3.1 GENERAL
   A. Install in accordance with manufacturer's instructions.

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

3.3 VIBRATION-CONTROL DEVICE INSTALLATION
   A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
B. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

C. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

F. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust active height of spring isolators.

C. Adjust restraints to permit free movement of equipment within normal mode of operation.
3.5 RESILIENT MOUNTINGS FOR SPECIFIC CLASSIFICATIONS OF MECHANICAL EQUIPMENT:

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>ISOLATION TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHU</td>
<td>C and Internal Isolation (see AHU specs)</td>
</tr>
<tr>
<td>Base Mounted Pumps</td>
<td>A</td>
</tr>
</tbody>
</table>

3.6 ISOLATION OF PIPING SYSTEMS:

A. All piping and rigidly connected devices such as pressure reducing valves which connects to resiliently mounted equipment shall be suspended with resilient hangers or supported by floor mounted isolators for a distance of 100 pipe diameters from the connected machine or within the mechanical equipment room, whichever is the greater distance. The first three supports from the connected machine shall have the same static deflection as indicated for the machine; the next two supports shall have static deflection at least equal to one-half of the static deflection indicated for the machine mounting, and remaining pipe supports shall provide static deflection of 0.35 inches minimum. These remaining isolators may be elastomer.

B. Steel spring hangers shall be as specified for Type E isolation except that a scale shall be attached to the hanger housing to indicate deflection. Elastomer hangers shall be as specified for Type F isolation. Floor mounts shall be free standing steel spring isolators as specified for Type A isolation where static deflection in excess of 0.35 inches is required. Floor mounts, where static deflection of 0.35 inches or less is required, shall be double deflection neoprene-in-shear as specified for Type C isolation.

C. Vertical pipe risers shall be resiliently mounted, preferably with each riser anchored near the center of the run. The risers shall be supported at the anchor points with steel spring or double deflection neoprene-in-shear isolators which provide static deflection of at least 0.35 inches. Isolators for the remainder of each run shall be steel spring type specifically designed to control load shifting due to pipe expansion and contraction. At least 0.35 inches deflection shall be maintained under all conditions.

D. Flexible synthetic rubber connectors shall be used to connect all piping to all isolated equipment. Flexible synthetic rubber connectors shall be fabricated using peroxide cured EPDM synthetic rubber and Kelvar tire cord reinforcement and shall be Mason Industries Safeflex of the most current design. Resilient connectors shall be selected for the pressure rating and temperature rating appropriate for the particular piping and pipe contents. Where synthetic EPDM flexible connectors are not permitted by code due to pipe contents and/or pressures provide swing pipe connectors changing direction a minimum of 3 times before joining isolated equipment. Swing connections should be made within approximately 6 feet of the isolated equipment.

E. Drain connections from isolated equipment to floor drains shall be at least 1” free from drain or use rubber hose.
3.7 ISOLATION OF AIR SUPPLY AND RETURN DUCTS

A. Sheet metal air handling ducts shall be connected to air handlers with resilient connectors and such ducts shall be suspended with resilient hangers or supported by floor mounted isolators for a distance of 30 feet from the connected machine or within the mechanical equipment room whichever is the greater distance. The first three supports from the connected machine shall have the same static deflection as indicated for the machine; the next two supports shall have static deflection at least equal to one-half of the static deflection indicated for the machine mounting, and remaining pipe supports shall provide static deflection of 0.35 inches minimum. These remaining isolators may be elastomer.

B. Steel spring hangers shall be as specified for Type E isolation. Elastomer hangers shall be as specified for Type F isolation. Floor mounts shall be free standing steel spring isolators as specified for Type A isolation where static deflection in excess of 0.35 inches is required. Floor mounts, where static deflection of 0.35 inches or less is required, shall be double deflection neoprene-in-shear as specified for Type C isolation.

3.8 ISOLATION OF FRACTIONAL HORSEPOWER EQUIPMENT:

A. All fractional horsepower fans, pumps, etc., which are mounted on or suspended from floors that are not on-grade shall be isolated with neoprene-in-shear isolators furnished by the vibration isolation supplier except where such isolators are furnished as an integral part of the machine.

END OF SECTION 23 05 48
SECTION 23 05 53 - HVAC IDENTIFICATION

1. GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe Markers.

D. Ceiling Tacks/Stickers.

E. Duct Markers.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents

1. Record actual locations of tagged valves.

F. Delivery, storage, and handling.

2. PRODUCTS

2.1 NAMEPLATES

A. Equipment Mark Nameplates: Laminated three-layer plastic with engraved black letters (matching equipment mark indicated on drawings) on light contrasting background color, with minimum 3/4 inch high letters.

B. Equipment Nameplates: Factory-applied permanent nameplate indicating the manufacturer’s name, model, serial number, temperature and pressure design, and any other data necessary to conform with specified requirements. On equipment installed outdoors, nameplate shall be stamped steel or engrave plastic.
2.2 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter or square.

B. Chart: Typewritten list that is plastic laminated and mounted in mechanical room. Valve list is to coordinate with mechanical piping schematics if provided on plans.

C. Pipe Schematics: Valve numbers are to be labeled on Engineer schematic drawings, plastic laminated and schematic shall be mounted in mechanical room.

2.3 PIPE MARKERS

A. Color: Conform to ASME A13.1, latest revision

B. Plastic Tape Pipe Markers: Minimum 1-1/2” letter size and 2-mil thickness, flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings; minimum information indicating flow direction arrow and identification of fluid being conveyed.

2.4 CEILING TACKS/STICKERS

A. Description: ½” self adhesive color coded stickers.

B. Color code as follows:

1. Yellow - HVAC equipment
2. Red - Fire dampers/smoke dampers, sprinkler/standpipe system valves
3. Green - Plumbing valves
4. Blue - Heating/cooling valves

2.5 DUCT MARKERS

A. Plastic Tape Duct Markers: Minimum 1-1/2” letter size and 2-mil thickness, flexible, vinyl film tape with pressure sensitive adhesive backing and printed marking; minimum information indicating flow direction arrow and identification of air system being conveyed.

3. EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
B. Install tags with corrosion resistant chain.

C. Install plastic tape pipe and duct markers in accordance with manufacturer's instructions. Directional arrow tape shall be overlapped to ensure proper adhesion and no peeling of tape in future.

D. Identify air handling units, exhaust fans, chillers, pumps, heat generating, heat rejecting, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

E. Identify pressure reducing valves, backflow preventers, valves, and meters with tags.

F. Identify control panels and major control components outside panels with plastic nameplates.

G. Identify valves in main and branch piping with tags.

H. Tag automatic controls, instruments, and relays. Key to control schematic.

I. Identify piping, concealed or exposed, with plastic tape pipe markers. Identify service, flow direction, and pressure when applicable, i.e. low pressure steam, high pressure steam. Install in clear view from floor and align with axis of piping. Locations of identification not to exceed 15 feet on straight runs including risers and drops, more often in congested areas, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction. Provide a minimum one label per pipe per room. Where pipes are racked, install pipe markers on each pipe in the same location to aid in differentiating each pipe in the rack.

J. Provide ceiling stickers or machine generated labels to locate valves, dampers, or HVAC equipment above T-bar type panel ceilings. Locate ceiling sticker on the ceiling grid closest to equipment. Label each sticker with the device located above the ceiling, i.e. VBR-33.

K. Identify ductwork with plastic tape duct markers. Identify service, flow direction and pressure when applicable, i.e. low pressure supply air, high pressure supply air. Install in clear view from floor and align with centerline of duct. Locations of identification not to exceed 15 feet from straight runs including risers and drops, more often in congested areas, at each side of penetration of structure or wall, and at each obstruction. When several ducts from different units are located in concealed congested areas, locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION 23 05 53
SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions apply to this section.

1.2 DESCRIPTION OF WORK

A. This scope of services specifies the requirements and procedures for mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results. The test and balance work will be performed by the Owner’s personnel. It is the Contractor’s responsibility to assist as outlined below.

B. Test, adjust and balance the following mechanical systems which are shown in the construction documents.

1. Supply air systems, all pressure ranges, including variable volume and constant volume systems.
2. Return air systems.
3. Exhaust air systems.
4. Hydronic systems.
5. Verify temperature control system operation.

C. The contractor’s responsibilities are as follows:

1. Notify the Owner’s Representative twenty-one (21) days prior to the schedule date for balancing the system.
2. Schedule a two (2) week allowance for the testing and balancing firm to complete the testing and balancing work when scheduling completion of all work required of the Contractor by the contract documents.
3. Cooperate with the testing and balancing firm and shall make all necessary preparations for the TAB efforts.
4. Complete the following work prior to requesting the TAB effort.
   a. Clean and flush all piping systems.
   b. Leak test and make tight all piping systems.
   c. Fill all piping systems with clean water.
   d. Clean and seal all ductwork systems.
   e. Service and tag all equipment.
   f. Set and align all motors and drives.
   g. Start up and prove all equipment and systems.
   h. Make preliminary settings on all control devices and have all systems operational.
   i. Operate all systems successfully for twenty-four (24) hours minimum.
5. Lubricate all motors and bearings.
6. Check fan belt tension.
7. Check fan rotation.
8. Patch insulation, ductwork and housing, using materials identical to those removed.
9. Seal ducts and piping, and test for and repair leaks.
10. Seal insulation to re-establish integrity of the vapor barrier.
11. Attend a coordination meeting prior to the balancing of the system and a coordination meeting following the balancing of the system.
12. Provide a complete set of as-built drawings prior to the TAB effort.
13. Provide craftsmen of the proper trade to work with the TAB firm to make adjustments and installation changes as required.
14. Change out fan sheaves when and if required by the TAB firm.
15. Dedicate the resources to accommodate all changes identified by the test and balance firm in a timely manner.
16. If a significant rebalance (Owner’s determination) of the HVAC system is required due to the Contractor’s failure to properly install and check out the HVAC system, the cost of rebalancing the system shall be borne by the Contractor.

1.3 PRE-BALANCING CONFERENCE

A. Prior to beginning of the testing, adjusting and balancing procedures, a conference with the Owner’s representative, Engineer and the Test and Balance Agency’s representative will be held. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting and balancing.

1.4 SEQUENCING AND SCHEDULING OF SERVICES

A. Test, adjust and balance the air conditioning systems during summer season and heating systems during winter season. This includes at least a period of operation at outside conditions within 5 deg. F wet bulb temperature of maximum summer design condition, and within 10 deg. F dry bulb temperature of minimum winter design conditions. Take final temperature readings during seasonal operation.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within +5 to 10 percent of design for supply systems, return and exhaust systems.

B. Air Outlets in Negatively Pressurized Spaces: Adjust total to within 0 to -5 percent of design to space.

C. Air Inlets in Negatively Pressurized Spaces: Adjust total to within 0 to +5 percent of design from space.
D. Air Outlets in Positively Pressurized Spaces: Adjust total to within 0 to +5 percent of design to space.

E. Air Inlets in Positively Pressurized Spaces: Adjust total to within 0 to -5 percent of design from space.

F. Air Outlets in Non-Pressurized Spaces: Adjust total to within 0 to +10 percent of design space.

G. Air Outlets in Non-Pressurized Spaces: Adjust total to within 0 to +10 percent of design space.

H. Hydronic Systems: Adjust to within +0 to 10 percent of design.

END OF SECTION 23 05 93
SECTION 23 07 13 - DUCTWORK INSULATION

1. GENERAL

1.1 SECTION INCLUDES

A. Ductwork insulation.

B. Insulation jackets.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

B. Submittals.

C. Delivery, Storage, and Handling.

D. Quality assurance.

1. Materials: Flame spread/smoke developed rating of 25/50 or less.

E. Qualifications.

1. Applicator: Company specializing in performing the work of this section with minimum three years experience.

F. Environmental requirements.

1. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
2. Maintain temperature during and after installation as recommended by the manufacturer.

2. PRODUCTS

2.1 GLASS FIBER, FLEXIBLE

A. Insulation: ASTM C553; flexible, noncombustible blanket.

1. 'K' value: ASTM C518, 0.30 at 75 degrees F.
2. Maximum service temperature: 250 degrees F.
3. Maximum moisture absorption: less than 3 percent by volume.
4. Density: 1.5 lb/cu ft.
B. Vapor Barrier Jacket

C. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
   1. Moisture vapor transmission: ASTM E96; 0.02 perm maximum.
   2. Secure with pressure sensitive tape.

D. Vapor Barrier Tape
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

E. Tie Wire: Annealed steel, 16 gage (1.5 mm).

2.2 GLASS FIBER, RIGID

A. Insulation: ASTM C612; rigid, noncombustible blanket.
   1. 'K' value: ASTM C518, 0.23 at 75 degrees F.
   2. Maximum service temperature: 250 degrees F.
   3. Maximum moisture absorption: less than 3 percent by volume.

B. Vapor Barrier Jacket
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
   2. Moisture vapor transmission: ASTM E96; 0.02 perm.
   3. Secure with pressure sensitive tape.

C. Vapor Barrier Tape
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.3 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, sheet.
   1. 'K' ('ksi') Value: ASTM C177 or C518; 0.27 at 75 degrees F.
   2. Minimum Service Temperature: -40 degrees F.
   3. Maximum Service Temperature: 220 degrees F.
   4. Maximum Moisture Absorption: ASTM D209; 0.2 percent by volume.
   5. Moisture Vapor Transmission: ASTM E96; 0.08 perm-inches.
   7. Maximum Smoke Developed: ASTM E84; 50.

B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.4 JACKETS

A. Aluminum Jacket: ASTM B209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

1. Jacket: Aluminum construction, stucco embossed finish, 0.032” thick, with minimum 3-mil thick heat-bonded polyethylene and kraft paper vapor barrier.

2. Lagging Adhesive: Compatible with insulation and application.

3. EXECUTION

3.1 EXAMINATION

A. Verify that ductwork has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

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

B. Continue insulation through walls, sleeves, hangers, and other duct penetrations.

C. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

1. Extend insulation entirely down to neck of supply air diffusers and on top of diffusers. Provide continuous vapor barrier with diffuser insulation.

D. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.

E. Secure insulation without vapor barrier with staples, tape, or wires.

F. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.

G. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.

H. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
I. Do not overtighten and/or compress flexible glass fiber duct insulation.

J. At duct access doors or other openings, insulation shall be properly framed and finished.

K. On all exterior ductwork, install metal jackets with a minimum 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Secure jacket with stainless steel bands 12” o.c. and at end joints.

L. Insulate the top of all supply air diffusers and the top/back of all supply air registers.

3.3 DUCTWORK INSULATION SCHEDULE

<table>
<thead>
<tr>
<th>Ductwork Application:</th>
<th>Type:</th>
<th>Thickness:</th>
<th>Vapor Barrier Required (Y/N):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed rectangular outside air and supply air duct in</td>
<td>Rigid</td>
<td>2”</td>
<td>Y</td>
</tr>
<tr>
<td>mechanical rooms and shafts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All other rectangular and round return air, relief air,</td>
<td>None</td>
<td>None</td>
<td>None required unless shown on</td>
</tr>
<tr>
<td>and exhaust air duct</td>
<td>required</td>
<td>on plans</td>
<td>plans</td>
</tr>
<tr>
<td>Rectangular and round return air, relief air, and</td>
<td>None</td>
<td>None</td>
<td>None required unless shown on</td>
</tr>
<tr>
<td>exhaust air duct in other areas</td>
<td>required</td>
<td>on plans</td>
<td>plans</td>
</tr>
<tr>
<td>Exposed/Concealed supply air duct</td>
<td>Flexible</td>
<td>2”</td>
<td>Y</td>
</tr>
<tr>
<td>Concealed round supply air duct</td>
<td>Flexible</td>
<td>2”</td>
<td>Y</td>
</tr>
</tbody>
</table>

Schedule Notes:

A. All ductwork in mechanical rooms shall be insulated as though it were “Exposed”.

END OF SECTION 23 07 13
1. GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

1. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255, and UL 723.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents.

F. Environmental requirements

1. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

2. Maintain temperature during and after installation for minimum period of 24 hours.
2. PRODUCTS

2.1 GLASS FIBER

A. Insulation: ASTM C547; rigid molded, noncombustible.

1. 'k' ((btu*in)/(hr*ft²*deg F)) value : ASTM C335

<table>
<thead>
<tr>
<th>Temperature (degrees F)</th>
<th>Maximum 'k' value (btu<em>in)/(hr</em>ft²*deg F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>0.23</td>
</tr>
<tr>
<td>100</td>
<td>0.24</td>
</tr>
<tr>
<td>150</td>
<td>0.25</td>
</tr>
<tr>
<td>200</td>
<td>0.28</td>
</tr>
<tr>
<td>300</td>
<td>0.34</td>
</tr>
<tr>
<td>400</td>
<td>0.42</td>
</tr>
<tr>
<td>500</td>
<td>0.51</td>
</tr>
</tbody>
</table>

2. Minimum Service Temperature: 0 degrees F.
3. Maximum Service Temperature: 1000 degrees F.
4. Maximum Moisture Absorption: 0.2% by volume.

B. Vapor Barrier Jacket

1. ASTM C921, White kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Transmission: ASTM E96; 0.02 perms.
3. Secure with self sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

C. Vapor Barrier Lap Adhesive: compatible with insulation. VOC Limit 50 g/L.

D. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool. VOC Limit 70 g/L (multipurpose construction adhesive).

E. Fibrous Glass Fabric: Cloth, untreated; 9 oz/sq yd weight with 1.0 lb/cu ft density blanket.
F. Indoor Vapor Barrier Finish: Vinyl emulsion type acrylic, compatible with insulation, white color. VOC Limit 50 g/L.

2.2 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. 'k' ((btu*in)/(hr*ft²*deg F)) value: ASTM C177 or C518; 0.22 to 0.28 at 60 degrees F.
2. Minimum Service Temperature: -20 degrees F.
3. Maximum Service Temperature: 180 degrees F.
4. Maximum Moisture Absorption: ASTM C209; 0.2 percent by volume.
5. Moisture Vapor Transmission: ASTM E96; 0.08 perm inches.
7. Maximum Smoke Developed: ASTM E84; 50.
9. Provide documentation indicating that product contains no urea formaldehyde.
10. Fittings: Pre-fabricated closed cell fittings of like material and thickness as adjacent pipe insulation.
11. In all exposed finished areas without jacketing, provide white insulation, otherwise use black.

B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. VOC Limit: 80 g/L.

2.3 INSULATION BLANKETS FOR STEAM AND CONDENSATE FLANGED VALVES AND EXPANSION JOINTS

A. Insulation: Tight-fitting, reusable insulation blanket consisting of high-density insulation (fiberglass, mineral wool, ceramic fiber) covered on outside with coated glass fabric having heavy adjustable straps with buckles. Inside of blanket shall be covered with fabric suitable to specified temperature of stainless steel square mesh woven wire cloth. Insulation shall be a minimum of 2" thick and shall be suitable for temperatures up to 500 Deg. F.

2.4 JACKETS

A. PVC Plastic

1. Jacket: ASTM C921, One piece molded type fitting covers and sheet material, white color.

   a. Minimum Service Temperature: 0 degrees F.
   b. Maximum Service Temperature: 150 degrees F.
   c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
   d. Maximum Flame Spread: ASTM E84; 25.
   e. Maximum Smoke Developed: ASTM E84; 50.
   f. Thickness: 20 mil.
   g. Connections: Brush on welding adhesive or pressure sensitive color matching vinyl tape.

   2. Covering Adhesive Mastic: Compatible with insulation. VOC Limit 50 g/L.
   1. Thickness: 0.040 inch.
   2. Finish: Smooth.
   4. Fittings: PVC pre molded fittings.
   5. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

3. EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

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

B. Painting of cellular foam insulation is not allowed.

C. On exposed piping, locate insulation and cover seams in least visible locations. For cellular foam insulation tape ALL visible seams with tape matching insulation color.

D. Fiberglass insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory applied or field applied.
   2. Insulate fittings, joints, flanges, unions, strainers, flexible connectors, and valves with molded insulation of like material and thickness as adjacent pipe. PVC or aluminum covers are required in all exposed locations as in mechanical rooms and finished areas.
   3. Finish with glass cloth and vapor barrier adhesive.
   4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
   5. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

E. Cellular foam insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:
   1. Insulate fittings, joints, flanges, unions, strainers, flexible connectors, and valves with molded insulation of like material and thickness as adjacent pipe. PVC or aluminum covers are required in all exposed locations as in mechanical rooms and finished areas.
   2. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
   3. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
F. Fiberglass insulated pipes conveying fluids above ambient temperature:

1. Provide vapor barrier jackets, factory applied or field applied.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. PVC covers are required in all exposed locations.
3. Finish with glass cloth and adhesive.
4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
5. For hot piping conveying fluids, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
6. For steam and condensate piping, insulate flanges and unions.

G. Inserts and Shields:

1. Refer to Section 23 05 29 for additional information.
2. Application: Piping 1 inch diameter or larger.
3. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
4. Insert Location: Between support shield and piping and under the finish jacket.
5. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
6. Insert Material: ASTM C640 cork, hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
7. Provide inserts and/or shields per manufacturer recommendations for cellular foam insulation applications in order to maintain continuous insulation throughout the pipe system. The removal of sections of cellular foam insulation to accommodate pipe supports is not acceptable. Manufacturer products specifically designed for supporting insulation and maintaining the integrity of the insulation system at pipe hanger locations, such Armaflex Armafix Insulation Pipe Hangers, are acceptable.

H. Finish insulation at supports, protrusions, and interruptions.

I. For pipe exposed in finished areas, finish with white PVC jacket and PVC fitting covers.

J. For piping exposed in mechanical rooms below 10 feet above finished floor, finish with aluminum jacket and aluminum fitting covers.

K. All valves in insulated systems shall have valve stem extensions. Insulation installer shall notify the contractor and Owner if valves without stem extensions are encountered. All valves without stem extensions in areas where stem extensions are required shall be replaced.

L. Install insulation blanket on steam and condensate valves.

M. Provide insulation clearance and access to valves and fittings in hangers and from structure and other equipment. Insulation shall be continuous through all hangers and supports. Refer to Section 23 07 19.
### 3.3 GLASS FIBER INSULATION SCHEDULE

#### A. Heating Systems

<table>
<thead>
<tr>
<th>PIPING SYSTEM</th>
<th>PIPE SIZE</th>
<th>THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Water Supply and Return</td>
<td>1-1/4&quot; &amp; smaller</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Heating Water Supply and Return</td>
<td>1-1/2&quot; and larger</td>
<td>2&quot;</td>
</tr>
<tr>
<td>Air Terminal Unit Reheat Coil Return Bends</td>
<td>1&quot; &amp; smaller</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Low Pressure (15 psig) Steam/Cond. Piping</td>
<td>3&quot; &amp; smaller</td>
<td>2-1/2&quot;</td>
</tr>
<tr>
<td>Low Pressure (15 psig) Steam/Cond. Piping</td>
<td>4&quot; &amp; larger</td>
<td>3&quot;</td>
</tr>
<tr>
<td>Med. Pressure (16-120 psig) Steam/Cond. Piping</td>
<td>3/4&quot; &amp; smaller</td>
<td>3&quot;</td>
</tr>
<tr>
<td>Med. Pressure (16-120 psig) Steam/Cond. Piping</td>
<td>1&quot; to 1-1/4&quot;</td>
<td>4&quot;</td>
</tr>
<tr>
<td>Med. Pressure (16-120 psig) Steam/Cond. Piping</td>
<td>1-1/2&quot; &amp; larger</td>
<td>4-1/2&quot;</td>
</tr>
<tr>
<td>High Pressure (125+ psig) Steam/Cond. Piping</td>
<td>3/4&quot; &amp; smaller</td>
<td>4-1/2&quot;</td>
</tr>
<tr>
<td>High Pressure (125+ psig) Steam/Cond. Piping</td>
<td>1&quot; &amp; larger</td>
<td>5&quot;</td>
</tr>
<tr>
<td>Pumped Steam Condensate Piping</td>
<td>3&quot; &amp; smaller</td>
<td>2-1/2&quot;</td>
</tr>
<tr>
<td>Pumped Steam Condensate Piping</td>
<td>4&quot; &amp; larger</td>
<td>3&quot;</td>
</tr>
<tr>
<td>Condensate Pump Steam Vent</td>
<td>All sizes</td>
<td>3&quot;</td>
</tr>
<tr>
<td>Relief Valve Steam Vent</td>
<td>All sizes</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Warm Drains</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
</tbody>
</table>

### 3.4 CELLULAR FOAM INSULATION SCHEDULE

#### A. Cooling Systems

<table>
<thead>
<tr>
<th>PIPING SYSTEM</th>
<th>PIPE SIZE</th>
<th>THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water Supply and Return</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Process Chilled Water Supply and Return</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Cold Condensate Drains</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Refrigerant</td>
<td>All sizes</td>
<td>1-1/2&quot;</td>
</tr>
</tbody>
</table>

#### B. Heat Recovery

<table>
<thead>
<tr>
<th>PIPING SYSTEM</th>
<th>PIPE SIZE</th>
<th>THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Recovery Water</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Heat Recovery Coil Return Bends</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Heat Recovery Coil Drains</td>
<td>All sizes</td>
<td>1&quot;</td>
</tr>
</tbody>
</table>
SECTION 230800 – COMMISSIONING OF MECHANICAL SYSTEMS

PART 1     GENERAL

1.1     DESCRIPTION

A. The purpose of this section is to specify the Contractor’s responsibilities and participation in the commissioning process relative to Division 23.

B. Commissioning testing shall be performed by this division Contractor and documented by the Commissioning Authority. Commissioning is primarily the responsibility of the Commissioning Authority, with start-up, testing and support for commissioning the responsibility of the Contractors. The commissioning process does not relieve the Contractor from participation in the process or diminish the role and obligations to complete all portions of work in a satisfactory and fully operational manner.

C. Work of Division 23 includes:

1. Testing and start-up of the HVAC equipment.
3. Providing qualified personnel to assist in commissioning tests, including seasonal testing.
4. Completion and endorsement of Pre-functional Construction Checklists provided by the Commissioning Authority to assure that Division 23 equipment and systems are fully operational and ready for functional testing.
5. Providing equipment, materials and labor necessary to correct deficiencies found during the commissioning process which fulfill contract and warranty requirements.
6. Provide a detailed start up plan for Burns & McDonnell (BMcD)’s review, comment and recommendation.
7. Provide at the end of the job the following items for inclusion in the systems manual.

   a. Control drawings, sequences of control
   b. A table of all set points
   c. Schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown
   d. A list of all manufacture recommended preventive maintenance procedures for all equipment and systems.

8. Use (BMcD)’s on-line and window based Commissioning application to fill out Construction Checklist and to track issues resolutions. Attendance a one BMcD training class is required for all contractors. This training will take place at the construction Cx kick off.
9. Providing operation and maintenance information and as-built drawings to the Commissioning Authority for review, verification and organization, prior to distribution.

10. Providing assistance to the Commissioning Authority to develop, edit and document system operation descriptions.

11. Providing training for the systems specified in this Division with coordination of Owner by the Commissioning Authority.

1.2 RELATED WORK

A. All installation, testing and start-up procedures and documentation requirements specified within Division 23.

B. Section 019113 – Commissioning

C. Commissioning Functional Test Procedures that required participation of the Division 23 Contractors.

D. Cooperate with the Commissioning Authority in the following manner:

1. All testing and start-up procedures and documentation requirements specified within Division 1 and Division 23 and related portions of this project.

2. Allow sufficient time before final completion dates so mechanical systems start-up, test and balance and commissioning can be accomplished.

3. Provide labor and material to make corrections when required without undue delay.

4. Put all heating, ventilation and air conditioning systems and equipment into full operation and continue the operation of the same during each working day of the testing, balancing and commissioning.

5. Include the costs of the dampers, replacement sheaves and belts, as required, to obtain satisfactory system performance as requested by the test and balance contractor or the Commissioning Authority.

6. Provide test holes in ducts and plenums where directed or necessary for pitot tubes for taking air measurements and to balance the air systems. Test holes shall be provided with an approved removable plug or seal. At each location where ducts or plenums are insulated, test holes shall be provided with an approved extension with plug fitting.

7. Provide pressure/temperature taps where directed or necessary for taking measurements to test and balance hydronic systems.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

A. Standard test equipment for commissioning will be provided by the Contractor.

B. Division 23 Contractor shall provide standard and specialized test equipment as necessary to test and start up the HVAC systems.
C. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment through the installing contractor. Manufacturer shall provide the test equipment, demonstrate its use and assist the Commissioning Authority in the commissioning process.

D. The Contractor shall provide all equipment, software and all test programming support as necessary to start up, calibrate, debug and verify proper function of the control/facility management system. This equipment and software shall be provided for use by both the test and balance contractor and the Commissioning Authority.

PART 3 EXECUTION

3.1 WORK PRIOR TO COMMISSIONING

A. Complete all phases of work so the systems can be energized, started, tested and otherwise commissioned. Division 23 has primary start-up responsibilities with obligations to complete systems, including all sub-systems, so they are functional. This includes the complete installation of all equipment materials, raceways, wire, terminations, controls, etc., per the Contract Documents and related directives, clarifications, change orders, etc.

B. A Commissioning Plan will be developed by the Commissioning Authority. Upon request of the Commissioning Authority, the Contractor shall provide assistance and consultation. The Commissioning Plan will be developed prior to completion of the installation. The Contractor is obligated to assist the Commissioning Authority in preparing the Commissioning Plan by providing all necessary information pertaining to the actual equipment and installation. If Contractor-initiated system changes have been made that alter the commissioning process, the Commissioning Authority will notify the Architect and the Contractor may be obligated to compensate the Commissioning Authority to test the revised product or confirm the suitability/unsuitability of the substitution or revision.

C. Specific pre-commissioning responsibilities of Division 23 are as follows:

1. Normal start-up services required bringing each system into a fully operational state. This includes motor rotational check cleaning, lug tightening, control sequences of operation, etc. The Commissioning Authority will not begin the commissioning process until each system is complete, including normal contractor start-up and debugging.

2. The Contractor shall perform pre-functional construction checklists on the systems to be commissioned to verify that all aspects of the work are complete in compliance with the plans and Specifications. Contractor start-up forms may be substituted for the pre-functional test forms with prior approval by the Commissioning Authority.

3. Factory start-up services will be provided for key equipment and systems specified in Division 23. Factory start-up activities to be documented and submitted. The Contractor shall coordinate this work with the manufacturer and the Commissioning Authority.

4. Notify Construction Manager and Commissioning Authority when systems are ready for functional testing.
D. Commissioning is intended to begin upon completion of a system. Commissioning may proceed prior to the completion of systems and/or sub-systems, if expediting this work is in the best interests of the Owner. Commissioning activities and schedule will be coordinated with the Contractor. Start of commissioning before system completion will not relieve the Contractor from completing those systems as per the schedule.

3.2 PARTICIPATION IN COMMISSIONING

A. Commissioning testing shall be performed by this division Contractor and documented by the Commissioning Authority. Provide skilled technicians to start up and debug all systems within this division of work. These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc., will be requested by the Commissioning Authority and coordinated by the Contractor. Contractor will ensure the qualified technician(s) are available and present during the agreed-upon schedules and of sufficient duration to complete the necessary tests, adjustments and/or problem resolutions.

B. System problems and discrepancies may require additional technician time, Commissioning Authority time, redesign and/or reconstruction of systems and system components. The additional technician time shall be made available for the subsequent commissioning periods until the required system performance is obtained.

C. The Commissioning Authority reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment, system and/or sub-system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment and an attitude/willingness to work with the Commissioning Authority to get the job done. A liaison or intermediary between the Commissioning Authority and qualified factory representatives does not constitute the availability of a qualified technician for purpose of this work.

D. The test, adjust and balance subcontractor shall provide a draft report with final test measurements to the Commissioning Authority and shall provide qualified technicians and instruments needed for balancing to demonstrate a sample of up to 100% of measurements until specified results are achieved.

3.3 WORK TO RESOLVE DEFICIENCIES

A. In some systems, maladjustments, misapplied equipment, and/or deficient performance under varying loads will result in a system that does not meet the original design intent. Correction of work will be completed under direction of the Architect, with input from the Contractor, equipment supplier and Commissioning Authority. Whereas all members will have input and the opportunity to discuss, debate and work out problems, the Architect/Engineer of Record will have final jurisdiction on the necessary work to be done to achieve performance.
3.4 ADDITIONAL COMMISSIONING

A. Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The Contractor, suppliers and Commissioning Authority shall include a reasonable reserve to complete this work as part of their standard contractual obligations.

B. The cost of compensation of the Commissioning Authority for repeat testing or troubleshooting due to systems that do not meet specified performance shall be borne by the Contractor.

C. Corrective work shall be completed in a timely fashion to permit the timely completion of the commissioning process. Experimentation to render system performance will be permitted. If the Commissioning Authority deems the experimentation work to be ineffective or untimely to the commissioning process, the Commissioning Authority will notify the Architect/Engineer of Record indicating the nature of the problem, expected steps to be taken and the deadline for completion of activities. If the deadline passes without resolution of the problem, the Owner reserves the right to obtain supplementary services and equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner will be the Contractor’s responsibility.

3.5 SYSTEMS TO BE COMMISSIONED

A. Refer to specification section 019113:

3.6 TRAINING

A. This Contractor will be required to participate in the training of the Owner’s engineering and maintenance staff for each system and the related components. Training may be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids, or in the field with the specific equipment. The type of training will be per the Owner’s option.

3.7 SYSTEMS DOCUMENTATION

A. Maintain as-built red-lines on the job site as required in Division 1. Given the size and complexity of this project, red-lining of the drawings at completion of construction based on memory of key personnel is not satisfactory. Continuous and regular red-lining and/or posting of drawings is considered essential and mandatory.

B. In addition to the stated requirements for operation and maintenance data, provide one (1) copy of equipment technical literature, operation and maintenance literature and shop drawings to the Commissioning Authority as soon as they are available. This requirement is for review of these documents prior to distribution of multiple copies for the Owner’s final use.

C. Schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown
D. A list of all manufacture recommended preventive maintenance procedures for all equipment and systems.

E.  

3.8 SOFTWARE

A. The Controls Contractor shall supply the Commissioning Authority with an unprotected electronic controls submittal with all flow diagrams, sequence of operation, bill of materials and point database in Microsoft Visio or AutoCAD format in time for use in preparing the functional test procedures and integrated one-line diagrams.

B. The Controls Contractor shall supply the Commissioning Authority with two (2) debugged printouts of all facility management systems software, including all user’s programming and engineering manuals required to interpret the software. Included in the printouts, though not limited to, shall be the following:

1. Point data base
2. All custom control programs written in the BAS control language
3. All parameters required for proper operation of BAS control and utility firmware such as start/stop routines, etc.
4. System graphics

C. The software printout shall be fully documented for ease of interpretation by the Commissioning Authority and Owner without assistance from the Contractor. English language descriptions shall be either integrated with or attached to the BAS printout. The following shall be specifically documented:

1. All point names, I/O and virtual.
2. All BAS programming language commands, functions, syntax, operators and reserved variables.
3. Use of all BAS firmware.
4. The intended actions, decisions and calculations of each line or logical group of lines in the custom control program(s). Sequences of operation alone are not sufficient.
5. Complete descriptions of and theories explaining all software and firmware algorithms. The algorithms to be described include, but are not limited to, PID, optimum start/stop, demand limiting and chiller and boiler optimization.
6. A table of contents to the documentation that locates the sections of the documentation and describes which programs or program sections are for each piece of controlled/monitored equipment.
7. Flow charts using IEEE symbol nomenclature that demonstrates the software’s algorithms and flow logic.

END OF SECTION
SECTION 23 09 00 – DIGITAL CONTROL EQUIPMENT

1. GENERAL

1.1 This section contains requirements for pneumatic, electric and digital control systems as indicated on the contract drawings.

1.2 Contractor is responsible for providing, installing and connecting all sensors, pneumatic actuators, control valves, control dampers, electrical components and all interconnecting pneumatic tubing and electrical wiring between these devices and up to the Direct Digital Controller (DDC).

1.3 DDC controllers consist of Johnson Controls METASYS controllers, type NAE, DX, AHU, VAV, VMA, or UNT controllers. Owner will provide Johnson Controls METASYS controllers for the contractor to install.

1.4 After all equipment has been installed, wired and piped, Owner will be responsible for all termination connections at the DDC controller’s and for checking, testing, programming and start-up of the control system. Contractor must be on site at start-up to make any necessary hardware adjustments as required.

1.5 Once each mechanical system is completely operational under the new control system, contractor shall make any final connections and adjustments. For controls renovation jobs, contractor shall remove all unused sensors, operators, panels, wiring, tubing, conduit, etc. Owner shall have the option of retaining any removed pneumatic controls.

1.6 RELATED SECTIONS

A. Drawings and general provisions of the contract, including General and supplementary conditions and Division 1 Specification sections, apply to work of this section.

B. EMCS Points List included on the plans or in the specifications.

C. Other appropriate Division 23 specifications.

D. Other appropriate Division 26 specifications.

1.7 SUBMITTALS

A. Shop Drawings: Submit shop drawings for each control system, containing the following information:

B. Product data for each damper, valve, and control device.
C. Schematic flow diagrams of system showing fans, coils, dampers, valves, and control devices.

D. Label each control device with setting or adjustable range of control.

E. Indicate all required electrical wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

F. Provide details of faces on control panels, including controls, instruments, and labeling.

G. Include written description of sequence of operation.

H. Provide wiring diagrams of contractor provided interface and I/O panels

1.8 PROJECT RECORD DOCUMENTS

A. See Section 230500.

1.9 OPERATION AND MAINTENANCE DATA

A. See Section 230500.

B. Maintenance Data: Submit maintenance instructions and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

1.10 QUALITY ASSURANCE

A. Contractor’s Qualifications:

1. Contractor shall be regularly engaged in the installation of digital control systems and equipment, of types and sizes required. Contractor shall have a minimum of five years experience installing digital control systems. Contractor shall supply sufficient and competent supervision and personnel throughout the project in accordance with General Conditions section 3.4.1 and 3.4.4.

1.11 Codes and Standards:

A. Electrical Standards: Provide electrical components of control systems which have been UL-listed and labeled, and comply with NEMA standards.

B. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for control systems.
C. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

D. NFPA Compliance: Comply with NFPA 70 "National Electric Code".

1.12 WARRANTY

A. Correct all defective work within a period of one (1) year after substantial completion.

1.13 DELIVERY, STORAGE, AND HANDLING

A. See Section 230500.

2. PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Air Piping:

1. Copper Tubing: Seamless copper tubing, Type M or L, ASTM B 88; wrought-copper solder-joint fittings, ANSI B16.22; except brass compression-type fittings at connections to equipment.
2. Flex Tubing: Virgin Polyethylene non-metallic tubing, ASTM D 2737, with flame-retardant harness for multiple tubing. Use compression or push-on polyethylene fittings. Tubing used above suspended ceilings to be plenum rated per NFPA 90A. See section 3.1.b for locations where flex tubing can be used.
3. Copper to polyethylene connections shall be compression barbed fittings or solder barbed fittings.

B. Conduit and Raceway:

1. Electrical Metallic Tubing: EMT and fittings shall conform to ANSI C80.3.
2. Surface Metal Raceway and Fittings: Wiremold 500, Ivory, or approved equal.
3. Flexible Metal Conduit: Indoors, per National Electric Code for connection to moving or vibrating equipment.
4. Liquidtight Flexible Conduit: Outdoors, per National Electric Code for connection to moving or vibrating equipment.
C. Control Valves: Provide factory fabricated pneumatic or electric control valves of type, body material, and pressure class as indicated on the drawings. Butterfly style control valves are not acceptable except for two position applications. Equip control valves with heavy-duty pneumatic actuators, with proper shutoff rating for each individual application.

1. Manufacturer
   a. TAC or approved equal. TAC shall be used as the basis of design.
   b. KMC valves and actuators not approved.

2. Steam and Hot Water.
   a. Water Service Valves: Equal percentage characteristics.
   b. Steam Service Valves: Equal percentage characteristics.
   c. Single Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
   d. Valve Trim and Stems: Polished stainless steel.
   e. Packing: Spring-loaded Teflon, self-adjusting.
   f. Control valves should have a minimum 100 psi close-off rating for chilled water applications.

3. Chilled Water.
   a. Chilled water control valves shall be pressure independent. The flow through the valve shall not vary more than +/- 5% due to system pressure fluctuations across the valve in the selected operating range. The control valve shall accurately control the flow from 1 to 100% full rated flow.
   b. The valve bodies shall be of cast iron, steel or bronze and rated for 150 PSI working pressure. All internal parts shall be stainless steel, steel, Teflon, brass, or bronze.
   c. Valves shall be DeltaP Valves manufactured by Flow Control Industries or approved equal.
   d. The valves shall have pressure taps across the valve for measuring the pressure drop across the valve. The pressure taps shall have ½-inch extensions for accessibility.
   e. Valve Tag shall include the model number, AHU being served, design flow, and maximum flow for that valve.
   f. The control valves shall be delivered preset to the scheduled design flow and should be capable of reaching 110% of the design flow to allow for field adjustment for capacity changes.
D. Control Dampers: Ruskin CD-50 or approved equal.
   1. Provide dampers with parallel blades for 2-position control.
   2. Provide opposed blades for modulating control.
   3. Dampers shall be low leakage design with blade and edge seals.
   4. Provide multiple sections and operators as required by opening size and sequence of operations, as indicated on the contract drawings.

E. Pneumatic Actuators: TAC or approved equal. Size pneumatic actuators to operate their appropriate dampers or valves with sufficient reserve power to provide smooth modulating action or 2-position action as specified. When so specified in sequence of operation, where two or more actuators are to be operated in sequence to each other, provide position feedback positive positioners with adjustable start point and operating range on each actuator. If pilot positioners are used on valves or actuators, then main air to positioner must be from a dry air source. If mixed air AHU has return air, exhaust air and outside air dampers that are not mechanically linked then static safety switch must be installed and wired to safety circuit.

F. Electric Actuators: Johnson Controls, Bray, Belimo, TAC or approved equal. KMC actuators are not approved. Size electric actuators to operate their appropriate dampers or valves with sufficient reserve power to provide smooth modulating action or 2-position action as specified. If mixed air AHU has return air, exhaust air and outside air dampers that are not mechanically linked then static safety switch must be installed and wired to safety circuit. Spring return actuators should be provided on heat exchanger control valves or dampers or as specified on the drawings. Control signal shall be 0 to 10 VDC unless otherwise specified on drawings. Actuators with integral damper end switch are acceptable. For VAV reheat valves, actuators shall have a manual override capability to aid in system flushing, startup, and balancing.

G. Air and Hot Water Temperature Sensors
   a. All electronic temperature sensors shall be compatible with Johnson METASYS systems.
   b. Sensors shall be 1,000 ohm platinum, resistance temperature detectors (RTDs) with two wire connections. Duct mounted sensors shall be averaging type. Contractor may install probe type when field conditions prohibit averaging type, but must receive permission from Owner's Representative.
   c. Coordinate thermowell manufacturer with RTD manufacturer. Thermowells that are installed by the contractor, but are to have the RTD installed by owner, must be Johnson Controls Inc. series WZ-1000.

H. Chilled Water Temperature Sensors
   a. General: The RTD/Temperature Transmitter/Thermowell assembly shall come as a complete assembly from a single manufacturer. The Assembly shall be suitable for use in the accurate measurement of Chilled/Tower/Dual Water temperatures in a mechanical room environment.
   b. Calibration: Each RTD must be match calibrated to the Transmitter via NIST traceable calibration standards. A calibration report for each RTD & Transmitter matched pair must be furnished to the Owner.
c. RTD:
1) RTD type: 2-wire or 3-wire 100 ohm platinum class A or B.
2) Outside Diameter: 0.25 inch
3) Tolerance: +/- 0.06% Type A, +/- 0.12% Type B.
4) Stability: +/- 0.1 % over one year.
5) TCR: 0.00385 (ohm/ohm/C).
6) RTD shall be tip sensitive.
7) Resistance vs. Temperature table for the RTD must be provided to the Owner.

d. Transmitter:
1) Transmitter shall be match calibrated to the RTD and assembled as a matched pair.
2) Type: 2 wire (loop powered).
3) Input: 2 or 3 wire 100 ohm platinum class A or class B RTD.
4) Output: Output shall be a 4-20 mA signal linear to temperature.
5) Calibrated Span:
   a) Chilled Water: 30 °F to 130 °F.
6) Calibration Accuracy, including total of all errors, of the Transmitter & RTD matched pair over the entire span shall be within +/- 0.2% of the calibrated span or +/- 0.18 °F, whichever is greater.
7) Supply Voltage: 24 VDC.
8) Ambient Operating Temp.: 32 to 122 °F
9) Epoxy potted for moisture resistance.
10) Mounting: Transmitter shall be mounted in the RTD connection head.

e. Thermowell:
1) Thermowell shall be suitable for immersion in chilled water.
2) Thermowell shall be stainless steel.
3) Thermowell shall have 1/2" NPT process connection to pipe thred-o-let.
4) Thermowell Insertion depth shall be ½ inside pipe diameter, but not to exceed 10".

f. Assembly:
1) Assembly configuration: Spring loaded RTD with thermowell-double ended hex-connection head.
2) Connection head shall be cast aluminum with chain connecting cap to body, have 1/2" NPT process and 3/4" NPT conduit connections, and a sealing gasket between cap and body.
g. RTD/Temperature Transmitter/Thermowell assembly shall be the following or approved equal:

1) Manufacturer: Pyromation, Inc.
2) RTD with connection head and transmitter:
   Model: RAF185L483-[length code]-SL-8HN31,T440-385U-S-[scale span code]F F
   with calibration SMC(40,60)F.
3) RTD with connection head, transmitter and thermowell:
   Model: RAF185L483-S4C [length code]08-SL-8HN31,T440-385U-S-[scale span code]F calibration SMC(40,60)F.

I. Room Thermostats: Provide wall mounted pneumatic thermostats in locations shown on drawings. Thermostats shall be a high output, direct acting, horizontal mount with exposed thermometer and concealed adjuster.

1. Johnson Controls Inc. series T-4002.

J. Occupant Override: Provide wall mounted occupant override button in locations shown on electrical drawings.

K. Low Limit Controllers: Provide unit-mounted low limit controllers, of rod-and-tube type, with an adjustable set point and a manual reset. Capillary shall be of adequate length to horizontally traverse face of cooling coil every 12". Multiple low limit controllers may be required for large coils. Controller shall have an extra set of contactors for connection to control panel for alarm status. Locate the thermostat case and bellows where the ambient temperature is always warmer than the set point.

1. Freeze Stats: Johnson Controls model A70HA-1 or approved equal.

L. Humidistats: Humidistats must be contamination resistant, capable of ±2% RH accuracy, have field adjustable calibration and provide a linear proportional signal.

1. HD20K-T91 or equivalent.

M. Humidity High Limit

1. Multi-function device that can function as a high limit or proportional override humidity controller, as stand-alone proportional controller, or a stand-alone two-position controller
   a. Johnson Controls TRUERH HL-67N5-8N00P or approved equivalent.

N. Power Supply Used to Provide Power to Contractor-Provided Control Devices: Shall have adjustable DC output, screw terminals, overload protection and 24 VAC and 24 VDC output.

1. Kele, DCPA-1.2 or approved equal.
O. Pressure Differential Switch:

1. Fans: NECC model DP222 or approved equal.

P. Differential Pressure Transmitter: Provide units with linear analog 4-20mA output proportional to differential pressure, compatible with the Johnson METASYS Systems.

1. Water: Units shall be wet/wet differential pressure capable of a bi-directional pressure range of +/- 50 psid. Accuracy shall be +/- 0.25% full scale with a compensated temperature range of 30 to 150 deg F and a maximum working pressure of 250 psig. Install transmitter in a pre-manufactured bypass valve assembly with shut-off valves, vent valves and a bypass valve, all enclosed in a NEMA 1 enclosure.
   a. Setra model 230 with Kele model BVA-5 bypass valve assembly, or approved equal.

2. Air: Units shall be capable of measuring a differential pressure of 0 to 5 in. WC. Accuracy shall be +/- 1.0% full scale with a compensated temperature range of 40 to 149 deg F and a maximum working pressure of 250 psig.
   a. Setra model 267, or approved equal.
   b. Shall be installed in control panel and piped 2/3 down the duct unless shown otherwise or approved by owners representative.

Q. Building Static Pressure: Transducer shall utilize a ceramic capacitive sensing element to provide a stable linear output over the specified range of building static pressure. Transducer shall be housed in a wall-mounted enclosure with LCD display. Transducer shall have the following capabilities.

1. Input Power: 24 VAC.
2. Output: 0-10 VDC.
3. Pressure Range: -0.25 to +0.25 inches w.g.
4. Display: 3-1/2 digit LCD, displaying pressure in inches w.g.
5. Accuracy: +/- 1.0% combined linearity and hysteresis.
6. Temperature effect: 0.05% / deg C.
7. Zero drift (1 year): 2.0% max.
9. Operating Environment: 0 to 140 deg F, 90% RH (non-condensing).
10. Fittings: Brass barbs, 1/8” O.D.
12. Outdoor Sensing Tube Enclosure: UV stabilized thermoplastic or aluminum “can” enclosure to shield outdoor pressure sensing tube from wind effects.
13. Transducer shall be Veris Industries Model PXPLX01S, equivalent from Setra, or approved equal.
R. Electrical Requirements: Provide electric-pneumatic switches, electrical devices, and relays that are UL-listed and of type which meet current and voltage characteristics of the project. All devices shall be of industrial/commercial grade or better. Residential types will be rejected.

1. EP Switches: Landis & Gyr Powers, Inc. Series 265 - Junction Box Type or approved equal.
2. Relays: Relays shall have an LED status indicator, voltage transient suppression, Closed-Open-Auto switch, plastic enclosure, and color coded wires. Kele model RIBU1C or approved equal.

S. Airflow/Temperature Measurement Devices

1. Provide airflow/temperature measurement devices where indicated on the plans. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans.
2. The measurement device shall consist of one or more sensor probe assemblies and a single, remotely mounted, microprocessor-based transmitter. Each sensor probe assembly shall contain one or more independently wired sensor housings. The airflow and temperature readings calculated for each sensor housing shall be equally weighted and averaged by the transmitter prior to output. Pitot tubes and arrays are not acceptable. Vortex shedding flow meters are not acceptable.
3. All Sensor Probe Assemblies
   a. Each sensor housing shall be manufactured of a U.L. listed engineered thermoplastic.
   b. Each sensor housing shall utilize two hermetically sealed, bead-in-glass thermistor probes to determine airflow rate and ambient temperature. Devices that use "chip" or diode case type thermistors are unacceptable. Devices that do not have 2 thermistors in each sensor housing are not acceptable.
   c. Each sensor housing shall be calibrated at a minimum of 16 airflow rates and have an accuracy of +/-2% of reading over the entire operating airflow range. Each sensor housing shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).
      1) Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.
   d. The operating temperature range for the sensor probe assembly shall be -20° F to 160 F. The operating humidity range for the sensor probe assembly shall be 0-99% RH (non-condensing).
   e. Each temperature sensor shall be calibrated at a minimum of 3 temperatures and have an accuracy of +/-0.15° F over the entire operating temperature range. Each temperature sensor shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).
f. Each sensor probe assembly shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated.

g. Each sensor assembly shall not require matching to the transmitter in the field.

h. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter at a given measurement location.

4. Duct and Plenum Sensor Probe Assemblies

a. Sensor housings shall be mounted in an extruded, gold anodized, 6063 aluminum tube probe assembly. Thermistor probes shall be mounted in sensor housings using a waterproof marine grade epoxy resin. All wires within the aluminum tube shall be Kynar coated.

b. The number of sensor housings provided for each location shall be as follows:

1) Area (sq.ft.) | Sensors

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c. Probe assembly mounting brackets shall be constructed of 304 stainless steel. Probe assemblies shall be mounted using one of the following options:

1) Insertion mounted through the side or top of the duct
2) Internally mounted inside the duct or plenum
3) Standoff mounted inside the plenum

d. The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

5. Transmitters

a. The transmitter shall have a 16 character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics. Configuration settings and diagnostics shall be accessed through a pushbutton interface on the main circuit board. Airflow shall be field configurable to be displayed as a velocity or a volumetric rate.

b. The transmitter shall be capable of independently monitoring and averaging up to 16 individual airflow and temperature readings. The transmitter shall be capable of displaying the airflow and temperature readings of individual sensors on the LCD display.

c. The transmitter shall have a power switch and operate on 24 VAC (isolation not required). The transmitter shall use a switching power supply fused and protected from transients and power surges.
d. All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.

e. The operating temperature range for the transmitter shall be 

-20° F to 120° F. The transmitter shall be protected from weather and water.

f. The transmitter shall be capable of communicating with the host controls using one of the following interface options:

1) Linear analog output signal: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA (4-wire)

2) RS-485: Field selectable BACnet-MS/TP, ModBus-RTU and Johnson Controls N2 Bus

3) 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, ModBus-TCP and TCP/IP

4) LonWorks Free Topology

g. The transmitter shall have an infra-red interface capable of downloading individual sensor airflow and temperature data or uploading transmitter configuration data to a handheld PDA (Palm or Microsoft Pocket PC operating systems).

6. The measuring device shall be UL listed as an entire assembly.

7. The manufacturer’s authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer’s placement requirements.

8. Manufacturer

a. Primary flow elements, sensors, meters and transducers shall be EBTRON, Inc. Model GTx116-P and GTx116-F or approved equal.

b. The naming of any manufacturer does not automatically constitute acceptance of this standard product nor waive their responsibility to comply totally with all requirements of the proceeding specification.

3. EXECUTION

3.1 INSTALLATION OF CONTROL SYSTEMS

A. General: Install systems and materials in accordance with manufacturers’ instructions, roughing-in drawings and details shown on drawings.

B. Control Air Piping:

1. All control air piping shall be copper. Exception: Flexible Tubing may be used for a maximum of two (2) feet at connections to equipment, except for steam control valves, and inside control cabinets.

2. Provide copper tubing with a maximum unsupported length of 3'-0”.

3. Pressure Test control air piping at 30 psi for 24 hours. Test fails if more than 5 PSI loss occurs.
4. Fasten flexible connections bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support tubing neatly.
5. Number-code or color-code tubing, except local individual room control tubing, for future identification and servicing of control system.
6. All control tubing at control panel shall be tagged and labeled during installation to assist owner in making termination connections at control panel.
7. Provide pressure gauges on each output device.
8. Paint all exposed control tubing to match existing.

C. Raceway: Raceway is to be installed in accordance with the National Electric Code. Use of flexible metal conduit or liquidtight flexible conduit is limited to 36" to connect from EMT to devices subject to movement. Flexible raceway is not to be used to compensate for misalignment of raceway during installation.

D. Control Wiring: Install control wiring in raceway, without splices between terminal points, color-coded. Install in a neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code.

1. Install circuits over 25-volt with color-coded No. 12 stranded wire.
2. Install electronic circuits and circuits under 25-volts with color-coded No. 18 stranded twisted shielded pair type conductor.
3. N2 communications bus wire shall be 18 AWG, plenum rated, stranded twisted shielded, 3 conductor, with blue outer casing, described as 18-03 OAS STR PLNM NEON BLU JK distributed by Windy City Wire, constructed by Cable-Tek, or approved equivalent.

   a. Metastat wiring shall be minimum 20 AWG, plenum rated, stranded, 8 conductor stranded wire.

4. FC communications bus wire shall be 22 AWG, plenum rated, stranded twisted shielded, 3 conductor, with blue outer casing, described as 22-03 OAS STR PLNM NEON BLU JK distributed by Windy City Wire, constructed by Cable-Tek, or approved equivalent.

   a. Network sensor wiring (SA Bus) shall be 22 gauge plenum rated stranded twisted wire, 4 conductor.

5. All control wiring at control panel shall be tagged and labeled during installation to assist owner in making termination connections at control panel. Label all control wires per bid documents.

E. All low voltage electrical wiring shall be run as follows:

1. Route electrical wiring in concealed spaces and mechanical rooms whenever possible.
2. Provide EMT conduit and fittings in mechanical rooms and where indicated on drawings.
3. Low voltage electrical wiring routed above acoustical ceiling is not required to be in conduit, but wire must be plenum rated. Clip wire to structural ceiling.
4. Provide surface raceway, fittings and boxes in finished areas where wiring cannot be run in concealed spaces. Route on ceiling or along walls as close to ceiling as possible. Run raceway parallel to walls. Diagonal runs are not permitted. Paint raceway and fittings to match existing conditions. Patch/repair/paint any exposed wall penetrations to match existing conditions.

F. All devices shall be mounted appropriately for the intended service and location.

1. Adjustable thermostats shall be provided with base and covers in occupied areas and mounted 48” above finished floor to the top of the device. Tubing and/or wiring shall be concealed within the wall up to the ceiling where ever possible. Surface raceway may only be used with approval of Owners Representative. Wall mounted sensors such as CO2, RH, and non-adjustable temperature sensors shall be mounted 54” above finished floor. Duct mounted sensors shall be provided with mounting brackets to accommodate insulation. Mounting clips for capillary tubes for averaging sensors are required.

2. All control devices shall be tagged and labeled for future identification and servicing of control system.

3. Preheat and mixed air discharge sensors must be of adequate length and installed with capillary tube horizontally traversing face of coil, covering entire coil every 24 inches bottom to top.

4. All field devices must be accessible or access panels must be installed.

G. Install magnehelic pressure gauge across each air handling unit filter bank. If the air handling unit has a prefilter and a final filter, two magnehelic pressure gauges are required.

3.2 ADJUSTING AND START-UP

A. Start-Up: If temporary control of Air Handling Units is desired by the contractor to protect finishes, etc., AHUs may be run using caution with temporary controls installed by contractor early in the startup process. All safeties including a smoke detector for shut down must be operational. Some means of discharge air control shall be utilized and provided by the contractor such as a temporary temperature sensor and controller located and installed by the Contractor.

B. The start-up, testing, and adjusting of pneumatic and digital control systems will be conducted by owner. Once all items are completed by the Contractor for each system, Contractor shall allow time in the construction schedule for owner to complete commissioning of controls before project substantial completion. This task should be included in the original schedule and updated to include the allotted time necessary to complete it. As a minimum, the following items are required to be completed by the Contractor for Owner to begin controls commissioning.

1. Process Control Network

a. The control boards and enclosures need to be installed in the mechanical rooms.
b. The fiber optic conduit and box for the process control network needs to be installed. Once in place, Owner needs to be contacted so the length of the owner provided fiber cable can be determined and ordered, if required. Coordinate with Owner to schedule the pull in and termination of the fiber cable. Power should be in place at that time. (Fiber for the process control network is required to allow metering of utilities prior to turn on)

2. Heating System

a. Pumps, heat exchangers, steam pressure reducing station, piping, control valves, steam and/or hot water meter, feeder conduit and wire, VFDs, control panels and control wiring installed in the mechanical room. The house keeping pads must be poured before pump operation. All must be in place in working order (pumps aligned, VFDs set up by vendor, motors checked for rotation, steam regulators set to required pressure, condensate pumps operational, heating system ready to circulate (all piping pressure tested, flushed, and insulated) with differential pressure sensors in place.

3. Cooling System

a. Pumps, heat exchangers, piping, control valves, chilled water meter, feeder conduit and wire, VFDs, control panels and control wiring installed in the mechanical room. The house keeping pads must be poured before pump operation. All must be in place in working order (pumps aligned, VFDs set up by vendor, motors checked for rotation, cooling system ready to circulate (all piping pressure tested, flushed, and insulated) with differential pressure sensors in place.

4. VAVs-First Pass

a. Power, (FC or N2 bus), and control wire installed before owner can make first commissioning pass. First pass includes installation of VAV controller, termination of power, control and network communication wiring.

5. Air Handlers

a. Prior to owner commissioning, at a minimum, the following items should be complete: Power wiring, motor rotation check, fire/smoke dampers open, control wiring including all safeties, IO cabinet, air handler cleaned, and filters installed as required. To protect the systems from dirt, outside air with no return will be used until the building is clean enough for return air operation.

6. VAVs-Second Pass

a. After the air handlers are running and under static pressure control and the heating water system is operating, a second pass can be made on the VAVs to download the control program and commission controllers to verify the VAV dampers, thermostat, and reheat control valves are working properly.
7. Exhaust and Energy Recovery Systems
   a. Exhaust fans need to be operational and under control before labs can be commissioned.

8. Lab Air Controls
   a. Lab Air Controls vendor will have the same requirements as stated above for VAVs.

9. Some balance work can be done alongside the control work as long as areas are mostly complete and all diffusers are in place.

3.3 CLOSEOUT PROCEDURES

   A. Contractor shall provide complete diagrams of the control system including flow diagrams with each control device labeled, a diagram showing the termination connections, and an explanation of the control sequence. The diagram and sequence shall be framed and protected by glass and mounted next to controller.

END OF SECTION 23 09 00
SECTION 23 21 13 - HYDRONIC PIPING

1. GENERAL

1.1 SECTION INCLUDES

A. Above grade pipe, fittings, and joints for:

   1. Heating water piping system.
   2. Chilled water piping system.
   3. Equipment drains and overflows.

B. Valves.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents.

   1. Record actual locations of valves.

F. Delivery, storage, and handling.

1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

C. Where connecting ferrous and non-ferrous piping materials, use full-port ball valves with bronze construction or a galvanized steel dielectric nipples with plastic liner to separate piping materials.
D. Use gate, ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers or as shown on plans.

E. Use ball or butterfly valves for throttling, bypass, or manual flow control services or as shown on plans.

F. Use lug end butterfly valves to isolate equipment.

1.4 REGULATORY REQUIREMENTS

A. Conform to International Mechanical Code for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state and local labor regulations.

C. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.6 EXTRA MATERIALS

A. Provide two repacking kits for each size and valve type.

2. PRODUCTS

2.1 STEEL PIPING, FITTINGS, AND JOINTS

A. Applicable Systems

1. Heating water
2. Chilled water


D. Fittings (2-1/2” and larger): ASTM B16.9, steel butt weld fittings.

E. Joints (2” and smaller): Threaded.

F. Joints (2-1/2” and larger): AWS D1.1, welded.
G. Branch Tees: Weld-O-Lets and Thread-O-Lets are acceptable for branch piping when main piping is 1” or larger than branch piping.

H. Saddle Tees: Are acceptable for branch piping when main piping is 2” or larger than branch piping.

I. Unions (2” and smaller): 150 psig malleable iron, threaded.

J. Flanges (2-1/2” and larger): 150 psig forged steel, slip-on, 1/16 inch thick preformed neoprene gaskets.

2.2 COPPER TUBING, FITTINGS, AND JOINTS

A. Applicable Systems

1. Heating water
2. Chilled water
3. Heat recovery water
4. Equipment drains and overflows

B. Pipe: ASTM B88, Type L, hard drawn

C. Copper Tubing: ASTM B88, Type DWV, hard drawn piping on equipment drains and overflows ONLY.

D. Fittings and Unions (2” and smaller): ASME B16.22 wrought copper and bronze:


E. Joints (All sizes):

1. Copper to copper: AWS A5.8/A5.8M, BCuP-5 (15% silver), Copper-phosphorus alloy.
2. Copper to bronze or steel: AWS A5.8/A5.8M, BAg-1, Silver alloy.

F. Flanges (2-1/2” and larger): Bronze, 1/16 inch thick preformed neoprene gaskets.

2.3 DIELECTRIC CONNECTIONS:

A. Dielectric Connections: Where connecting ferrous and non-ferrous piping materials, use full-port ball valve with bronze construction or dielectric couplings to separate piping materials.
2.4 VALVES

A. CALIBRATED BALANCE VALVES

1. Pre-Set Balance Feature. Valves to be designed to allow Installing Contractor to pre-set balance points for proportional system balance prior to system start-up in accordance with scheduled flow rates.
2. Valve Design and Construction. All valves shall have a calibrated orifice or venturi section, two ¼" threaded pressure tap ports with integral seals, and memory stop to retain the set position. Valves should be rated for 125 psig working pressure and 250 Deg. F maximum operating temperature.
3. Valves shall be selected based on flowrate, not on pipe size dimensions.
4. Preformed Insulation. All valves to be provided with molded insulation to permit access for balance and read-out.

B. BALL VALVES

1. Up To and Including 3 Inches:
   a. Bronze two piece body, stainless steel full-port ball on all systems, Teflon seats and stuffing box ring, lever handle with balancing stops, solder or threaded ends. Include stem extensions on valves used in insulated piping systems.

C. BUTTERFLY VALVES

1. 4 Inches and Larger:
   a. Body: Cast or ductile iron with resilient replaceable EPDM seat, lug ends, extended neck.
   b. Disc: Aluminum bronze on closed systems and stainless steel on open systems.
   c. Stem: Stainless steel, extended on insulated systems as required to allow valve operation without damage to the insulation.
   d. Operator (4" and smaller): 10 position lever handle with memory stop, gear drive.
   e. Operator (6" and larger): Handwheel, gear drive.
   f. Chainwheel: On valves 6" and larger and installed higher than 8-feet above finished floor, provide sprocket rim, brackets, and chain compatible with valve.

D. SWING CHECK VALVES

1. Up To and Including 2 Inches:
   a. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder or threaded ends.
2. Over 2 Inches:
   a. Iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends.

E. SPRING LOADED CHECK VALVES
   1. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

3. EXECUTION

3.1 PREPARATION
   A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
   B. Remove scale and dirt on inside and outside before assembly.
   C. Prepare piping connections to equipment with flanges or unions.
   D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.2 INSTALLATION
   A. Grooved pipe fittings and joints may only be used in accessible locations.
   B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
   C. Heating water connections to terminal units shall be copper (no steel).
   D. Install all piping in accordance with ASME B31.9.
   E. Route piping in orderly manner, parallel to building structure, and maintain gradient.
   F. Install piping to conserve building space, and not interfere with use of space.
   G. Group piping whenever practical at common elevations.
   H. Sleeve pipe passing through partitions, walls and floors.
   I. Slope piping and arrange to drain at low points.
   J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
K. Refer to Section 23 05 29 and Section 23 05 48 for installation of supports and hangers.

L. Provide insulation clearance and access to valves and fittings in hangers and from structure and other equipment. Insulation shall be continuous through all hangers and supports. Refer to Section 23 07 19.

M. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with General Contractor and requirements of Section 23 05 00.

N. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

O. Install unions on both sides of each control valve and on one side of all other valves. Install unions on the equipment side of final connections to each piece of equipment. Unions are not required at flanged valves or equipment.

P. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

Q. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

R. Install valves with stems upright or horizontal, not inverted.

S. Provide insulated valve stem extensions on all valves installed in insulated piping systems.

T. Install chainwheel operators on valves 6" and larger that are installed 8-feet above finished floor or greater. Extend chain down to maximum 5-feet above finished floor.

U. Where possible, pipe connections shall be installed with the branch piping connected to the top of the main/header. If this is not possible due to space constraints, a connection with the same vertical centerline is acceptable. Connections to the bottom of the main/header is not allowed.

V. Provide solid chrome plated steel escutcheons cover the sleeves and openings at walls and ceilings in exposed areas.

3.3 SYSTEM FLUSHING, FILLING, PRESSURE TESTING AND CLEANING

A. Flush, fill, pressure test and clean all new hydronic systems and parts of existing systems which have been altered, extended or repaired.

B. Flush and fill systems with all valves open to coils. Bleed air from coils and piping. Clean strainers. Refer to Section 23 25 00.

C. Pressure Test Procedure:

1. Reference Section 23 05 00 for minimum test pressures.
2. Submit copy of Pipe Pressure Test Log provided in section 23 05 00 for each section of piping tested. Refer to 23 05 00 for general pipe pressure testing requirements (i.e., test pressure gages, inspections, etc.).

3. Leave joints including welds uninsulated and exposed for examination during the test.

4. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.

5. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.

6. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.

7. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure (but not less than 100 psi). The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test.

8. After the hydrostatic test pressure has been applied for at least 12 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

D. Clean systems. Refer to Section 23 25 00 for cleaning procedure.

END OF SECTION 23 21 13
SECTION 23 21 16 - HYDRONIC SPECIALTIES

1. GENERAL

1.1 SECTION INCLUDES

A. Air vents.

B. Strainers.

C. Relief valves.

D. Rigid connections.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

B. Submittals.

C. Project record documents

1. Record actual locations of hydronic specialties.

D. Operation and maintenance data.

E. Qualifications

F. Delivery, storage and handling.

2. PRODUCTS

2.1 AIR VENTS

A. Manual Type: Short vertical sections of equal diameter pipe, up to 2", to form air chamber, with ball valve, hose connection, and cap.

B. Automatic Type: Bronze body, nonferrous internal parts, noncorrosive metal float, 150 psig CWP, 240 def F maximum operating temperature.
2.2 STRAINERS

A. Size 2 inch and Under:
   1. Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch Type 304 stainless steel perforated screen.

B. Size 2-1/2 inch to 4 inch:
   1. Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch Type 304 stainless steel perforated screen.

C. Size 5 inch and Larger:
   1. Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch Type 304 stainless steel perforated screen.

D. Provide blowdown valves where shown on plan.

2.3 SAFETY RELIEF VALVES

A. ASME Section IV certified pressure relief valve featuring a raised seat and non-mechanical disc alignment. Working parts and spring shall be isolated from any discharge by a high temperature resistant material. Valve shall be a Watts Regulator Company Series 174 A or equivalent.

   1. Materials: Bronze body construction, non-metallic disc-to-metal seating.
   2. Pressure Rating: 30 psi to 150 psi.
   3. Maximum Temperature: 250 deg F.

2.4 RIGID CONNECTIONS

A. Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket, with threaded or flanged ends to match equipment, 150 psig CWP rating, 250 deg F maximum operating temperature, capable of withstanding 3/4" misalignment.

B. Flexible grooved coupling may be used at base mounted pumps. Provide Victaulic Model 77 or approved equivalent.

2.5 GLYCOL FEEDER

A. Mixing Tank: 55 gallon polyethylene drum with hinged cover. Fully supported by a carbon steel bottom mount stand, painted with water based enamel.

B. Control Panel: NEMA 4X with 2-position main power switch and light, 3-position, hand-off-auto, switch and light for gear pump, red low light and 15 A fuse.
C. Low Level Switch: Polypropylene side entry low level switch with 10 A relay.

D. Gear Pump: Includes PVC ball valve, flexible tubing and cast iron Y-strainer. Pump discharge tubing includes brass construction spring check valve, PVC piping, and ¼” NPT back tap pressure gauge.

E. Pressure Switch: ¼” NPT

F. Pressure Relief Valves: 50-250 PSI brass valve

3. EXECUTION

3.1 INSTALLATION

A. Install specialties in accordance with manufacturer’s instructions and as shown on drawings.

B. Provide manual air vents at all system high points and in accessible locations.

C. Provide drain valves at all low points and in accessible locations.

D. Provide valved drain and hose connection on strainer blow down connection.

E. Provide full-size piping from relief valve outlet to nearest floor drain.

F. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION 23 21 16
SECTION 23 31 13 - DUCTWORK

1. GENERAL

1.1 SECTION INCLUDES

A. Metal ductwork.

B. Duct cleaning.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

B. Performance requirements.

1. No variation of duct configuration or sizes shall be permitted except by written permission.

C. Submittals.

1. Submit detailed CAD-generated ductwork drawings at minimum ¼” scale, with details of the following:

   a. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   b. Duct layout indicating pressure classification and sizes on plans.
   c. Seam and joint construction.
   d. Penetrations through fire-rated and other partitions.
   e. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

NOTE: No installation of ductwork shall be allowed until detailed shop drawings have been reviewed by the Engineer. Any ductwork that is installed prior to the Engineer’s review of the shop drawings shall be subject to removal and replacement at the Contractor’s expense.

D. Project record documents.

1. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

E. Quality assurance.

1. Perform Work in accordance with the following standards:

   b. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
c. NFPA 91 - Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying.
e. SMACNA – HVAC Duct Construction Standards - Metal and Flexible.
f. SMACNA - Round Industrial Duct Construction Standards

F. Qualifications.

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
2. Installer: Company specializing in performing the work of this section with minimum five years experience.

G. Regulatory requirements.

1. Construct all ductwork per codes listed in section 1.2.E

1.3 Environmental requirements.

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures during and after installation of duct sealants.

2. PRODUCTS

2.1 MATERIALS


B. Stainless Steel Ducts: ASTM A 480/A 480M, Type 316 sheet form with No. 4 finish for surfaces of ducts exposed to view, and Type 304 sheet form with No. 1 finish for concealed ducts.

C. Insulated Flexible Ducts:

1. UL 181, Class 1, mechanically-locked spun nylon fabric supported by helically wound spring steel wire; fiberglass insulation; fire retardant polyethylene vapor barrier film.
2. Pressure Rating: 6 inches WG positive, 5.0 inches WG negative (through 16" diameter), 1.0' WG negative (18" to 20").
4. Temperature Range: -20 degrees F to 250 degrees F.
5. Minimum Sound Attenuation Performance (Insertion Loss in dB of 12' Length of 12'' Round Duct):
   a. 63 Hz Octave Band: 13
   b. 125 Hz Octave Band: 37
   c. 250 Hz Octave Band: 31
   d. 500 Hz Octave Band: 34
   e. 1 kHz Octave Band: 37
   f. 2 kHz Octave Band: 47
   g. 4 kHz Octave Band: 34

6. Manufacturer: Flexmaster Type 6B or equivalent.

D. Fasteners: Rivets, bolts, or sheet metal screws.

E. Sealant: ASTM E84 and UL rated, NFPA 90A and 90B approved, Non-hardening, water resistant, fire resistive, compatible with mating materials; and rated for all pressure duct systems. Fabric and metal backed duct tapes are not acceptable.

F. Hanger Rod: ASTM A36; steel or galvanized, threaded.

2.2 SHOP FABRICATED DUCTWORK

A. Fabricate, reinforce and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, latest edition, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Construct T's, and elbows in accordance with SMACNA HVAC Duct Construction Standards-Metal and Flexible, latest edition, using radius of not less than 1-1/2 times width of duct on centerline. Where mitered rectangular elbows are used or indicated, provide dual wall airfoil turning vanes.

C. Reference SMACNA figure 2-9 to construct gradual transitions where ductwork changes size or offsets.

2.3 MANUFACTURER FABRICATED DUCTWORK

A. Fabricate, reinforce and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, latest edition, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Round and oval duct shall be spiral lockseam duct with light reinforcing corrugations unless indicated otherwise.

C. Construct T's, bends, and elbows with minimum bend radius elbows shall be 1.5 times the duct diameter (major or minor axis on oval ductwork depending on direction of bend). Where not possible and where mitered elbows are used or indicated, provide double wall airfoil turning vanes.
D. Fabricate round and oval duct; fittings in accordance with SMACNA Standards. Joints shall be minimum 2 inch insertion length for joint connections.

E. Weld ductwork is to be weld with filler rod of the same material as the metal that is being welded. Coat welded joints with protective paint to prevent damage to galvanized surfaces.

F. On round and oval ducts, provide 45 deg wye tee take-offs or 90 deg conical tee take-offs or 45 degree low loss entry tee take-offs or other fitting as indicated on plans. Straight taps are not acceptable.

2.4 TRANSVERSE DUCT CONNECTION SYSTEM – RECTANGULAR DUCT

A. Slide on flange system: Ductmate and Ductmate WDCI connection system complete with interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips. Gasket material shall be chemical resistant material in all fume exhaust ductwork.

B. Formed on flange system: TDC, TDF or equivalent connection system or equivalent. Such flanges shall be constructed as SMACNA T-24 flange (Page 1-25 and 1-37 ’85 SMACNA Duct Construction Manual, 1985 Edition).

2.5 TRANSVERSE DUCT CONNECTION SYSTEM – ROUND AND OVAL DUCT

A. Slip type connector: Keating coupler.

B. Slide on flange system. Spiralmate and Ovalmate connection system complete with interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

C. Formed on flange system: Factory-applied Van Stone connection on one end of the duct with field-applied Van Stone connector on the other end of the duct. Provide factory-applied Van Stone connections on each end of fittings.

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions; SMACNA HVAC Duct Construction Standards - Metal and Flexible, current edition and International Mechanical Code requirements.

B. Seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, current edition.

C. Drawings indicate general arrangement of ducts, fittings, and accessories.

D. Construct and install each duct system for the specific duct pressure classification indicated.

E. Install round in lengths not less than 12 feet, unless interrupted by fittings.
F. Install ducts with fewest possible joints.

G. Install fabricated fittings for changes in directions, changes in size and shape, and connections.

H. Install only low loss high efficiency fittings at takeoffs. Extractors not allowed.

I. Install couplings tight to duct wall surface with a minimum of projections into duct.

J. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs.

K. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

L. Install ducts with a clearance of 2 inch, plus allowance for insulation thickness.

M. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.

N. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

O. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

P. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.

Q. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire damper, sleeve, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 07 Section "Firestopping."

R. Verify location of air outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement. Refer to reflected ceiling plans, finish schedule, material finish specification, and shop drawings.

S. Coordinate routing with all other trades to establish space requirements for each.

T. Contractor may vary route and shape of ductwork and make offsets during progress of work if required to meet structural or other interferences. Where such changes impair the system performance, the changes will be corrected at Contractor's expense.
DUCTWORK

U. All ductwork shall be substantially and neatly supported on galvanized steel straps or angles riveted or bolted to duct flanges and properly anchored to the construction so that horizontal ducts are without sag or sway, vertical ducts are without buckle, and all ducts are free from the possibility of deformation, collapse or vibration. Support at each joint and at 4 feet on center maximum.

V. Openings required for ductwork through structural elements in new construction shall be coordinated with the General Contractor. Shop drawings locating such openings shall be prepared in ample time to meet the construction schedule.

W. Provide sleeves at all duct penetrations through walls, floors and roofs. Openings through sound-rated partitions shall have annular space stuffed with fiberglass insulation for full thickness of wall.

X. Provide 2-inch deep bitumastic coated drip pans on all non-ducted hoods, fans or penthouses used for relief or exhaust air service. Pans shall be 12 inches larger all around than roof opening with clear vertical openings between pan and structure as indicated. Insulate pan where indicated.

Y. Install automatic control dampers as recommended by the manufacturer.

Z. Prevent passage of unfiltered air around filters with felt, rubber, neoprene gaskets, or other approved safing material.

AA. Provide openings in ductwork to accommodate thermometers and controllers. Provide pitot tube openings for testing of systems, complete with metal cap with spring device or screw to prevent air leakage.

BB. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

CC. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system. Keep openings covered until ready for continuing duct run or final connections.

DD. Paint ductwork visible behind wall-mounted air outlets and inlets matte black.

EE. Change duct sizes gradually, not exceeding 30 degrees (15 degrees ideally) divergence and 45 degrees (30 degrees ideally) convergence.

FF. Use crimp joints with or without bead for joining round duct sizes 8 inches and smaller and install with crimp in direction of air flow.

GG. Provide closure flanges around exposed ductwork at wall and ceiling penetrations, 1-1/4 inches wide minimum.

HH. Provide return air grilles open to ceiling plenum with duct boot with minimum longitudinal dimension 2’ X 2’.
II. Provide flexible connect between ductwork and all moving equipment.

1. Provide 1-inch slack for free movement.

JJ. Join VAV boxes to medium pressure supply duct mains with minimum straight length of duct equal to 5 times box inlet diameter size. Duct to be rigid. Flexible ductwork is not allowed to join boxes to supply duct main.

KK. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA’s “Duct Cleanliness for New Construction”.

LL. Threaded cap test holes shall be provided in all ductwork. Test holes shall be installed after the reheat coil in all VAV boxes. Provide extensions to allow for insulation thickness. Test holes shall be “Ventlok” or equal.

MM. Exterior Ductwork:

1. Slope top of rectangular ductwork to allow proper drainage.
2. Utilize PHP systems or equivalent roof supports with galvanized channels for exterior ductwork. For support loading and spacing, use manufacturer recommendations.

3.2 GENERAL

A. Install in accordance with manufacturer's instructions; SMACNA HVAC Duct Construction Standards - Metal and Flexible, current edition and International Mechanical Code requirements.

B. Seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, current edition.

C. Duct sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.

D. Provide openings in ductwork where required to accommodate thermometers and controllers.

E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

F. Cover all exposed fiberglass insulation with duct tape.

G. During construction provide temporary closures of metal or tape polyethylene on open ductwork to prevent construction dust from entering ductwork system.

H. Connect flexible ducts to metal ducts with stainless steel bands with worm gear tightener, nylon bands are unacceptable.
I. Duct transition from round to rectangular and vise versa shall be made with rectangular to round duct transition fitting.

J. Provide flange-type joint at transverse joints or seal as specified. All transverse joints shall be inspected by the Owner prior to insulating ductwork.

K. Duct work upstream of air terminal units shall be rigid duct with minimum three diameters of straight ductwork upstream of air terminal units.

L. Air terminal take-offs from rectangular main ducts shall be lo-loss 45°F take-offs, extractors are not allowed.

M. Diffusers and register take-offs from rectangular duct mains shall be lo-loss 45° fittings, with integral balancing damper that is provided with stand-off bracket and quadrant lock. Extractors are not allowed.

N. Do not exceed 6’ of flexible duct upstream of each diffuser or grille. See details on Drawings.

O. Exhaust grille/register branch duct connections to rectangular mains shall be lo-loss 45° entry fittings with integral balancing damper.

P. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

Q. Plenum construction shall be fully coordinated with other trades to accommodate walls, floor, structure, piping, and other components in the vicinity. All penetrations and joints shall be sealed airtight.

3.3 INSTALLATION OF 2” AND GREATER PRESSURE CLASS DUCTWORK (POSITIVE OR NEGATIVE PRESSURE)

A. All round and oval duct elbows installed shall be die-formed, gored, pleated or mitered. All mitered elbows shall be equipped with turning vanes.

B. On round and oval ducts, provide 45 deg wye or 90 deg conical tee take-offs as indicated on plans. Straight taps are not acceptable.

C. All diverging flow fittings shall be constructed such that no excess material projects from the body into the branch tap entrance.

D. Transverse joints of all rectangular ducts greater than 24” wide or deep shall be fabricated with flanging system as called out previously (Ductmate or equivalent).
3.4 INSTALLATION OF 1" AND LESS PRESSURE CLASS DUCTWORK (POSITIVE OR NEGATIVE PRESSURE)

A. All round duct elbows installed shall be of the adjustable, die-formed, gored, pleated or mitered type. All adjustable elbows shall be sealed after installation.

B. All mitered elbows shall be equipped with turning vanes.

C. Connect ceiling diffusers to low pressure ducts with adjustable elbow at duct and short length of flexible duct held in place with strap or clamp. Do not use flexible duct to change direction. Connection detail as well as maximum length of flex duct allowed to diffusers is indicated on the plans.

3.5 PLENUMS

A. General

1. Unless otherwise noted, mount casings on 4-inch high concrete curbs.

3.6 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

F. Exposed ductwork serving ventilated workstations and corrosive storage cabinets:

1. Install the exposed stainless steel ductwork serving the ventilated workstations with the longitudinal weld facing the adjacent wall and away from public view. If possible, install one continuous exposed duct without transverse joints. Install escutcheon ring at ceiling penetration. Ring shall be same material and same finish as exposed duct. Note that exposed ductwork shall be provided with a No. 4 finish. Verify acceptable appearance of installed ductwork with Architect after installation.
3.7 CLEANING

A. The air handling units, energy recovery wheel, exhaust fans, and other HVAC airside equipment shall not be used for temporary building conditioning without the written permission from the Owner and Architect/Engineer. Open ductwork that has been installed shall be protected during the duration of the project with polyethylene plastic and duct tape over the open ends. Uninstalled ductwork shall be protected from construction dust by covering the uninstalled ductwork with polyethylene plastic. Prior to installing ductwork, the inside of the ductwork shall be wiped down or vacuumed.

B. Clean inside all air handling units, energy recovery units, and outside air duct systems before the fans are turned on. Call for inspection by the owner’s representative to verify that all ducts are cleaned. If the ductwork is unacceptable, the contractor shall provide vacuuming of these duct systems by forcing air at high velocity through duct where manual cleaning is not possible due to duct lengths or size. Call for re-inspection by Owner's representative.

C. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

D. Call for inspection by Owner's representative.

E. Install a fresh set of filters in all equipment immediately prior to project turnover.

3.8 DUCTWORK SCHEDULE

<table>
<thead>
<tr>
<th>Duct System:</th>
<th>Material:</th>
<th>Longitudinal Joints:</th>
<th>Transverse Joints:</th>
<th>Pressure Class:</th>
<th>Sealant Class:</th>
<th>Leakage Class:</th>
<th>Additional Notes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside air system upstream of AHU</td>
<td>Galv. Steel</td>
<td>3A</td>
<td>4A, 4C</td>
<td>-2&quot;</td>
<td>B</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Rectangular SA system upstream of terminal units</td>
<td>Galv. Steel</td>
<td>3A, 3E</td>
<td>4A, 4C, 4D</td>
<td>+6&quot;</td>
<td>A</td>
<td>6</td>
<td>8B</td>
</tr>
<tr>
<td>Round SA system upstream of terminal units</td>
<td>Galv. Steel</td>
<td>3C, 3E</td>
<td>4B, 4D</td>
<td>+6&quot;</td>
<td>A</td>
<td>3</td>
<td>8B</td>
</tr>
<tr>
<td>Rectangular SA system downstream of terminal units</td>
<td>Galv. Steel</td>
<td>3A, 3B, 3E</td>
<td>4A, 4C, 4D</td>
<td>+2&quot;</td>
<td>A</td>
<td>24</td>
<td>8B</td>
</tr>
<tr>
<td>Round SA system downstream of terminal units</td>
<td>Galv. Steel</td>
<td>3C, 3E</td>
<td>4B, 4D</td>
<td>+2&quot;</td>
<td>A</td>
<td>12</td>
<td>8B</td>
</tr>
<tr>
<td>Rectangular general EA or RA system upstream of terminal unit</td>
<td>Galv. Steel</td>
<td>3A, 3B, 3E</td>
<td>4A, 4C, 4D</td>
<td>-2&quot;</td>
<td>A</td>
<td>24</td>
<td>8B</td>
</tr>
<tr>
<td>Round general EA or RA system upstream of terminal unit</td>
<td>Galv. Steel</td>
<td>3C, 3E</td>
<td>4B, 4D</td>
<td>-2&quot;</td>
<td>A</td>
<td>12</td>
<td>8B</td>
</tr>
<tr>
<td>Duct System:</td>
<td>Material:</td>
<td>Longitudinal Joints:</td>
<td>Transverse Joints:</td>
<td>Pressure Class:</td>
<td>Sealant Class:</td>
<td>Leakage Class:</td>
<td>Additional Notes:</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
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</tr>
<tr>
<td>Rectangular general EA or RA system downstream of terminal unit</td>
<td>Galv. Steel</td>
<td>3A, 3E</td>
<td>4A, 4C, 4D</td>
<td>-6”</td>
<td>A</td>
<td>6</td>
<td>8B</td>
</tr>
<tr>
<td>Round general EA or RA system downstream of terminal unit</td>
<td>Galv. Steel</td>
<td>3C, 3E</td>
<td>4B, 4D</td>
<td>-6”</td>
<td>A</td>
<td>3</td>
<td>8B</td>
</tr>
<tr>
<td>Rectangular fume EA system upstream of terminal unit</td>
<td>Stainless Steel</td>
<td>3E</td>
<td>4D</td>
<td>-2”</td>
<td>A</td>
<td>3</td>
<td>8B</td>
</tr>
<tr>
<td>Round concealed fume EA system upstream of terminal unit</td>
<td>Stainless Steel</td>
<td>3E</td>
<td>4D</td>
<td>-2”</td>
<td>A</td>
<td>3</td>
<td>8B</td>
</tr>
<tr>
<td>Round exposed fume EA system upstream of terminal unit</td>
<td>Stainless Steel</td>
<td>3E</td>
<td>4D</td>
<td>-2”</td>
<td>A</td>
<td>3</td>
<td>8B</td>
</tr>
<tr>
<td>Rectangular fume EA system downstream of terminal unit</td>
<td>Stainless Steel</td>
<td>3E</td>
<td>4D</td>
<td>-6”</td>
<td>A</td>
<td>6</td>
<td>8B</td>
</tr>
<tr>
<td>Round fume EA system downstream of terminal unit</td>
<td>Stainless Steel</td>
<td>3E</td>
<td>4D</td>
<td>-6”</td>
<td>A</td>
<td>3</td>
<td>8B</td>
</tr>
</tbody>
</table>

**DUCTWORK SCHEDULE NOTES:**

**Longitudinal Joint Options:**

3A: Pittsburgh lock. Refer to Figure 1-5, SMACNA.
3B: Button punch snap lock. Refer to Figure 1-5, SMACNA.
3C: Spiral lockseam.
3D: Snaplock.
3E: Welded.
3F: Double-wall, pre-manufactured sheet metal plenum.

**Transverse Joint Options:**

4A: Pre-manufactured flanged duct connection system specified under “Products” section of this specification.
4B: 0-24” Major Axis Diameter: Interior slip coupling beaded at center, fastened to duct with sealing compound applied continuously around joint before assembling and after fastening.
26” Major Axis Diameter and Up: Pre-manufactured flanged duct connection system specified under “Products” section of this specification.
4C: Any standard transverse joint as shown in Figure 1-4 of SMACNA is acceptable.
4D: Welded.
Sealant Class Options:
6: Seal class is defined by the following table (refer to Table 4-1, SMACNA HVAC Air Duct Leakage Test Manual):

<table>
<thead>
<tr>
<th>Seal Class</th>
<th>Sealing Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>All transverse joints, longitudinal seams, and ductwork penetrations. Pressure sensitive tape shall not be used as a primary sealant on metal ducts.</td>
</tr>
<tr>
<td>B</td>
<td>All transverse and longitudinal seams. Pressure sensitive tape shall not be used as a primary sealant on metal ducts.</td>
</tr>
<tr>
<td>C</td>
<td>Transverse joints only.</td>
</tr>
</tbody>
</table>

Leakage:
7: Leakage Class is defined by Figure 4-1, SMACNA HVAC Air Duct Leakage Test Manual.

Additional Comments:
8A: See Drawings for further information regarding extent of stainless steel ductwork.
8B: Field welded ductwork is to be welded with filler rod of the same material as the metal that is being welded. Field coat welded joints with protective paint to prevent damage to galvanized surfaces.

3.9 PRESSURE TESTING
A. Perform the following field tests and inspections according to SMACNA’s “HVAC Air Duct Leakage Test Manual” and prepare test reports:
1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days’ advance notice for testing.
3. Maximum Allowable Leakage: Refer to paragraph 3.6.
4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.
5. Test no less than 25% of the supply air ductwork upstream of terminal units, 25% of the return air ductwork downstream of terminal units, 25% of the exhaust air ductwork downstream of terminal units, and 50% of the fume exhaust ductwork downstream of terminal units.

3.10 CLEANING NEW SYSTEMS
A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.
B. Use service openings, as required, for physical and mechanical entry and for inspection.

END OF SECTION 23 31 13
SECTION 23 33 00 - DUCTWORK ACCESSORIES

1. GENERAL

1.1 SECTION INCLUDES

A. Air turning devices.
B. Duct access doors.
C. Duct test holes.
D. Flexible duct connections.
E. Combination fire and smoke dampers.
F. Volume control dampers.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.
B. Submittals.
C. Project record documents.
   1. Record actual locations of access doors, test holes etc.
D. Qualifications.
   1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
E. Regulatory requirements.
   1. Products Requiring Electrical Connection: UL Listed and classified.
F. Delivery, storage, and handling.
   1. See Section 23 05 00.
G. Extra materials.
1. Provide two of each size and type of fusible link for fire and combination fire/smoke dampers.

2. **PRODUCTS**

2.1 **AIR TURNING DEVICES**

A. Note that air extractors or "scoops" shall not be used under any circumstances.

B. General:

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
2. Note that air extractors or "scoops" shall not be used under any circumstances.

C. Manufactured and Fabricated Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

2. Single-Thickness Vane Construction: Vanes shall be single-thickness, quarter-circle shape with 2” radius, minimum 3.15” length, and spaced 1.5” on center.
3. Double-Thickness Vane Construction: Vanes shall be double-thickness, quarter-circle shape, with 4.5” radius and spaced 3.25” on center.

2.2 **DUCT ACCESS DOORS**

A. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.

1. Less Than 12 Inches Square: Secure with sash locks.
2. Up to 18 Inches Square: Provide two hinges and two sash locks.
3. Up to 24 x 48 Inches: Three hinges and two compression latches with outside and inside handles.
4. Larger Sizes: Provide an additional hinge.

B. Access doors with sheet metal screw fasteners are not acceptable.

2.3 **DUCT TEST HOLES**

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.
2.4 FLEXIBLE DUCT CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Construct flexible connector of neoprene coated flameproof fabric crimped into duct flanges for attachment to duct and equipment.

2.5 COMBINATION FIRE AND SMOKE DAMPERS

A. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.

B. Provide factory sleeve and collar for each damper.

C. Multiple Blade Dampers: Fabricate with 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.

D. Operators: UL listed and labeled spring return electric type suitable for 120 volts, single phase, 60 Hz. Locate damper operator on exterior of duct and link to damper operating shaft.

E. Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally.

F. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.6 VOLUME CONTROL DAMPERS

A. Fabricated in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

1. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.

2. Operator: Minimum 3/8 inch square shaft with nylon end bearings at each end to reduce air leakage.

B. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.

C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
D. End Bearings: Except in round ductwork 6 inches and smaller, provide nylon end bearings on each end. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

E. Quadrants:

1. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Regulator shall be equivalent to Sheet Metal Connectors Model RP-3, with heavy-gauge steel regulator, wing nut locking assembly, and stamped dial indicating damper position.
2. On externally insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters to avoid damaging or compression of insulation.
3. Where rod lengths exceed 30 inches, provide regulator at both ends.

F. Remote damper actuators:

1. Provide Young Regulator model 270-896C or equivalent remote volume damper actuator when volume control damper is located above non accessible ceilings. Provide necessary Bowden cable and match manual volume control damper to make for a complete and operable system.

2.7 TAKEOFFS

A. Manufactured high-efficiency takeoff with 45-degree slope on the body, with gauge thickness equal to adjacent ductwork.

3. EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 13 for duct construction and pressure class.

B. Provide duct access doors:

1. For inspection and cleaning before and after filters, coils, fans, automatic dampers.
2. At fire dampers, combination fire and smoke dampers.
3. Elsewhere as indicated on plans.

C. Unless duct access door size is explicitly indicated, provide minimum 24 x 18 inch size duct access doors wherever possible. Provide 18 x 18, 12 x 12 inch or 8 x 8 inch size elsewhere, using the largest size possible.
D. Provide duct test holes where indicated and required for testing and balancing purposes. Install with minimum 24” clear dimension from any side wall or other obstruction.

E. Provide fire dampers, combination fire and smoke dampers and smoke dampers at locations indicated and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

F. Coordinate installation of all fire dampers, combination fire and smoke dampers, and smoke dampers with all other disciplines to ensure a minimum of 24”x24” clear horizontal access area from the ceiling vertically to the damper. The clear access area will be used for the inspection of damper fusible links and damper operators, as well as for the resetting of damper. Clear access areas and appropriate wall/ceiling access panels, if required, shall be clearly shown on the coordination drawings.

G. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.

H. Demonstrate re-setting of fire dampers to Owner's representative.

I. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and supported by vibration isolators. Install flexible connectors with adequate flexibility to allow for all thermal, axial, transverse and torsional movement. Provide airtight seal. For fans developing static pressures of 5.0 inches and over, cover connections with leaded vinyl sheet, held in place with metal straps.

J. Provide balancing dampers at points on supply, return, and exhaust systems where indicated on plans.

K. Provide a high-efficiency takeoff with 45-degree entry for each branch connection.

L. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

M. The use of splitter dampers is not acceptable.

N. Install remote manual volume control damper actuators where the volume damper is not accessible. Install all actuator assemblies serving the same room in the same location above the ceiling and near a return air grille or access panel. Label each actuator with the location of the diffuser or grille that it serves.

1. If an actuator is required to be installed in a ceiling, its location shall be coordinate with the Architect prior to installation and the smallest possible ceiling open and cover shall be provided. Covers should be painted as necessary to match adjacent surfaces.

END OF SECTION 23 33 00
SECTION 23 36 00 - AIR TERMINAL UNITS

1. GENERAL

1.1 SECTION INCLUDES

A. Variable volume terminal units.

B. Integral heating coils.

C. Integral damper motor operators.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of one to 4 inch wg (250 to 1000 Pa).

B. References.

C. Submittals.

D. Project record documents.

E. Operation and maintenance data.

F. Qualifications.

G. Regulatory requirements.

H. Warranty.

1. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

2. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

2. PRODUCTS

2.1 MANUFACTURED UNITS

A. Variable air volume air control terminals for connection to single duct central air systems, with digital variable volume controls.
B. Identify each terminal unit with clearly marked identification label and air flow indicator. Include unit nominal air flow, maximum factory set airflow, minimum factory set air flow, and coil type.

2.2 SINGLE DUCT VARIABLE VOLUME UNITS

A. See Drawings for further information.

B. Basic Assembly:
   2. Liner: Fiber-free internal liner.
   3. Air Outlets: S slip and drive connections.

C. Basic Unit:
   2. Volume Damper: Construct of steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 4 percent of design air flow at three (3) inches inlet static pressure.
   3. Mount damper operator to position damper normally open or normally closed as required by the operation sequence.
   4. On units with heating coils, provide hinged and gasketed access door on bottom of unit to facilitate coil inspection.

D. Hot Water Heating Coil:
   1. Coils will be provided separately from the box.

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide ceiling access doors or locate units above easily removable ceiling components. In no instance shall units be installed in inaccessible locations.

C. Support units individually from structure. Do not support from adjacent ductwork.

D. Connect to ductwork in accordance with Section 23 31 13.

E. Verify that electric power is available and of the correct characteristics.

F. Maintain a minimum of 18” clearance in front of VAV controller.
AIR TERMINAL UNITS

3.2 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation as indicated on equipment schedule.

END OF SECTION 23 36 00
SECTION 23 37 00 - AIR OUTLETS AND INLETS

1. GENERAL

1.1 SECTION INCLUDES

A. Diffusers.

B. Registers/grilles.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.
   1. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.
   2. Test and rate louver performance in accordance with AMCA 500. Submit AMCA certification with submittal.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents.
   1. Record actual locations of valves.

F. Delivery, storage, and handling.

2. PRODUCTS

2.1 CEILING DIFFUSERS

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

D. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule.

2.2 WALL REGISTERS AND GRILLES

A. General: Except as otherwise indicated, provide manufacturer’s standard wall registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide wall registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer’s current data.

C. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

D. Types: Provide wall registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule.

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with adjustable elbow. Install maximum length of 5’ of flexible duct upstream of each diffuser and grille, unless otherwise noted. See details on Drawings. All connections shall be air tight.

D. In laboratories with ventilated workstations, position diffusers so that airflow is directed parallel to the front of the workstation, not perpendicular to it.

E. Where diffusers are located near fume hoods, canopy hoods, biological safety cabinets, or other devices which are sensitive to air turbulence, install diffuser to direct airflow parallel to the front face of the device (i.e. not directed at device).
F. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly. Where a balancing damper has been omitted from drawing, consult engineer.

G. Paint ductwork visible behind air outlets and inlets matte black.

H. Provide return air sound boot on grilles as shown on drawings.

I. Where slot diffusers or linear diffusers are located near perimeter windows, adjust at least one slot to direct air toward window.

END OF SECTION 23 37 00
SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1—specification sections, apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. The work included under this Section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete electrical systems required by these specifications and/or shown on the drawings of the contract.

B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, conduit, and outlets. Follow the drawings in laying out the work and verify spaces for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of outlets or equipment, obtain instructions from the Engineer before proceeding with the work.

1.3 QUALITY ASSURANCE

Installers shall have at least 2 years of successful installation experience on projects with electrical installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for satisfactory operation.

1.4 REFERENCES

A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall conform to the following codes, standards and regulations, etc.:

1. Safety and Health Regulations for Construction.
2. Occupational Safety and Health Standards, National Consensus Standards and Established Federal Standards.
5. National Electric Manufacturer's Association (NEMA).
6. Institute of Electrical and Electronic Engineers (IEEE).
8. Insulated Cable Engineers Association (ICEA).
12. Factory Mutual Engineering Corporation or other recognized National Laboratories.

B. The latest adopted edition by the local and state inspection authorities of all standards and specifications listed above shall apply.

C. Furthermore, the electrical work shall be in accordance with all applicable National and State Standards, and Local Codes and Building Ordinances. The electrical work shall merit the approval of the enforcing authorities having jurisdiction.

1.5 MATERIALS AND EQUIPMENT

A. Electrical materials and equipment for the entire project shall meet the requirements specified under the Supplementary Conditions Section of this specification.

B. Equipment and fixtures shall be connected to provide circuit continuity in accordance with applicable Codes whether or not each piece of conductor, conduit, or protective device is shown between such items of equipment or fixtures and the point of circuit origin.

C. The electrical work includes the installation or connection of certain materials and equipment furnished by others. Verify all connection details.

D. All equipment over 50 pounds shall be provided with adequate lifting means.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 ACCESS TO EQUIPMENT

A. Starters, switches, receptacles, pull boxes, etc. shall be located to provide easy access for operation, repair and maintenance. If the devices listed above are concealed, access doors shall be provided.

3.2 SUBMITTALS

A. Test Reports: Provide the tests as outlined in this specification and all other tests necessary to establish the adequacy, quality, safety, completed status, and suitable operation of each electrical system. Provide the Engineer with a complete schedule of all tests.

1. Ground Rod Test: Immediately after installation, test driven grounds and counterpoises with a ground resistance direct-reading single-test megger, using the AC fall-of-potential method and two reference electrodes. Orient the ground to be tested and the two reference electrodes in a straight line spaced 50 feet apart. Drive the reference electrodes five feet deep. Disconnect the ground rod to be tested from other ground systems at the time of testing. The ground resistance for the electrical service must be 15 Ohms or less. Submit the results, date of test, and soil conditions to the Engineer in writing immediately after testing.
2. Final Tests: Start final tests after complete preliminary tests have been made which indicate adequacy, quality, completion, and satisfactory operation of all electrical systems. Included in these tests are the following:

a. Completion of the form "Electrical Test Report" (attached to the end of this specification section) in sufficient quantity to provide the indicated information for each panelboard and switchboard in the project.
b. Completion of the form "Motor Test Report" (attached to the end of this specification section) in sufficient quantity to provide the indicated information for all three phase motors.

3. The Contractor shall submit the above completed reports to the Engineer, noting all deviations from the requirements listed below:

a. Plus or minus five percent variation between nominal system voltage and no load voltage, or plus or minus five percent variation between no load and full load voltage.
b. Plus five-percent variation between rated and actual motor current.
c. Plus or minus ten percent variation between average phase current and measured individual phase current. The Contractor shall balance phase currents of all distribution equipment within the tolerances specified.
d. Insulation resistance between conductors and ground of not less than 1,000,000 Ohms.

4. Final Corrections: Correct promptly any failure or defects revealed by these tests as determined by the Engineer. Reconduct tests on corrected items as directed by the Engineer.

B. Operation and Maintenance Manuals: Operation and Maintenance Manuals shall be provided according to Division 1 requirements. In general, during the time of the contract, and before substantial completion of the electrical installation, submit to the Engineer the number of copies described in the Division 1 specifications and the General and Supplemental Conditions copies of descriptive literature, maintenance recommendations (from the equipment manufacturer), data on initial operation, wiring diagrams, performance curves, engineering data and tests, operating procedures, routine maintenance procedures, and parts lists for each item of electrical equipment installed under this contract and submit all manufacturer's guarantees and warranties.

C. Shop Drawings: The Contractor shall furnish shop drawing portfolios and proper transmittal forms for all materials, equipment, and lighting fixtures to be incorporated in the work in accordance with the General Conditions, Supplementary Conditions, and all other applicable Conditions.

1. Shop drawings on component items forming a system or that are interrelated shall be submitted at one time as a single submittal in order to demonstrate that the items have been properly coordinated and will function properly as a system. A notation shall be made on each shop drawing submitted as to the item's specific use, either by a particular type number referenced on the drawings or in the specifications, by a reference to the
applicable paragraph of the specifications, or by a description of its specific location. The shop drawings shall be organized and bound into sets with each set collated.

2. The Engineer shall have the final authority as to whether the equipment or material submitted is equal to the specified item. Proposed substitutions may be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions are rejected, the Contractor shall furnish the specified item.

D. A coordination study shall be provided by the contractor for this project. The study shall include maximum short circuit calculations, a complete coordination analysis, and settings for all protective devices with adjustable set points. The protective device settings must address the need to minimize arc flash hazards while maintaining proper system coordination. The coordination study shall be based on the specific devices installed and include (but not be limited to) the following:

1. Service Entrance Equipment.
   a. All overcurrent protective devices installed in service entrance panels/switchboards.

2. Feeder Circuits.
   a. All three (3) phase feeder circuit overcurrent protective devices.

   a. All three (3) phase branch circuit overcurrent protective devices. installed with a rating equal to or greater than 30 amps.
   b. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.

4. Motor Control Centers
   a. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.

5. Format
   a. The preliminary coordination study should be submitted to the Owner’s Representative no later than six (6) weeks after overcurrent protective device shop drawings have been reviewed.
   b. The coordination study shall be reviewed and updated to reflect any changes within one week of the final electrical walk through for project.
   c. The low voltage coordination study shall include the stamp or seal and signature of the preparing engineer, and shall be reviewed by the Engineer of Record.
   d. A complete set of manufacturers’ descriptive literature and detailed instructions for adjusting overcurrent protective devices shall be provided to the Owner’s Representative within six (6) weeks after overcurrent protective device shop drawings have been approved.
e. The low voltage coordination study shall be provided using the SKM Systems Analysis, Inc SKM Power Tools Electrical Engineering Software (PTW 32).
f. Prior to project completion, the low voltage coordination study shall be provided to the Owner’s Representative in both hard copy and on computer disk. The hard copy shall include time current curves (for phase and ground fault settings) for each panel and the corresponding TCC report clearly showing each device set point. The computer disk shall include the complete coordination file including all device curves (use the SKM “Project - Backup” command).

E. All overcurrent protective devices feeding the emergency system(s) shall be selectively coordinated in accordance with the applicable version of NEC article 700. Selective coordination is required to the 0.10 second level. At least one manufacturer’s equipment has been evaluated during design to ensure selective coordination. If an equipment manufacturer has a conflict with selective coordination they shall bring this to the attention of the design engineer a minimum of 10 business days prior to the bid date.

F. A low voltage Arc Flash Hazard Analysis shall be provided by the contractor for this project. The analysis shall be based on the specific equipment installed, and shall be updated to include project “as built” documentation. Where the arc flash hazard/risk category is equal to or greater than level 3, the overcurrent protective device coordination study shall be reviewed and recommendations shall be provided to reduce the hazard/risk level. The analysis shall be based on the specific devices installed and include (but not be limited to) the following:

1. Service Entrance Equipment.
   a. All overcurrent protective devices installed in service entrance panels/switchboards.

2. Feeder Circuits.
   a. All three (3) phase feeder circuit overcurrent protective devices.

   a. All three (3) phase branch circuit overcurrent protective devices installed with a rating equal to or greater than 30 amps.
   b. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.

   a. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.

5. The project shall include printed waterproof labels for equipment that lists the specific arc flash hazard/risk category at each location.
6. Format

a. A preliminary Arc Flash Hazard Analysis should be submitted to the Owner’s Representative no later than six (6) weeks after the overcurrent protective device shop drawings have been reviewed.

b. The Arc Flash Hazard Analysis shall be reviewed and updated to reflect any changes and corrections to conductor length within one week of the final electrical walk through for the project.

c. The low voltage arc flash hazard analysis shall include the stamp or seal and signature of the preparing engineer, and shall be reviewed by the Engineer of Record.

d. Owner approved waterproof Arc Flash Hazard warning labels shall be furnished and installed prior to project completion. Coordinate label requirements with the owner.

e. The low voltage arc flash hazard analysis shall be provided using the SKM Systems Analysis, Inc SKM Power Tools Electrical Engineering Software (PTW 32).

f. Prior to project completion, the low voltage arc flash hazard analysis shall be provided to the Owner’s Representative in both hard copy and on computer disk. The hard copy shall clearly show each device set point. The computer disk shall include the complete coordination file including all device curves (use the SKM “Project - Backup” command).

3.3 EXISTING UTILITIES

A. The Contractor shall verify the location of all existing utilities with the Owner and Utility providers prior to commencing excavation work. In addition, the contractor is responsible for locating and maintaining all existing utilities without damage. Fully coordinate all new underground utility work with existing utilities on the site. The drawings and survey data of the contract documents indicate the available information on the existing power and communication services, and on new services to be provided to the project by utility provider. Accuracy of this information is not assured.

3.4 SMOKE AND SMOKE/FIRE DAMPERS

Provide all necessary duct detectors for smoke and smoke/fire dampers. In addition, provide all necessary connections, including power supply circuits (fed from the nearest panelboard, emergency if available, of the appropriate voltage unless indicated otherwise on the drawings) to smoke dampers and smoke/fire dampers so that upon fire alarm conditions or integral smoke detector activation, the dampers close. Coordinate damper and control locations with the mechanical and controls contractors. Refer to the mechanical drawings for damper schedule and locations.

3.5 ELECTRICAL PRODUCT COORDINATION

A. Refer to Division 2 through Division 32 and the electrical drawings for the power characteristics required and available for the operation of each power-consuming item of equipment. Coordinate purchases to ensure uniform interface with every item requiring electrical power.
3.6 CUTTING AND PATCHING

A. The Electrical Contractor shall be responsible for all cutting and patching of holes in building construction which are required for the passage of electrical work. Cutting and patching shall conform to the requirements of Division 1 and, if applicable, Division 2 of these specifications.

B. Cutting of structural framing, walls, floors, decks and other members intended to withstand stress is not permitted.

3.7 PAINTING, FINISHING

A. Painting of electrical work exposed in occupied spaces, except mechanical and electrical machine rooms and maintenance/service spaces; and work exposed on the exterior of the facility is specified and performed under other divisions of these specifications.

B. Factory finishes, shop priming, and special protective coatings are specified in the individual equipment specification sections.

C. Where factory finishes are provided on equipment and no additional field painting is specified, all marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish at the time of final inspection.

3.8 EXCAVATION AND BACKFILLING

A. Contractor shall perform all excavation and backfilling necessary to install the required electrical work. Coordinate the work with other excavating and backfilling work in the same area. Except as indicated otherwise, comply with the applicable sections in Division 31 of these specifications, excavation filling and backfilling (for structures) to 5’ outside the building line, and exterior utilities sections for beyond 5’ from the building line.

B. Landscape work, pavement, flooring and similar exposed finish work that is disturbed or damaged by excavation shall be repaired and restored to their original condition by the Contractor.

3.9 CONDUITS AND SUPPORT, GENERALLY

A. Conduits, except electrical conduits run in floor construction, shall be run parallel with or perpendicular to lines of the building unless otherwise noted on the drawings. Electrical conduits shall not be hung on hangers with any other service, unless specifically approved by the Engineer. Electrical conduits shall be hung above all other service pipes. Hangers on different service lines running close to and parallel with each other shall be in line with each other and parallel with, or perpendicular to, the lines of the building. Exact location of electric outlets, piping, ducts, and the like shall be coordinated to avoid interferences between lighting fixtures, piping, ducts, and similar items.
3.10 ACCESS PANELS

A. Furnish and install panels for access to junction boxes and similar items where no other means of access, such as a readily removable, sectional ceiling is shown or specified.

B. Panels shall not be less than 12-inches by 16-inches in size. Larger panels shall be furnished where required. Panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

1. Refer to Section 08 31 13 – Access Doors and Panels for specific information on type and size of panels

3.11 INSTALLATION OF EQUIPMENT

A. Install and connect all appliances and equipment as specified and indicated for this project, in accordance with the manufacturers’ instructions and recommendations. Furnish and install complete electric connections and devices as recommended by the manufacturer or required for proper operation.

3.12 ELECTRICAL DEMOLITION

A. Refer to Division 01 Sections for general demolition requirements and procedures.

B. Refer to the drawings for additional demolition requirements.

C. Disconnect, demolish, and remove electrical systems, equipment and components specified under Divisions 26, 27 & 28 and as indicated on the drawings.

1. For conductors serving devices shown to be removed: Disconnect the device and remove all conduit and conductors back to the panel or to the next device shown to remain or as required by actual circuiting.

2. Coordinate all phasing and related electrical system outages with the Owner and all other disciplines.

3. For mechanical equipment indicated shown to be removed on either the mechanical and/or the electrical plans: Disconnect the equipment and remove all conduit, conductors and associated electrical supply equipment. Remove conduit and conductors back to the panel or the next device shown to remain or as required by actual circuiting.

3.13 COORDINATION

A. Coordinate the electrical work with work of the different trades so that:

1. Interferences between mechanical, electrical, architectural, and structural work, including existing services, will be avoided.

2. Within the limits indicated on the drawings, the maximum practicable space for operation, repair, removal and testing of electrical and other equipment will be provided.

3. Pipe, conduits, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes, conduits, ducts, and
similar items shall be located so that they will not interfere with the intended use of other equipment.

B. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.

C. Before any sleeves or inserts are set, or any electrical equipment or foundations are installed, prepare and submit for approval composite coordination drawings for all equipment rooms, and other areas in which work of two or more trades or subcontractors is to be installed and in which the probability of interference exists. Drawings shall show the work of all trades covered, shall be drawn to a scale not smaller than 1/2" = 1'-0", and shall show clearly in both plan and elevation that all work can be installed without interference.

D. Any work installed prior to approval of coordination drawings shall be at the Contractor's risk. Subsequent relocations required to avoid interference's shall be made without additional expense to the Owner.

3.14 SINGULAR NUMBER

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

3.15 WARRANTY

A. Refer to the General Conditions section of this Specification for warranty requirements and information.

3.16 CLOSE OUT AND OPERATION INSTRUCTIONS

A. Sequence operations properly so that all work of this project will not be damaged or endangered. Operate each item of equipment and each system in a test run of appropriate duration to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance.

B. Conduct a full-day walk-through instruction seminar for the Owner's personnel to be involved in the continued operation and maintenance of electrical equipment and systems. Explain the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, security, safety, efficiency and similar features of the systems.

C. At the time of substantial project completion, turn over the prime responsibility for operation of the electrical equipment and systems to the Owner's operating personnel. Until the time of final acceptance, provide full time operating personnel, who are completely familiar with the work, to consult with and continue training the Owner's personnel.
SUBSTITUTIONS

D. All proposals shall be based on providing and installing the materials or items of equipment which are hereinafter specified by name and/or manufacturer. Substitutions, for materials or items of equipment specified, will not be allowed, unless approved by Engineer prior to (14 days before) bid date.

E. Refer to Instructions to Bidders for complete requirements for substitutions.

3.17 AS-BUILT DRAWINGS

A. Contractor shall provide the Owner with as-built drawings for all electrical systems as described in these specifications and/or shown on the Drawings.

END OF SECTION 26 05 00
## MOTOR TEST REPORT

**DATE:** __________________________  
**SHEET NO. _______ OF ________**

**PROJECT NAME:** ____________________________________________________________  
**PROJECT NUMBER:** __________________________________________________________

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**COMMON WORK RESULTS FOR ELECTRICAL**

26 05 00- 11
# ELECTRICAL TEST REPORT

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**SHEET NO. ______ OF ________**

**PROJECT NAME:**

**PROJECT NUMBER:**

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**COMMON WORK RESULTS FOR ELECTRICAL**

26 05 00- 12
SECTION 26 05 01- BASIC MATERIALS AND METHODS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. The extent of Basic Materials and Methods is indicated by the drawings and specifications. Basic materials are defined but not limited to cable and conduit seals, outlet boxes, pull boxes, conduit fittings, safety switches, and fuses.

1.3 QUALITY ASSURANCE

A. Manufacturers: All materials shall be new, unused, and unweathered, and of the quality specified. Materials shall be standard products of manufacturer's regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design.

B. Installer: All equipment and materials shall be installed in a neat and workmanlike manner, shall be complete in both effectiveness and appearance, whether finally concealed or exposed and shall be executed by experienced mechanics.

1.4 REFERENCES

A. The electrical work shall conform to all applicable sections of standards, codes and specifications promulgated by organizations listed below.

1. Occupational Safety and Health Standard, National Consensus Standards and Established Federal Standards

2. National Electrical Code (NEC)

3. National Electric Manufacturer's Association (NEMA)

4. American Society for Testing of Materials (ASTM)

5. Underwriters Laboratories, Inc. Standards (UL)

6. Factory Mutual Engineering Corporation or other Recognized National Laboratories
1.5 SUBMITTALS

A. Shop drawings: Prepare a set of shop drawings showing manufacturers product data for all component parts specified in this Section.

2. PRODUCTS

2.1 Equipment and Materials Furnished by Others: Certain materials and equipment for this project will be furnished under other divisions. These materials and equipment, which are shown or noted on the plans, will be installed and/or connected under this Division. It shall be incumbent upon this Contractor to become familiar with all of the materials and equipment that will be furnished under other Divisions, but which will be installed and/or connected under this Division.

2.2 Cable and Conduit Seals: Seals shall be provided around all conduits and cables which penetrate smoke walls, fire walls, and floors. Nelson Flameseal System shall be used to seal penetrations of electrical cables and conduits.

A. Materials used shall be flameseal putty, ceramic fiber insulation and where rigid support on large oversized openings is required, ceramic fiber board. Board shall be rigid and able to withstand temperatures in excess of 2000 degrees F.

B. Accessory hardware shall be provided as required on oversized openings.

C. Follow manufacturers instructions in selecting the type of seals and accessories. Also follow the manufacturers instructions on installation of the cable and conduit seals. Equal quality equipment by OZ Gedney and 3M shall be acceptable.

2.3 Outlet Boxes, Pull Boxes and Conduit Fittings: Furnish and install outlet boxes, pull boxes, and conduit fittings as described below. Catalog numbers shown are Appleton Electric Company; Steel City, O.Z. Gedney, and Raco, are equally acceptable.

A. OUTLET BOXES

1. Lighting Boxes (concealed) No. 40-3/4
2. Lighting Boxes (concrete) OCR Series
3. Lighting Boxes (exposed) 4S-3/4 or 40-3/4
4. Flush Switches, Receptacles and Flush Junction Boxes No. 4S-3/4 with separate extension plaster ring; M"-250 in masonry construction (* refers to number of devices in the box)
5. Weatherproof type Switch, Receptacle and Telecommunications Boxes (exposed) FS Series w/FS cover and neoprene gasket.

6. Switch, Receptacle and Telecommunications Boxes (exposed) 4S-3/4 with 8360 or 8370 series raised surface cover.

7. Telecommunications Boxes
   a. At minimum, the typical communications backbox shall be 4-11/16-inch square by 2-1/8-inch deep with 1-1/4-inch knockouts and a 4-11/16-inch Square Mud-Ring for one (1) device (single-gang) unless noted otherwise.
   b. For outlets in stud wall, Manufacturer shall be:
      1) RACO/Hubbel Electrical Products – 4-11/16-inch Square Box, 2-1/8-inch Deep, 1-1/4-inch Side Knockouts. (P/N RACO259) with 4-11/16-inch Square Mud-Ring for one (1) device (verify appropriate Mud-Ring depth).
      2) Randl Industries, Inc. – 5-square Telecommunications Outlet Box (P/N T55017) with appropriate mud-ring.
      3) Or approved equivalent.
   c. For outlets in CMU wall, submit appropriate backbox for application.
   d. For outlets above ceiling for applications such as Wireless Access Points
      1) Grainger Single-gang Galvanized Steel Box (P/N 2DDB6) with Grainger 3/4" nipple (P/N 1UGX5), two (2) Grainger 3/4" lock nuts (P/N 5XC31) and a Grainger 3/4" plastic bushing (P/N 5XC35).
      2) Or approved equivalent.

B. Extension and plaster rings shall be installed as required by the NEC.

C. Outlet boxes shall comply with the National Electrical Code in regard to the allowable fill.

2.4 PULL BOXES

A. Pull boxes shall be fabricated of code gauge galvanized sheet metal and shall be sized in accordance with the National Electrical Code requirements or as shown on the drawings. Provide removable cover on the largest access side of the box. In-line conduit pull boxes may be O.Z., Type PBW, or equal. Provide pull boxes at all code required locations, and as needed to aid in cable pulling.

2.5 SAFETY SWITCHES
A. Furnish and install heavy duty type safety switches, having the electrical characteristics, ratings and modifications shown on the drawings. All switches shall have:

B. NEMA 1 general purpose enclosures unless otherwise noted for all interior applications;

C. NEMA 3R rainproof enclosures unless otherwise noted for all exterior applications;

D. NEMA 4/4X stainless steel enclosures unless otherwise noted in all animal holding, cage wash rooms, treatment rooms and kitchens;

E. Fully rated neutral assemblies;

F. Equipment grounding kits;

G. Metal nameplates, front cover mounted that contain a permanent record of switch type, catalog number and H.P. ratings with both standard and time delay fuses;

H. Handle that is padlockable in "OFF" position;

I. Non-teasable, positive quick-make, quick-break mechanism;

J. UL approval and shall bear the UL label;

K. All fusible switches shall have Class R Fuse rejection clips.

L. Safety switches, as manufactured by the following, will be equally acceptable, but all safety switches furnished by this Contractor shall be the product of one manufacturer:

1. Square D Company
2. General Electric
3. Cutler Hammer
4. Siemens

2.6 FUSES

A. Fuses shall be furnished and installed in each fused switch, and shall be rated as shown on the drawings.

B. Provide fuses according to the following and in accordance with recommendations of manufacturers whose equipment is being protected:
1. Provide UL Class L current limiting time-delay fuses rated 600-volts, 60 Hz, 601 to 6000 amps, with 200,000A RMS symmetrical interrupting current rating for protecting transformers, motors and circuit breakers. (Similar to Buss Low-Peak fuses.)

2. Provide UL Class L current limiting fast-acting fuses rated 600-volts, 60 Hz, 601 to 6000 amps, with 200,000A RMS symmetrical interrupting current rating for protecting service entrances and main feeder circuit breakers. (Similar to Buss Limitron fuses.)

3. Provide UL Class RK1 current limiting, dual-element, time-delay fuses rated 600-volts, 60 Hz, 1/10 to 600 amps, with 200,000A RMS symmetrical interrupting current rating for protecting motors and circuit breakers. (Similar to Buss Low-Peak fuses.)

4. Provide UL Class RK1 current-limiting fuses rated 250-volts, 60 Hz, 1/10 to 600 amps, with 200,000A RMS symmetrical interrupting current for protecting motors and circuit breakers. (Similar to Buss Low-Peak fuses.)

5. Provide UL Class J current-limiting fuses rated 600-volts, 60 Hz, 1 to 600 amps, with 200,000A RMS symmetrical interrupting current rating for protecting circuits with no heavy inrush current where reduced dimension devices are required.

6. Provide UL Class H fuses rated 600-volts, 60 Hz, 1/10 to 600 amps, with 10,000A RMS symmetrical interrupting current rating for protecting general purpose light duty feeders.

7. Provide UL Class T fuses rated 600-volts, 60 Hz, 1 to 1,200 amps, with 200,000A RMS symmetrical interrupting current rating for protection of non-motor loads where reduced dimension devices are required.

C. Three spare fuses shall be furnished for each size and type used. Each fused switch shall be provided with a mastic backed label clearly identifying the type and size of fuse required.

3. EXECUTION

3.1 PRODUCT INSTALLATION, GENERAL

A. Except where more stringent requirements are indicated, comply with product manufacturer’s installation instructions and recommendations, including handling, anchorage, assembly, connections, cleaning and testing.

3.2 MOUNTING HEIGHTS

A. Mounting heights to the center of the box above finished floor for the items listed below shall be as follows, unless otherwise shown. All other device mounting heights shall be as shown on the drawings. All devices shall be mounted in accordance with ADA (Americans with Disabilities Act) requirements.
B. Flush tumbler switches 48"
C. Switches in concrete block 46"
D. Switches over wainscot 6" above 48" wainscot
E. Convenience outlets 18" mounted vertically with ground prong slot at bottom
F. Safety switches 54"
G. Motor controllers 54"
H. Panelboards to top 72"
I. Telecommunications outlets 18"
J. Telecommunications outlets (pay and wall type) 54" for non-ADA type 44" for ADA type
K. Clock outlets 8' ceiling 84" 9' ceiling 96"
L. Receptacles above counters 8" above counters mounted vertically
M. Convenience outlets in mechanical, electrical, telecommunications, janitor and elevator machine rooms 48"
N. Exterior W.P. convenience outlets 24" above grade mounted
O. Fire alarm pull station 48"
P. Fire alarm horn, speaker, bell chime And/or strobe 84"
Q. Intercom System Pushbutton Stations 48"
R. Card Readers 48"
S. Contractor shall check all equipment layouts and verify exact mounting heights.

3.3 CUTTING AND PATCHING FLOORS, WALLS OR CEILINGS

A. Cutting, patching, repairing, and finishing of carpentry work, metal work, or concrete work, etc., which may be required for this work shall be done by craftsmen skilled in their respective trades. When cutting is required, it shall be done in such a manner as not to weaken walls, partitions, or floors. Holes required to be cut in floors must be drilled without breaking out around the holes. Cutting, patching, and painting shall conform to the requirements of the General Conditions section of this Specification.

B. Cutting of structural framing, walls, floors, decks, or other members intended to withstand stress is not permitted.

C. Sleeves through floors or walls shall be black iron pipe and shall be flush with finished faces of floors, walls or ceilings. Sleeves shall be sized to accommodate raceways indicated.

D. Use care in piercing waterproofing. After the part piercing the waterproofing has been set in place, seal openings, and make absolutely watertight.

3.4 SLEEVES

A. Sleeves shall be used to accommodate conduit or tubing where conduit or tubing pass through newly poured concrete walls or slabs.

B. All sleeves through floors and walls shall be black iron pipe, flush with walls or finished floors; and of sizes to accommodate the raceways shown. Sleeves through outside walls above grade shall be caulked with approved caulking compound. Sleeves shall not be required through on grade slabs.

C. For raceways which enter buildings below grade, install manufactured floor and thruwall seals, similar to Type "FSK" or "WSK" as manufactured by O.Z. Electric Manufacturing Co.

3.5 INSTALLATION METHODS

A. Conductors shall be installed in concealed raceways except as shown otherwise on the drawings or specified to be otherwise in these specifications. Exposed conduits and wires shall be installed parallel or perpendicular to building surfaces and shall be painted to match building surface. Conduits and wires in the space above ceilings shall be supported adequately and shall not be laid on the top of ceiling systems. Conduits and wires installed above ceilings shall be considered exposed.

B. Electrical conduits shall not be hung on hangers with any other service foreign to the electrical systems, nor shall they be attached to other foreign services.
C. The lighting and power branch circuit conductors shall be installed in separate raceway systems unless specifically shown or noted otherwise.

D. Equipment Bases. Provide concrete equipment bases for all floor mounted equipment furnished under this contract. Concrete bases shall be 3-1/2"-inches high unless noted otherwise and shall extend 3-inches beyond all sides of the unit. Trowel all edges at a 45 degree angle. This work shall be done in accordance with Division 3 of the specifications by the Division 26 Contractor. Bases shall be provided for switchboards, motor control centers, transformers and all other floor mounted equipment.

E. Outlet Box Locations. Outlet boxes shall be located so they are not placed back-to-back in the same wall, and in metal stud walls, are separated by at least one stud space in order to limit sound transmission from room to room. Outlet boxes installed on opposite sides of fire rated walls shall be spaced at least 24" apart.

3.6 WIRING - NUMBER OF WIRES REQUIRED

A. The number of wires for lighting and receptacle branch circuits is shown on the drawings. The number of wires in any circuit is determined in accordance with the National Electrical Code, and wiring is provided to perform all functions of the devices being installed. Additionally, wires shall be provided as required by the contract documents, i.e. equipment grounds, etc. Provide the number of wires required for a complete and workable system.

3.7 PROTECTION FROM WEATHER

A. Raceway stub ups shall be capped or otherwise protected from moisture and debris until such time that the conductors are pulled. Conductors shall not be installed in raceways until the building is protected from the weather, all concrete and plastering is completed, and raceways in which moisture has collected have been swabbed or blown out.

3.8 ELECTRICAL ROOM COORDINATION

A. Where a number of electrical panels and/or related electrical items are shown, the Electrical Contractor shall coordinate the physical sizes with his equipment suppliers to ensure that there is adequate space for the items shown to be installed in those areas and that all Code required clearances are maintained.

B. The Contractor shall rearrange the equipment layout to achieve full use of the available space prior to installing conduit stub ups. Where a conflict or rearrangement exists, the Contractor shall submit a proposed revised layout of the area to the Engineer.

3.9 NAMEPLATES

A. Nameplates shall be provided for all items such as panelboards, cabinets, motor controllers (starters), safety switches, separately enclosed circuit breakers, individual breakers and
controllers in switchboards and motor control centers, control devices and other significant equipment

B. Nameplates shall be 1"x 2-1/2" laminated black phenolic resin with a white core with engraved lettering, a minimum of 3/16-inch high. Manufacturers factory installed nameplates shall be acceptable provided all information is furnished.

C. Nameplates shall identify the equipment item that the device is serving and also from where the device is being fed from. Nameplates shall also identify the system voltage of the item of equipment.

3.10 RACEWAY SUPPORTS

A. Raceways shall be securely supported and fastened in place with pipe straps, wall brackets, caddy clips, hangers or trapeze hangers at intervals specified in Section 260533 "RACEWAYS" or:

1. As shown on the drawings.

2. As may be required by special adverse field conditions.

B. Spring tension clamps on building steel work may be used only by special permission.

C. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws or welded threaded studs on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine wood screws. Threaded C-clamps shall not be used. Raceways or pipe straps shall not be welded to steel structures. Holes cut in reinforced concrete beams or in concrete joists shall avoid cutting the main reinforcing bars. Holes not used shall be filled. In partitions of light steel construction, sheet-metal screws may be used, and bar hangers may be attached with saddle ties of not less than No. 16 AWG double strand zinc-coated steel wire. No raceway shall be attached to the suspended ceiling construction. Conduits shall be fastened to all sheet-metal boxes and cabinets with two locknuts and insulating bushings.

3.11 BOX SUPPORTS

A. Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel work. Plastic expansion shields shall not be used. Threaded studs driven in by powder charge and provided with lockwashers and nuts may be used in lieu of wood screws, expansion shields, or machine screws. In open overhead spaces, cast metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Raceways shall be supported with an approved type fastener not
more than 24-inches from the box. Penetration into reinforced concrete beams and into reinforced-concrete joists shall avoid cutting any main reinforcing steel.

3.12 LIGHTING FIXTURE SUPPORTS

A. Lighting fixtures shall be supported as follows and in accordance with all applicable Codes and Regulations:

1. By fixture studs or other devices securely attached to outlet box, or;

2. By special hangers designed and intended for use as lighting fixture supports, or;

3. By a special clip or device attached to the ceiling system grid designed to secure the lighting fixture in place or;

4. By other methods and devices designed and intended for use as lighting fixture support, or;

5. As shown on the drawings.

6. All lighting fixtures installed in grid type suspended ceiling systems, shall be positively attached to the ceiling system with clips that are UL listed for the application. In addition, a minimum of four (4) ceiling support system rods or wires shall be provided for each light fixture and shall be installed not more than six (6) inches from fixture corners. Provide two (2) No. 9 gage hangers from each fixture housing to the building structure above (wires may be installed slack). Light fixtures that weigh more than 56 pounds shall be supported directly from the structure above by UL listed and approved hangers. Light fixtures that are smaller than the ceiling grid shall be installed at locations indicated on the reflected ceiling plans, or shall be installed in the center of the ceiling panel and shall be supported independently by at least two metal channels that span and are secured to the ceiling system.

7. Suspended lighting fixtures shall be supported directly from the building structure without using suspended ceilings as support systems. Support systems shall be UL listed and approved for the specific installation. Where pendants or rods exceed 48 inches in length, brace support systems to limit swinging

B. The lighting fixture support system detail shall be submitted with and be a part of the lighting fixture shop drawing submittal.

C. Lighting fixtures shall not be supported from the leg of pre-cast pre-stressed concrete.

END OF SECTION 26 05 01
SECTION 26 05 19 – LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work in this Section.

B. This Section is a Division 26 "Basic Materials and Methods" section, and is part of each Division 26 section making reference to conductors.

1.2 Description of Work: Extent of electrical wire and electrical cable work is indicated by drawings and schedules. Types of wire, cable and connectors in this Section include the following:

A. Conductors

B. Power-limited circuit cable

C. Service entrance cable

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of electric wire and cable products of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer: Qualified with at least 3 years of successful installation experience on projects with electrical wiring work similar to that required for this project.

1.4 REFERENCES

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wire, cable and connectors.

B. UL Compliance: Comply with UL standards pertaining to wire cable and connectors.

C. UL Labels: Provide electrical wires, cables and connectors which have been UL-listed and labeled.

D. NEMA/ICEA Compliance: Comply with applicable portions of NEMA/Insulated Cable Engineers Association Standards pertaining to materials, construction and testing of wire and cable.
E. ANSI/ASTM: Comply with applicable portions of ANSI/ASTM standards pertaining to construction of wire and cable.

F. IEEE Compliance: Comply with applicable portions of IEEE standards pertaining to wire and cable.

G. NECA Compliance: Comply with NECA's "Standard of Installation."

1.5 SUBMITTALS

A. Submit manufacturer's data on electric wire and cable.

2. PRODUCTS

2.1 Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of wire, cable and connector):

A. WIRE AND CABLE:

1. Advance Wire and Cable, Inc.
2. Cerro Wire and Cable, Co.
3. Electrical Conductors, Inc.
4. General Cable Corp.
5. Hitemp Wires, Inc.
6. Rome Cable Corp.
7. Southwire Company
8. The Okonite Company

B. CONNECTORS:

1. Amp, Inc.
2. Burndy Corp.
5. Ideal Industries, Inc.
7. O-Z/Gedney Co.
8. Pyle National Co.
9. Thomas and Betts Co.

2.2 WIRE, CABLE, AND CONNECTORS

A. General: Except as otherwise indicated, provide wire, cable and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, and as required for the installation.
B. WIRE:

1. All conductors shall be 600-volt and shall be copper, soft drawn, annealed, having a conductivity of not less than 98% pure copper with dual rated type THHN/THWN insulation unless otherwise specified or indicated on the drawings.
2. Minimum insulation rating is 90 degrees Celsius.
3. No wire shall be smaller than No. 12 AWG, except wiring for signal and pilot control circuits, and pre-manufactured fixture whips for light fixtures.
4. All wire No. 12 AWG shall be solid unless otherwise indicated within these specifications. All wire No. 10 AWG and larger shall be stranded.
5. All wiring installed in light poles or other areas subject to vibration shall be stranded.
6. Wire sizes shown are minimum based on code requirements, voltage drop and/or other considerations. Larger sizes may be installed at the Contractor's option to utilize stock size, provided conduit sizes are increased where necessary to conform to the National Electrical Code. Sizes of wires and cables indicated or specified are American Wire Gage (Brown and Sharpe).
7. All feeder and branch circuit wiring shall be color-coded as follows:

<table>
<thead>
<tr>
<th>PHASE</th>
<th>120/208 VOLT</th>
<th>277/480 VOLT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Black</td>
<td>Brown</td>
</tr>
<tr>
<td>B</td>
<td>Red</td>
<td>Orange</td>
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<tr>
<td>C</td>
<td>Blue</td>
<td>Yellow</td>
</tr>
<tr>
<td>Neutral</td>
<td>*White</td>
<td>*White</td>
</tr>
<tr>
<td>Ground</td>
<td>Green</td>
<td>Green</td>
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* CONNECTIONS

8. Wire connections shall be as follows unless otherwise indicated on the drawings.
   a. Use preinsulated connectors 3M Company "Scotchlok," or Ideal Industries, Inc. "super nut," for splices and taps in conductors No. 10 AWG and smaller. All other twist-on connectors must be reviewed by the Architect prior to installation. Use this type of connector for factory-made splices in fixtures or equipment.
   b. Pressure indent type connectors must be submitted to the Architect for review.
   c. Tape all splices and joints with vinyl plastic tape manufactured by Minnesota Mining and Manufacturing Company. Use sufficient tape to secure insulation strength equal to that of the conductors joined.
   d. Keep splices in underground junction boxes to an absolute minimum. Where splices are necessary, use resin pressure splices and resin splicing kits manufactured by the 3M Company, St. Paul, Minnesota, to totally encapsulate the splice. Arrange the splicing kit to minimize the effects of moisture.
   e. Connect wire No. 10 AWG and larger to panels, motors and electrical apparatus using OZ (or equivalent) type XL set screw type lugs. Lugs shall accommodate full wire capacity for stranded conductors. All connections and connectors shall be solderless.
f. Connectors of the porcelain cup type with or without metal inserts shall not be used, including all splices in fixtures which are made in advance by the fixture manufacturer. Splices in wire No. 8 AWG and larger shall be made with approved solderless lugs. If any type of pressure indent type connector is proposed for use on any size conductor, it shall be specifically submitted for approval prior to use.

3. EXECUTION

3.1 INSTALLATION

A. General: Install electric cables, wires and connectors as indicated in compliance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices.

B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.

C. Conductors shall be continuous from outlet to outlet and no splices shall be made except within outlet or junction boxes. Junction boxes may be utilized wherever required.

D. Splicing: No splicing or joints will be permitted in either feeder or branch circuits except at outlet or accessible junction boxes.

E. Wire shall not be installed in raceways until the concrete work and plastering is completed and all conduits in which moisture has collected have been swabbed out. Insulation resistance to ground shall not be less than that approved by NEC. Eliminate splices wherever possible.

F. Use pulling compound or lubricant where necessary. Compound must not deteriorate conductor insulation.

G. Prior to energization, check cable and wire for continuity of circuitry, and for short circuits. Correct malfunctions when detected.

H. Bury a continuous, pre-printed, bright colored plastic ribbon cable marker with each underground cable, regardless of whether conductors are in conduit. Locate each directly over cables 12" below finished grade.

I. Conductor Installation: Install all conductors in a single raceway at one time, insuring that conductors do not cross one another while being pulled into raceway. Leave sufficient cable at all fittings or boxes and prevent conductor kinks. Keep all conductors within the allowable tension and exceeding the minimum bending radius.

J. Conductor Support: Provide conductor supports as required by the code and recommended by the cable manufacturer. Where required, provide cable supports in vertical conduits similar to OZ Type C.M.T., and provide the lower end of conduit with OZ Type KVF ventilators.
K. Conductor Termination: Provide all power and control conductors, that terminate on equipment or terminal strips, with solderless lugs or fork and flanged tongue terminals. Provide T and B "sta-kon" tongue terminal. This type conductor termination is not required when the equipment is provided with solderless connectors.

L. Many circuits are shown on the drawings to be provided with dedicated neutral and ground conductors. Carefully review circuiting and the electrical abbreviations and symbols legend and provide the number of conductors indicated.

M. Unless otherwise indicated provide dedicated neutral conductors for all branch circuits. Neutral conductors shall not be shared between circuits. Where the drawings indicate shared neutral conductors, for a multi-wire branch circuit, group the breakers together in accordance with NEC requirements.

3.2 CONDUCTOR ARCPROOFING

A. Cover two or more power feeder cables occurring in the same switchboard section, junction box or pull box (including pull boxes over switchboards) with arcproof and flameproof tape.

B. Provide 3M Company "Scotch" No. 77 tape or Plymouth Rubber Co. Slipknot No. 30 tape, to provide an installation capable of withstanding a 200-amp arc for not less than 30 seconds.

C. Apply tape in a single layer, one-half lapped, or as recommended by the manufacturer to conform to the above requirements. Apply with the coated side next to the cable and hold in place with a random wrap of 1/2 inch wide, pressure-sensitive, glass cloth electrical tape, 3M Company "Scotch" No. 69. Tape to be color coded as specified previously.
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SECTION 26 05 33 - RACEWAYS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.

B. This Section is a Division 26 "Basic Materials and Methods" section, and is part of each Division 26 section making reference to electrical raceways specified herein.

1.2 DESCRIPTION OF WORK

A. Extent of raceways is indicated by drawings and schedules.

B. Types of raceways in this Section include the following:

1. Electrical metallic tubing.
2. Flexible metal conduit.
3. Liquid-tight flexible metal conduit.
4. Rigid metal conduit.
5. Rigid nonmetallic conduit.

1.3 REFERENCES

A. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

B. UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL-listed and labeled. Each length of raceway shall bear the Underwriters Laboratories label.

C. NEC Compliance: Comply with NEC requirements which are applicable to the construction and installation of raceway systems.

D. NECA Compliance: Comply with NECA's "Standard of Installation".

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of raceway required.
2. **PRODUCTS**

2.1 **STEEL CONDUIT**

A. **Steel Conduit**: Rigid steel conduit and steel electrical metallic tubing shall be hot-dipped, galvanized or sheradized as manufactured by Youngstown Sheet and Tube Company, National Electric, General Electric, or equal.

B. **Joints**: Raintight non-insulated throat type compression fittings (connectors and couplings) shall be provided for electrical metallic tubing systems. All fittings shall be of the steel type with steel locknuts equal to Appleton 95 Series.

C. **Expansion Joints**: Provide expansion fittings, O.Z. Type AX with bonding jumper for rigid conduit and O.Z. Type TX with bonding jumper for electrical metallic tubing. Where embedded raceways cross building expansion joints, provide combination deflection/expansion fittings, O.Z. Type AXDX, or equal.

2.2 **RIGID NON-METALLIC (PVC) CONDUIT**

A. **PVC (polyvinyl chloride) Conduit**: Heavy wall rigid PVC conduit shall be composed of high impact PVC and shall conform to industry NEMA Standards and to Federal Specification WC-1094. Conduits shall be Carlon Schedule 40 type, or approved equal.

2.3 **FLEXIBLE METAL CONDUIT**

A. **Flexible metal conduit** shall conform to UL1. It shall be formed from continuous length of spirally-wound, interlocked zinc-coated strip steel.

B. **Pre-wired armored cabling, types AC or MC are not allowed.**

2.4 **LIQUID-TIGHT, FLEXIBLE METAL CONDUIT**

A. **Liquid-tight flexible metal conduit** shall be constructed of a single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; and coated with an oil-resistant, liquid-tight thermoplastic jacket.

2.5 **WIREWAYS**

A. **General**: Provide electrical wireways of types, grades, sizes, weights (wall thicknesses), and number of channels for each type service indicated. Provide complete assembly of wireways including, but not necessarily limited to couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other components and accessories as needed for a complete system. Where types and grades are not indicated, provide proper selection as determined by the Installer to fulfill wiring requirements and comply with applicable provisions of NEC for electrical raceways.
B. Surface Metal Raceways: Provide surface metal raceways of sizes and channels indicated; in compliance with FS W-C-582. Construct of galvanized steel with snap-on covers, with 1/8" mounting screw knockouts in base approximately 8" o.c. Provide fittings indicated which match and mate with raceway. Finish with manufacturer's standard prime coating suitable for painting. Provide all necessary devices as shown on the drawings for a complete installation.

C. Manufacturers: Subject to compliance with requirements, provide surface metal raceways of one of the following:

1. B-Line Systems, Inc.
2. Midland-Ross Corporation
3. Power-Strut Division; Youngstown Sheet and Tube Company
4. Square D Company
5. Versa-Tech Corporation
6. Walker/Parkersburg Division; Textron, Inc.
7. Wiremold Company

3. EXECUTION

3.1 GENERAL

A. Install electric raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation" and complying with recognized industry practices.

B. Raceways embedded in concrete or in earth below floor slabs shall be rigid steel conduit, or rigid schedule 40 PVC conduit. Rigid PVC conduit shall be provided with rigid metal conduit elbows when the raceway system exits the concrete topping or earth.

C. Electrical metallic tubing shall not be embedded in concrete or installed in earth.

D. Rigid heavy wall Schedule 40 PVC conduit shall be installed in earth and concrete only.

E. Conduits are NOT allowed to be embedded in concrete slabs.

F. Conduits located below concrete slabs must be a minimum of 12" below the slab.

G. Raceways in outside walls (excluding building perimeter) or in refrigerated areas shall be rigid steel conduit.

H. Provide rigid steel conduit for exposed raceways from floor to eight feet above the floor in mechanical rooms and in areas designated on the plans.

I. Rigid galvanized steel conduit or shall be used where conduit is exposed to weather.
J. Conduits in hazardous locations shall conform to the National Electrical Code. Rigid galvanized steel conduit shall be used in hazardous locations. PVC conduit shall not be used in hazardous areas.

K. Rigid metal, electric metallic tubing or PVC conduit where allowed in other section 3.1 paragraphs shall be used for feeders and branch circuits.

L. Flexible metal conduit may be used to connect light fixtures in accordance with NEC requirements but must be limited to a maximum of 6'-0" in length. "Daisy chaining" from fixture to fixture is not permitted. Provide flexible metal conduit for connections to motors, transformers, generators, and other equipment subject to vibration. Length of flexible conduit shall be a minimum of one foot for conduit diameters up to 1-1/2". A minimum of 3" of flexible conduit shall be added for every 1/2" increase in conduit diameter. Flexible metal conduit installation shall be kept to a minimum in connecting other electrical equipment items. Sealtight, flexible conduit shall be used where the flexible conduit may be subject to moist or humid atmosphere, corrosive atmosphere, subject to water spray and subject to dripping oil, grease or water. **Flexible metal conduits shall not be permitted for any other applications, unless specifically approved by the Owner**

M. Conduits shall be 3/4" diameter, minimum. Raceway sizes shown on the drawing are based on type THHN/THWN conductors.

N. Type Material: Except as noted otherwise all conduit shall be steel.

### 3.2 INSTALLATION

A. All raceways shall be installed concealed except where shown or noted otherwise.

B. At the Owner’s option, concealed raceways may be routed below the slab. At the Contractor's option, concealed raceways may be installed in furred spaces above ceilings or behind walls.

C. Continuity: Provide metallic raceways continuous from outlet to outlet, and from outlets to cabinets, junction or pull boxes. Enter and secure conduit to all boxes to provide electrical continuity from the point of service to outlets. Provide double locknut and bushing on terminals of metallic conduits.

D. A nylon or polypropylene pull string shall be installed in all empty conduits to facilitate future installation of cabling.

E. Provide accessible "seal-off" fittings for all raceways entering or leaving the hazardous areas, entering or leaving refrigerated areas and as otherwise required by the National Electrical Code.

F. Where conduits penetrate the roof seal, they shall be installed in curbs provided for mechanical equipment. When this is not possible, suitable pitch pockets, lead flashing, or approved fittings shall be provided. Details for special conduit installations shall be as shown on the drawings.
G. Reinforced Concrete: No reinforcing steel shall be displaced to accommodate the installation of raceways and outlet boxes. Outlet boxes shall not be installed in beams or joists. In general, all embedded conduits shall be located in the physical center of the particular section of concrete. Unless otherwise indicated, raceways embedded in reinforced concrete shall conform to the following usual types of conditions. Particular attention is called to the fact that there are many extenuating conditions where the Contractor may be instructed in writing during the course of the project not to place embedded conduits in certain areas, generally due to the possibility of unsightly cracking or for structural reasons. This instruction shall not entitle the Contractor to extra compensation. Any condition not covered by the following usual conditions shall require special clarification.

<table>
<thead>
<tr>
<th>Location</th>
<th>Maximum Allowance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Columns</td>
<td>Displacement of 4 percent of plan area of column.</td>
</tr>
<tr>
<td>2. Floors and Walls</td>
<td>Displacement of 1/3 of thickness of concrete spaced not less than three diameters on center.</td>
</tr>
<tr>
<td>3. Beams and Joists</td>
<td>Displacement of 1/3 of least dimension, spaced not less than three diameters on center.</td>
</tr>
<tr>
<td>4. Sleeves thru Floors and Walls</td>
<td>2” maximum pipe size, not less than three diameters on center.</td>
</tr>
</tbody>
</table>

H. Plain Concrete: Raceways shall not be placed in plain concrete, such as cement toppings on structural floors without special instructions.

I. Furred Spaces: Raceways installed in furred spaces shall be installed in accordance with the requirements of the National Electrical Code. Do not anchor or strap conduits to the ceiling furring channels or attach to furred ceiling hanger wires. Raceways may be attached to the suspension system (wire hangers) of drop ceilings if installed in such a manner that the ceiling panels may be removed without interference with the raceway, and the wire hangers are sized to carry the additional raceway load.

J. Stub Ups: Extend conduit stubs at least one foot above slab or fill, before connection is made to electrical metallic tubing.

K. Exterior Conduits: Install raceways a minimum of 42” below finished grade unless noted otherwise on the drawings.

L. Elbows for rigid metal conduit 3” and larger is to be plastic coated or tape coated.

M. Rigid metal conduit shall extend for a minimum of 5'-0" horizontally from the building.
N. Provide marking of conduit and junction boxes to indicate which distribution system they are serving. The markings could be colored tape on conduit at or near junction boxes with different colored tapes indicating different distribution systems. Concealed junction boxes shall be legibly marked with a magic marker to indicate the panel and circuit number that junction box serves.

1. The distribution systems shall be color coded as follows:
   a. Fire Alarm - Red
   b. Nurse Call - Yellow
   c. Paging System - Blue
   d. 120/208 Volt - Green
   e. 277/480 Volt - Orange
   f. Cable TV System - Black
   g. Telephone System - White

O. Steel Conduit (galvanized rigid steel or EMT):

1. Cutting: Cutting shall be done with hand or power hacksaws. All cut ends shall be reamed to remove burrs and sharp edges.
2. All threaded joints shall be made up wrench-tight and all compression joints shall be made up mechanically secure and snug so as to make continuous current-carrying electrical contact.
3. All metallic conduits buried or otherwise in contact with earth shall be painted using one heavy continuous coat of asphalt varnish after assembly of conduit and fittings.
4. Expansion joints shall be installed in steel conduit systems in structures as follows (expansion joints are specified elsewhere in the specification):
   a. Where conduit run crosses a building expansion joint.
   b. In any conduit run exceeding 100 feet in length.
   c. Where shown on the drawings.

P. Threads: Clean all threads of rigid metal conduit. Coat all male threads of all steel conduit installed in concrete with red or white lead immediately before being coupled together.

Q. Running Threads: Use “Erickson” type couplings in lieu of running threads.

R. PVC Conduit:

1. Joints: Conduits shall be joined by using couplings and solvent cement furnished or recommended by the raceway manufacturer. Finished joints shall be secure and watertight.
2. Cutting: Cutting shall be done with hacksaws and ends shall be reamed to remove burrs and sharp edges.
3. Expansion Joints: Expansion joints shall be installed:
a. Where conduit run crosses a building expansion joint.
b. As recommended by the manufacturer or as shown on the drawings.

4. Bends for PVC conduit sizes 2" and smaller may be made "hot" in the field. Inside dimension shall be thereby undistorted. For PVC sizes larger than 2", provide only factory bends.

5. PVC conduit sizes smaller than 2" are to be Schedule 80.

END OF SECTION 26 05 33
SECTION 260800 – COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1     GENERAL

1.1     DESCRIPTION

A. The purpose of this section is to specify the Contractor’s responsibilities and participation in the commissioning process.

B. Commissioning testing shall be performed by this division Contractor and documented by the Commissioning Authority. Commissioning is primarily the responsibility of the Commissioning Authority, with start-up, testing and support for commissioning the responsibility of Division 26. The commissioning process does not relieve the Contractor from participation in the process or diminish the role and obligations to complete all portions of work in a satisfactory and fully operational manner.

C. Work of Division 26 includes:

1. Testing and start-up of the electrical equipment.
3. Providing qualified personnel to assist in commissioning tests required after the initial commissioning.
4. Completion and endorsement of Pre-functional Construction Checklists provided by the Commissioning Authority to assure that Division 26 equipment and systems are fully operational and ready for functional testing.
5. Providing equipment, materials and labor necessary to correct deficiencies found during the commissioning process which fulfill contract and warranty requirements.
6. Providing operation and maintenance information and as-built drawings to the Commissioning Authority for review verification and organization prior to distribution.
7. Providing assistance to the Commissioning Authority to develop, edit and document system operation descriptions.
8. Provide a detailed start up plan for Burns & McDonnell (BMcD)’s review, comment and recommendation.
9. Provide at the end of the job the following items for inclusion in the systems manual.
   a. Control drawings, sequences of control
   b. A table of all set points
   c. Schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown
   d. A list of all manufacture recommended preventive maintenance procedures for all equipment and systems.
10. Use (BMcD)’s on-line and window based Commissioning application to fill out Construction Checklist and to track issues resolutions. Attendance a one BMcD
training class is required for all contractors. This training will take place at the construction Cx kick off.

11. Providing training for the systems specified in this Division.

1.2 RELATED WORK

A. All installation, testing and start-up procedures and documentation requirements specified within Division 26 and related portions of this project.

B. Section 019113 – Commissioning

C. Commissioning Functional Test Procedures that required participation of the Division 26 Contractors.

D. Cooperate with the Commissioning Authority in the following manner:

1. Provide all testing and start-up procedures and documentation requirements specified within Division 1 and Division 26 and related portions of this project.

2. Allow sufficient time before final completion dates so electrical systems start-up and commissioning can be accomplished.

3. Provide labor, specialty equipment and material to make required connections, circuitry and delay.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

A. Standard test equipment for commissioning will be provided by the Contractor.

B. Division 26 Contractor or 3rd party NETA certified agency shall provide standard and specialized test equipment as necessary to test and start up the electrical systems.

C. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment through the installing contractor. Manufacturer shall provide the test equipment, demonstrate its use and assist the Commissioning Authority in the commissioning process.

D. The Contractor shall provide all equipment, software and all test programming support as necessary to start up, calibrate, debug and verify proper function of the control/facility management system. This equipment and software shall be provided for use by both the test and balance contractor and the Commissioning Authority.
PART 3 EXECUTION

3.1 WORK PRIOR TO COMMISSIONING

A. Complete all phases of work so the systems can be energized, started, tested and otherwise commissioned. Division 26 has primary start-up responsibilities with obligations to complete systems, including all sub-systems, so they are functional. This includes the complete installation of all equipment materials, raceways, wire, terminations, controls, etc., per the Contract Documents and related directives, clarifications, change orders, etc.

B. A Commissioning Plan will be developed by the Commissioning Authority. Upon request of the Commissioning Authority, the Contractor shall provide assistance and consultation. The Commissioning Plan will be developed prior to completion of the installation. The Contractor is obligated to assist the Commissioning Authority in preparing the Commissioning Plan by providing all necessary information pertaining to the actual equipment and installation. If Contractor-initiated system changes have been made that alter the commissioning process, the Commissioning Authority will notify the Architect and the Contractor may be obligated to compensate the Commissioning Authority to test the revised product or confirm the suitability/unsuitability of the substitution or revision.

C. Specific pre-commissioning responsibilities of Division 26 are as follows:

1. Normal start-up services required bringing each system into a fully operational state. This includes motor rotational check cleaning, lug tightening, control sequences of operation, etc. The Commissioning Authority will not begin the commissioning process until each system is complete, including normal contractor start-up and debugging.

2. The Contractor shall perform pre-functional construction checklists on the systems to be commissioned to verify that all aspects of the work are complete in compliance with the plans and Specifications. Contractor start-up forms may be substituted for the pre-functional test forms with prior approval by the Commissioning Authority.

3. Factory start-up services will be provided for key equipment and systems specified in Division 26. Factory start-up activities to be documented and submitted. The Contractor shall coordinate this work with the manufacturer and the Commissioning Authority.

4. Notify Construction Manager and Commissioning Authority when systems are ready for functional testing.

D. Commissioning is intended to begin upon completion of a system. Commissioning may proceed prior to the completion of systems and/or sub-systems, if expediting this work is in the best interests of the Owner. Commissioning activities and schedule will be coordinated with the Contractor. Start of commissioning before system completion will not relieve the Contractor from completing those systems as per the schedule.
3.2 PARTICIPATION IN COMMISSIONING

A. Commissioning testing shall be performed by this division Contractor and documented by the Commissioning Authority. Provide skilled technicians to start up and debug all systems within this division of work. These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc., will be requested by the Commissioning Authority and coordinated by the Contractor. Contractor will ensure the qualified technician(s) are available and present during the agreed-upon schedules and of sufficient duration to complete the necessary tests, adjustments and/or problem resolutions.

B. System problems and discrepancies may require additional technician time, Commissioning Authority time, redesign and/or reconstruction of systems and system components. The additional technician time shall be made available for the subsequent commissioning periods until the required system performance is obtained.

C. The Commissioning Authority reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment, system and/or sub-system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment and an attitude/willingness to work with the Commissioning Authority to get the job done. A liaison or intermediary between the Commissioning Authority and qualified factory representatives does not constitute the availability of a qualified technician for purpose of this work.

3.3 WORK TO RESOLVE DEFICIENCIES

A. In some systems, maladjustments, misapplied equipment, and/or deficient performance under varying loads will result in a system that does not meet the original design intent. Correction of work will be completed under direction of the Architect, with input from the Contractor, equipment supplier and Commissioning Authority. Whereas all members will have input and the opportunity to discuss, debate and work out problems, the Architect/Engineer of Record will have final jurisdiction on the necessary work to be done to achieve performance.

3.4 ADDITIONAL COMMISSIONING

A. Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The Contractor, suppliers and Commissioning Authority shall include a reasonable reserve to complete this work as part of their standard contractual obligations.

B. The cost of compensation of the Commissioning Authority for repeat testing or troubleshooting due to systems that do not meet specified performance shall be borne by the Contractor.

C. Corrective work shall be completed in a timely fashion to permit the timely completion of the commissioning process.
3.5 SYSTEMS TO BE COMMISSIONED
   Refer to specification section 019113.

3.6 TRAINING
   A. This Contractor will be required to participate in the training of the Owner’s engineering
      and maintenance staff for each system and the related components. Training may be
      conducted in a classroom setting, with system and component documentation, and
      suitable classroom training aids, or in the field with the specific equipment. The type of
      training will be per the Owner’s option.

3.7 SYSTEMS DOCUMENTATION
   A. Maintain as-built red-lines on the job site as required in Division 1. Given the size and
      complexity of this project, red-lining of the drawings at completion of construction based
      on memory of key personnel is not satisfactory. Continuous and regular red-lining and/or
      posting of drawings is considered essential and mandatory.
   B. In addition to the stated requirements for operation and maintenance data, provide one (1)
      copy of equipment technical literature, operation and maintenance literature and shop
      drawings to the Commissioning Authority as soon as they are available. This
      requirement is for review of these documents prior to distribution of multiple copies for
      the Owner’s final use.
   C. Schedules, instructions for operation of each piece of equipment for emergencies,
      seasonal adjustment, startup and shutdown
   D. A list of all manufacture recommended preventive maintenance procedures for all
      equipment and systems

END OF SECTION
SECTION 26 24 16 - PANELBOARDS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary
Conditions and Division 1 specification sections, apply to the work of this Section.

B. This Section is a Division 26 "Basic Materials and Methods" section, and is a part of each
Division 26 section making reference to panelboards specified herein.

1.2 DESCRIPTION OF WORK

A. Extent of panelboard and enclosure work, including cabinets and cutout boxes is indicated on
the drawings and by schedules.

B. Types of panelboards and enclosures in this Section include the following:

1. Distribution Panels
2. Lighting and Appliance Panels
3. Transient Voltage Surge Suppression (TVSS) Panels

C. Refer to other Division 26 sections for cable/wire, connectors and electric raceway work
required in conjunction with panelboards and enclosures; not work of this Section.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of panelboards and enclosures, of
types, size and ratings required, whose products have been in satisfactory use in similar service
for not less than five (5) years.

B. Installer: A firm of at least three (3) years of successful installation experience on projects with
electrical installation work similar to that required for this project.

1.4 REFERENCES

A. Special Use Markings: Provide panelboards, constructed for special use, with UL markings
indicating that special type usage. Panels identified or shown on the drawings for use as main
service entrance equipment shall be labeled at the factory with "SERVICE ENTRANCE" type
UL label.
B. UL Compliance: Comply with applicable UL safety standards pertaining to panelboards, accessories, and enclosures. Provide units which have been UL listed and labeled. UL standards are as follows:

1. Panelboards - UL67
2. Cabinets and Boxes - UL50

C. NEC Compliance: Comply with the NEC as applicable to the installation of panelboards, cabinets, and cutout boxes.


E. NECA Compliance: Comply with NECA’s "Standard of Installation".

1.5 SUBMITTALS

A. Product Data: Submit manufacturer’s data including specifications, installation instructions and general recommendations for each panelboard required. Include data substantiating that units comply with specified requirements.

B. Shop Drawings: Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures and required individual panelboard devices, including but not limited to circuit breakers, fusible switches, fuses, ground fault circuit interrupters, and accessories.

2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements provide products of one of the following:

1. Square D Company
2. General Electric
3. Cutler Hammer
4. Siemens
2.2 FEEDER PROTECTIVE DEVICE COORDINATION

A. All overcurrent protective devices feeding the emergency system(s) shall be selectively coordinated in accordance with NEC Article 700. Selective coordination is required to the 0.10 second level. At least one manufacturer’s equipment has been evaluated during design to ensure selective coordination. If an equipment manufacturer has a conflict with selective coordination they shall bring this to the attention of the design engineer a minimum of 10 business days prior to the bid date. The panelboard manufacturer and generator system manufacturer shall fully coordinate the overcurrent protective device selection to ensure selectivity between equipment.

2.3 GENERAL

A. Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials, and which are designed and constructed in accordance with published product information. Provide solderless lugs, or connectors, in the correct number and size for conductors on mains, on the load side of each branch, circuit, and on ground and neutral bars. Provide tin plated copper busses. Provide an insulated neutral bus and a bonded equipment ground bus mounted at the opposite end of the structure from the mains, and having numbered screw or lug terminals for connection of wires. Equip panels with the number of unit devices as required for a complete installation. Where more than one type of component meets the indicated requirements, selection is installer's option. Where types, sizes or ratings are not indicated, comply with NEC, UL and established industry standards for applications indicated.

B. Provide ground fault circuit interrupting type circuit breakers for all devices noted with a “GFI” subscript on the panelboard schedules for this project.

C. Provide UL listed HACR type circuit breakers for all devices which serve heating, ventilating, or air conditioning equipment.

D. Panelboards shall be provided with covers for surface or flush mounting as shown on the drawings, or as required for actual project conditions.

E. Panelboards shall be constructed for top or bottom feeder service, as required by actual project conditions.

F. A minimum of 20% spare capacity shall be provided in each panelboard construction.

2.4 LIGHTING AND APPLIANCE PANELS

A. Lighting and appliance panelboards shall be Square D type NF (or equal) for 277/480 volt or Square D type NQOB (or equal) 120/208 volt applications. All branch circuit breakers are to be quick-make, quick-break, trip indicating and common trip on all multi-pole breakers, and shall be bolt-on type. Trip indication shall be clearly shown by breaker handle located between the “ON” and the “OFF” positions. Panelboards shall have distributed phase copper bussing throughout.
B. **Review drawings and provide main circuit breaker type panels where indicated on the drawings. Additionally, provide main lug only type panels where indicated on the drawings.**

C. Provide fully rated main circuit breaker or main lug only (see drawings) type panelboards where the short circuit rating of the complete panelboard assembly is determined by the lowest rated branch device. Provide panelboard interrupting ratings as noted on the drawings.

D. Lighting and appliance panels shall be 5.75" deep, maximum and shall have 6-inch minimum gutters. Fronts are to be complete with door and cylinder lock, with all locks keyed alike. Fronts shall have adjustable trim clamps, directory frames, and shall be equipped with a typewritten directory that identifies each circuit breaker by number and the equipment that the breaker serves. One additional blank directory card for each panel shall be furnished to the Owner.

E. Two section panels (as required by Code) shall be equipped with boxes of equal dimensions.

F. Panelboards shall be Underwriters' Laboratory listed and shall bear the UL label. The size of the panelboard main disconnect device or main lugs, the rating and number of branch circuits, and the type of mounting shall be as shown on the drawings.

2.5 **DISTRIBUTION PANELS**

A. Distribution panels shall be Square D I-Line (or equal) panels as indicated on the plans. Provide appropriate type of panels to meet specific project requirements. Panelboards shall have distributed phase copper bussing throughout.

B. Circuit breakers shall be as specified for lighting panels unless indicated otherwise. Power panels shall have combination card holder and name-plate and shall be equipped with typewritten directories that identify all loads served and all spare circuits. Provide a copper ground bus in all power panels.

C. Power panels shall be Underwriters' Laboratory approved and shall bear the UL label. Main lugs and gutters shall be suitable for copper and aluminum wire. The size of the panelboard main protective device or main lugs, the size, type and the number of branch circuits and the type of mounting shall be as shown on the drawings.

D. **Review drawings and provide main circuit breaker type panels where indicated on the drawings. Additionally, provide main lug only type panels where indicated on the drawings.**

E. Provide fully rated main circuit breaker or main lug only (see drawings) type panelboards where the short circuit rating of the complete panelboard assembly is determined by the lowest rated branch device. Provide panelboard interrupting ratings as noted on the drawings.
2.6 FEEDER PROTECTIVE DEVICES

1. The following paragraphs list the general feeder protective device requirements. For circuit breakers that are part of the emergency distribution system electronic circuit breakers may be required to achieve selective coordination in accordance with NEC Article 700.

   a. Feeder protective devices as shown shall be molded case air circuit breakers, built, tested and UL labeled per UL 489.
   b. In general 100 ampere through 400-ampere frames shall be thermal-magnetic trip with inverse time current characteristics. Breakers with 225 ampere through 400-ampere frames shall have continuously adjustable magnetic pick-ups of approximately five to ten times trip rating.
   c. In general breakers with 600 ampere frames and above shall be Square D Powerpact or approved equivalent with solid-state trip complete with built in current transformers, solid-state trip unit and flux transfer shunt trip. Breakers shall have easily changed trip-rating plugs with trip ratings as indicated on the drawings. Rating plugs shall be interlocked so they are not interchangeable between frames and interlocked such that breakers cannot be latched with rating plug removed. Breaker shall have built-in test points for testing long delay, instantaneous and ground fault (where shown). Functions of the breaker shall be tested by means of a 120 volt operated test kit. Provide one test kit capable of testing all breakers 600 ampere and above.
   d. Solid state instantaneous element shall be continuously adjustable from approximately 4 to 8 times the trip rating, with short time adjustment from instantaneous to 10-cycle delay for coordination purposes. Provide short delay override feature providing for instantaneous tripping on high magnitude faults.
   e. Molded case breakers shall have a minimum UL listed interrupting capacity as listed on the drawings.
   f. Breakers 2000 thru 3000A frame on the drawings shall be UL listed and labeled for 100 percent application per the N.E.C.
   g. For all circuit breakers rated 1200 Amps or more, provide circuit breaker with an energy reducing maintenance switch per NEC paragraph 240.87

2. All overcurrent protection devices installed within existing panelboards or distribution panels shall be fully compatible with the existing panelboard/distribution panel, and shall maintain the interrupt rating and UL listing of the existing system.

2.7 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) PANELS

   A. Transient voltage surge suppression (TVSS) panels shall be designed for non-linear loads incorporating transient voltage surge suppression and high-frequency electrical line noise filtering connected in parallel with the facility’s wiring system. The specified unit shall be suitable for non-linear loads and shall provide effective high-energy transient voltage suppression, surge current diversion, high-frequency electrical line noise attenuation, and line control in ANSI/IEEE C62.41-1991 environments when connected downstream from the facility’s main overcurrent device. Comply with all requirements of this specification for lighting and appliance and distribution panels.
B. The manufacturer of the unit must have been engaged in the design and manufacture of such products for a minimum of five years.

C. The specified unit shall be designed, manufactured, tested and installed in compliance with the latest edition of the following standards:

1. ANSI/IEEE C62.41, C62.45
2. FIPS PUB 94
3. NEMA LS-1
4. NFPA 70, 75 and 78
5. UL 50, 67, 489, 943, 1283 and 1449.

D. The unit shall be UL 1449, second edition listed as a transient voltage surge suppression unit.

E. Environmental Requirements

1. Operating temperature range shall be -40 degrees to +60 degrees C.
2. Operation shall be reliable in an environment with 5% to 95% non-condensing relative humidity.
3. The unit shall not generate audible noise greater than 35 dB at 3 feet from the unit.
4. No appreciable magnetic fields shall be generated. The unit shall be capable of use directly in computer rooms in any location without danger to data storage systems or devices.

F. Electrical Requirements

1. The nominal unit operating voltage and configuration shall be as indicated on the drawings.
2. The maximum continuous operating voltage of all suppression components utilized in the unit shall not be less than 115% of the facility’s nominal operating voltage.
3. The operating frequency range of the unit shall be 47 to 63 Hertz.
4. The unit’s primary mode of protection shall be line-to-neutral. The secondary modes of protection shall be line-to-ground and neutral-to-ground.
5. Based on ANSI/IEEE C62.41-1991’s standard 8 x 20 microsecond current waveform, the maximum repetitive surge current capacity, in amps, of the unit shall be no less than 100 KA per mode.
6. The unit’s published performance ratings shall be the UL 1449 Listed suppression ratings. The UL 1449 suppression rating shall be, for each mode of protection and system voltage as follows:

   a. L-L: 1500 Volts for 480Y/277 Volt, 3 phase, 4 wire systems, 700 Volts for 208Y/120 Volt, 3 phase, 4 wire systems and 240/120 Volt 1 phase, 3 wire systems.
   b. L-N: 800 Volts for 480Y/277 Volt 3 phase, 4 wire systems, 400 Volts for 208Y/120 Volt 3 phase, 4 wire systems and 240/120 Volt 1 phase, 3 wire systems.
   c. L-G: 1500 Volts for 480Y/277 Volt 3 phase, 4 wire systems, 700 Volts for 208Y/120 Volt 3 phase, 4 wire systems and 240/120 Volt 1 phase, 3 wire systems.
   d. N-G: 800 Volts for 480Y/277 Volt 3 phase, 4 wire systems, 400 Volts for 208Y/120 Volt 3 phase, 4 wire systems and 240/120 Volt 1 phase, 3 wire systems.
G. Documentation and Testing

1. The manufacturer shall furnish an equipment manual with installation, operation and maintenance instructions for the specified unit.
2. Documentation of the unit’s UL 1449 suppression rating shall be included as required product data submittal information. Manufacturer shall make available upon request certified documentation of applicable Location Category Testing in full compliance with ANSI/IEEE C62.41-1991 and ANSI/IEEE C62.45-1987 guidelines.
3. A list of customer-replaceable spare parts shall be included in the unit’s installation, operation and maintenance instructions. All spare parts shall be quickly and easily field-replaceable.
4. The TVSS device repetitive surge current capacity shall be tested utilizing a 1.2 x 50 microsecond waveform as defined by ANSI/IEEE 62.41-1991 and ANSI/IEEE 62.45-1992 at one minute intervals. A failure is defined as either performance degradation or more than 10% deviation of clamping voltage at the specified surge current. The device shall be capable of surviving 5000 impulses without failure or performance degradation.
5. The unit shall be factory tested and burned in at the applicable MCOV for a minimum of one hour.
6. The unit shall be provided with a five-year warranty.
7. The unit shall be thoroughly factory-tested before shipment. Testing of each unit shall include but shall not be limited to quality assurance checks, MCOV and clamping voltage verification tests.

H. Construction

1. Panel trim, box, interior, bus and circuit breakers shall be as specified for lighting and appliance panels and on the drawings. The TVSS shall be mounted integral to the panelboard equipment and shall not violate the equipment manufacturer’s UL label.

I. Suppression/Filter System

1. The unit shall include an engineered solid-state high-performance suppression system, utilizing arrays of fused non-linear voltage dependent metal oxide varistors with similar operating characteristics. The suppression system’s components shall optimally share surge currents in a seamless, low-stress manner assuring maximum performance and proven reliability. The suppression system shall not utilize gas tubes, spark gaps, silicon avalanche diodes or other components which might short or crowbar the line, thus leading to interruption of normal power flow to or system upset of connected loads. The suppression system shall not incorporate any other components which may degrade performance or reliability of the suppression system.
2. The fusing system shall be capable of allowing the rated maximum surge current to pass through without fuse operation. Systems utilizing a fusing system that opens below the maximum surge current level are unacceptable.
3. The unit shall include an EMI/RFI noise suppression filter capable of a minimum of –40 dB attenuation at 100 kHz.
4. Any TVSS unit mounted in a distribution panel shall have an integral disconnect or circuit breaker to be used as a means of disconnecting the suppression/filter system for maintenance and/or test purposes without interruption of power to the facility’s distribution system.
5. All internal wiring associated with the suppression/filter system and subject to surge currents shall utilize low-impedance copper bus bar and/or #8 AWG copper conductor or larger. All internal connections associated with the suppression/filter system and subject to surge currents shall be made with compression solderless-type lugs and shall be bolted to the bus bars in order to reduce overall system impedance. No plug-in component modules, quick-disconnect terminals or printed circuit boards shall be used in surge current-carrying paths.

6. The unit shall include the following accessories:

   a. The unit shall include Form C dry contacts (N.O. and N.C.) to facilitate connection to a building management system in order to monitor the on-line status of the unit. The contacts shall be normally open or normally closed and shall close or open upon failure of the suppression system and/or fuse.
   b. Operational status indicating lights.
   c. Audible alarm and alarm indicating light.
   d. Transient Voltage surge counter with battery backup.

3. EXECUTION

3.1 INSTALLATION

A. General: Install panelboards and enclosures where indicated, in accordance with the manufacturers' written instructions, applicable requirements of the NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate the installation of panelboards and enclosures with cable and raceway installation work.

C. Provide all required electrical connections within the enclosure.

D. Fill out typewritten panelboard circuit directory cards upon completion of the installation work.

END OF SECTION 26 24 16
SECTION 26 27 26 - WIRING DEVICES

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.

B. This section is a Division 26 "Basic Materials and Methods" section, and is a part of each Division 26 section making reference to wiring devices specified herein.

1.2 DESCRIPTION OF WORK

A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry, but not utilize electrical energy.

B. Types of electrical wiring devices in this Section include the following:

1. Receptacles
2. Switches
3. Wall Plates
4. Dimmer Controls
5. Floor Outlets
6. Service Pedestals

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of wiring devices of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer: Qualified with at least 2 years of successful installation experience on projects with electrical installation work similar to that required for this project.

1.4 REFERENCES

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring devices.

B. UL Compliance and Labeling: Provide electrical wiring devices which have been UL listed and labeled.

C. NEMA Compliance: Comply with NEMA standards for general and specific purpose wiring devices.
D. NECA Compliance: Comply with NECA’s “Standard of Installation.”

1.5 SUBMITTALS

A. Product Data: Submit manufacturer’s data on electrical wiring devices.

2. PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following:

1. Pass and Seymour Corporation
2. Cooper
3. Hubbell, Inc.
4. Leviton, Inc.
5. Crouse Hinds
6. Lutron
7. Walker Duct

2.2 WIRING DEVICES

A. General: Where shown on the drawings, furnish and install wiring devices indicated by the appropriate symbols. Wiring devices shall be products of Pass and Seymour Corporation, or equal. Catalog numbers shown below are P & S hard use specification grade. Similar devices manufactured by Hubbell or Leviton shall be equally acceptable.

B. Switches: Branch circuit switches shall be flush tumbler type as follows:

1. Single Pole CSB20AC1 Series - Gray
2. Two Pole CSB20AC2 Series - Gray
3. Three-Way CSB20AC3 Series - Gray
4. Four-Way CSB20AC4 Series - Gray
5. Single Pole SW With Pilot CSB20-AC1-RPL Series
6. LED and Fluorescent Dimmer Switches: Provide dimmer switches capable of 0-10 Volt dimming of LED and fluorescent loads, Lutron NTF-10-277-Gray or engineer approved equal. Provide adequate number of conductors between dimmer switches and dimmed fixtures regardless of circuiting shown on drawings.
7. Switches fed by a generator circuit (standby or life safety) shall be the same as above but RED in color.

C. Occupancy Sensors/Switches and Time Switches

1. See Plans for lighting control requirements.

2.3 RECEPTACLES

A. All receptacles shall be side and back wired, self-grounding of the type indicated on the drawings, or as follows. Catalog numbers shown below are Pass & Seymour specification grade
unless otherwise indicated. Similar devices manufactured by Hubbell or Leviton shall be equally acceptable:

1. Duplex Convenience Receptacles  
   20A-125V (Grounding Type)  
   CRB5362 Series-Gray

2. Weatherproof Duplex Receptacles  
   20A-125V (Grounding Type)  
   CRB5362-Gray-WP Series- with Weatherproof Plate

3. Duplex GFI Receptacle  
   20A-125V  
   2095 Series-Gray

4. Weatherproof Duplex GFI Receptacle  
   20A-125 Volt  
   2095 Series-Gray with WP Wall Plate

5. Duplex USB Receptacle  
   TR5362USB-Gray

6. Hospital Grade Receptacle  
   20A-125 Volt  
   PS8300H Gray for Normal Power and PS8300H Red for Emergency Power

7. Hospital Grade GFI Receptacle  
   20A-125 Volt  
   2095HG Gray for Normal Power and 2095HG Red for Emergency Power

8. Tamper Resistance Receptacle  
   TR63-Gray for Normal and TR63-Red for Emergency

9. Isolated Ground Receptacles  
   20A-125 Volt, Ground Wire shall be routed back to main switchboard ground or separately derived system ground in accordance with NEC requirements. IG5362 with Orange Cover Plate

B. Hospital grade, tamper proof receptacles shall be utilized for all new devices installed under this project’s scope. Receptacles on emergency power shall be red in color. Coverplates for emergency outlets in these areas shall be engraved with panel and circuit no. designation per NEC. Engraving shall be 1/8” high, block style letters, with red filler on front side of coverplates.
2.4 PLATES

A. Furnish and install wall plates for all wiring devices. Where switches and/or receptacles are shown adjacent to each other, provide a common cover plate for each group of devices. Oversize plates are not acceptable.

1. Plates shall be Pass and Seymour Type 302 stainless steel.
2. Cover plates for all electrical devices shall be engraved with panel and circuit no. designation. Engraving shall be 1/8" high, block style letters, with black filler on front side of cover plates.
3. Weatherproof switch plates shall be Crouse Hinds DS185 type.
4. Weatherproof receptacle plates shall be Crouse Hinds WLRD1 type.
5. "In-Use" Weatherproof plates shall be Intermatic WP5000 Series. Provide necessary number of gangs, mounting bases, inserts and gaskets.

2.5 TWO PIECE SURFACE METAL RACEWAYS

A. Aluminum two-piece surface metal raceway, see plans for type. Where indicated on the drawings, provide, surface metal raceway systems complete with all necessary electrical and telecommunications devices, bases, covers, dividers, wire clips, couples, inserts, end fittings, device mounting brackets, device covers, etc. to ensure a complete and functional installation.

B. Cover plates for all power devices installed in two piece surface metal raceways shall be engraved with panel and circuit no. designation. Engraving shall be 1/8" high, block style letters, with black filler.

2.6 FLOOR OUTLETS

A. Flush Mounted Floor Boxes and Floor Outlets. See plans for types. Unless noted otherwise on the plans provide one receptacle faceplate, and one blank faceplate (to support telecom devices) for each flush mounted floor convenience outlet. When carpet is indicated on the finish schedule, supply each floor box or outlet with an appropriate carpet flange.

B. Poke-Thru Service Fittings and Service Pedestals: See plans for types. Provide all necessary faceplate types, conduit adapters for installation on counter tops and all other accessories as noted on the drawings, or as required to meet specified project needs.

2.7 Where devices are installed on exposed fittings or boxes, the plates shall be galvanized and of a type designed to fit the box. Blank covers shall be installed on all boxes without devices or fixtures, of same type as installed on devices in the room or area.

2.8 Test wiring devices to ensure electrical continuity of grounding connections and proper polarity.
3. EXECUTION

3.1 INSTALLATION

A. Install wiring devices as indicated in compliance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate with other work including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices and other work.

C. Testing: Test wiring devices for electrical continuity of grounding connections and proper polarity. Test wiring devices to demonstrate compliance with requirements.

D. Where devices are installed on exposed fittings or boxes, the plates shall be galvanized and of a type designed to fit the box. Blank covers shall be installed on all boxes without devices or fixtures, of same type as installed on devices in the room or area.

E. All outlets shall be located as shown on the drawings, except that where practicable, outlets shall be located in center of panels or trim or otherwise symmetrically located to conform with existing structural layout. Outlets incorrectly installed shall be corrected. Damaged items or damaged finishes shall be repaired or replaced at no expense to the Owner.

F. Outlets shall be set plumb or horizontal and shall extend to the finished surface of the walls, ceiling or floor, as the case may be, without projecting beyond the same.

G. Receptacles, switches, etc., shown on wood trim, cases or other fixtures shall be installed symmetrically; and, where necessary, shall be set with the long dimensions of the plate horizontal, or ganged in tandem.

H. Where dimmer switches are shown adjacent to standard switches, both shall be installed in separate back boxes with adequate space between so that neither cover plate requires cutting.

I. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that cover plates do not require cutting.

J. Where devices are shown mounted adjacent to one another on the drawings, provide multi-gang faceplates to cover all devices.

END OF SECTION 26 27 26
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SECTION 26 51 00- LIGHTING

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections apply to the work of this Section.

B. Division 26 "Basic Materials and Methods" sections apply to the work in this Section.

1.2 DESCRIPTION OF WORK

A. Types of interior and exterior lighting fixtures in this Section include the following:

   1. LED

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of interior and exterior light fixtures of types and ratings required, whose products have been in satisfactory use in similar service for not less than three years.

B. Installer: Qualified with at least three years of successful installation experience on projects with interior and exterior lighting fixture work similar to that required for this project.

1.4 REFERENCES

A. NEC Compliance: Comply with the NEC as applicable to the installation and construction of lighting fixtures.

B. NEMA Compliance: Comply with applicable requirements of NEMA Standard Pub. Nos. LE-1 and LE-2 pertaining to lighting equipment.

C. ANSI/UL Compliance: Comply with ANSI/UL Standards pertaining to interior and exterior lighting fixtures for hazardous locations.

D. UL Compliance: Provide light fixtures that have been UL listed and labeled.

E. CBM Labels: Provide fluorescent lamp ballasts that comply with Certified Ballast Manufacturers Association Standards and carry the CBM label.

F. NECA Compliance: Comply with NECA's "Standard of Installation".
1.5 SUBMITTALS

A. Product Data: Submit manufacturer's product data on lighting fixtures.

B. SHOP DRAWINGS

1. Furnish shop drawing portfolios (collated bound sets) containing the following information:
   a. Name of manufacturer
   b. Descriptive cut sheets
   c. Complete photometric information
   d. Coefficient of utilization tables
   e. Fixture voltage
   f. The number, type and wattage of the fixture lamps
   g. Lens types
   h. Fixture options
   i. Fixture mounting details
   j. Fixture door types
   k. Construction of fixture housing and/or door
   l. Fixture ballast manufacturer and type

2. All lighting fixtures required to be used on this project shall be submitted in one single submittal so that all fixtures can be reviewed at one time. Those fixtures not receiving a shop drawing action of "Reviewed" or "Reviewed and Noted" on the first submittal shall be resubmitted for review. A light fixture receiving a shop drawing action of "Resubmit" or "Rejected" after the third review for any reason, shall be furnished as originally specified.

3. The portfolios shall be made from standard manufacturer's specification sheets. Each fixture shall be identified by the letter or number indicated on the fixture schedule. The combining of more than one fixture type of fixture on a single sheet shall not be acceptable.

1.6 EXTRA MATERIALS

A. At substantial completion of the project, furnish the following extra materials that match specified and installed products to the Owner for future use after completion of project warranty periods. Extra materials shall be delivered and stored at a location or locations directed by the Owner. Products shall be packaged with protective covering for storage and shall be suitably labeled by product type.

1. Provide ten extra lamps for every 100 lamps (of each rating and type) installed on the project. Provide a minimum of at least one extra lamp for each lamp type and rating used.

2. Provide one extra lens and one extra louver for every 100 units (of each type) installed on the project. Provide a minimum of at least one extra lens and one extra louver for each type used.
3. Provide one extra ballast/driver for every 100 units (of each type) installed on the project. Provide a minimum of at least one extra ballast/driver for each type used.

2. **PRODUCTS**

2.1 Manufacturer: Manufacturers of lighting fixtures are noted on the drawings by notes and/or by the light fixture schedule.

2.2 Substitutions: If the Contractor proposes to substitute lighting fixtures for those shown on the drawings or specified herein, he shall submit a list of proposed fixtures together with technical data to substantiate that the substitute fixtures are equivalent in all respects to the specified equipment. Proposed substitute fixtures must be submitted to the architect/engineer for review a minimum of ten (10) days prior to the project bid date. Only original documentation will be accepted for review. After review of the proposed substitute fixtures, an addendum or bid bulletin will be issued to include acceptable equipment. The review of substitute equipment in no way relieves the contractor of the responsibility to provide equipment that is equivalent in all respects to specified fixtures. Lighting fixtures as shown on the drawings or specified herein shall be used as a basis and standard of comparison in the review and consideration of fixtures of other manufacturers. The Architect/Engineer shall have the final authority as to whether the fixture is equivalent to the specified item. The proposed substitution may be rejected for the aesthetic value if felt necessary or desirable. In the event the proposed substitutions are rejected, the Contractor shall furnish the specified item.

2.3 **LED Drivers**

A. Driver shall operate from 60 Hz input source of 120V through 277V with sustained variations of +/- 10 percent (voltage and frequency).

B. Driver input current shall have Total Harmonic Distortion (THD) of less than 20 percent when operated at nominal line voltage.

C. Driver shall have a Power Factor greater than 0.90.

D. Driver shall avoid interference with infrared devices and eliminate visible flicker.

E. Driver shall comply with ANSI C62.41 Category A for Transient protection.

F. Driver shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

G. The luminaire shall be capable of continuous dimming over a range of 100% to 5% of rated lumen output. Dimming shall be controlled by a 0-10VDC signal.
H. Control device must be compatible with type of driver, and coordinated prior to submission of shop drawings.

I. If driver is remote-mounted, provide maximum allowable distances for secondary wire runs to luminaires.

J. Provide with mounting hardware as required.

2.4 LED’s

A. Color temperature specified shall be uniform for all LED modules within like luminaire types. Color temperature measurement shall have a maximum 2 SDCM on the MacAdam Ellipse.

B. Correlated color temperature of 4000K unless otherwise specified. Minimum color rendering index (CRI) of 85.

C. LED light output and efficacy shall be measured in accordance with IES LM-79 standards.

D. LED efficacy is to be a minimum 90 lumens/watt.

E. LED life and lumen maintenance shall be measured in accordance with IES LM-80 and TM21 standards.

F. Rated minimum life of 50,000 hours at L70.

G. The individual LED’s shall be connected such that a catastrophic loss or the failure of one LED will not result in a light output loss of the entire luminaire.

2.5 PLASTER FRAMES

A. Standard plaster frames shall be provided for all recessed lighting fixtures installed in plaster or drywall finished walls or ceilings. Coordinate with architectural drawings.

2.6 THERMAL PROTECTION

A. All recessed light fixtures shall be provided with thermal protection per N.E.C requirements.

3. EXECUTION

3.1 INSTALLATION

A. Install lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer’s written instructions, applicable requirements of the NEC, NECA’s “Standard of
Installation*, NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

B. Coordinate with other electrical work as appropriate to properly interface installation of lighting fixtures with other work.

C. Adjust and Clean: Clean lighting fixtures of dirt and debris upon completion of the installation. Protect installed fixtures from damage during the remainder of the construction period.

D. Field Quality Control: Upon completion of the installation of lighting fixtures, and after building circuits have been energized, apply electrical energy to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

E. Undercabinet and undercounter light fixtures shall be installed with 3/8” deep x 2” x 4” wood spacers painted black to provide an air space between the fixture and the top of the millwork.

F. Lighting fixture supports: Properly support and install fixtures in strict accordance with all applicable building codes and standards. Fully and completely coordinate the installation of fixtures with actual ceiling systems, and with all building trades. In general, provide fixture supports according to the following (unless applicable codes require more restrictive support details):

1. All lighting fixtures installed in grid type suspended ceiling systems, shall be positively attached to the ceiling system with clips that are UL listed for the application. In addition, a minimum of four (4) ceiling support system rods or wires shall be provided for each light fixture and shall be installed not more than six (6) inches from fixture corners. Provide two (2) No. 12 gage hangers from each fixture housing to the building structure above (wires may be installed slack). Light fixtures that weigh more than 56 pounds shall be supported directly from the structure above by UL listed and approved hangers. Light fixtures that are smaller than the ceiling grid shall be installed at locations indicated on the reflected ceiling plans, or shall be installed in the center of the ceiling panel and shall be supported independently by at least two metal channels that span and are secured to the ceiling system.

2. Suspended lighting fixtures shall be supported directly from the building structure without using suspended ceilings as support systems. Support systems shall be UL listed and approved for the specific installation. Where pendants or rods exceed 48 inches in length, brace support systems to limit swinging.

G. Square and rectangular fixtures shall be mounted with sides parallel to building and ceiling lines, unless otherwise noted.

H. Where special fixtures to be used in special ceilings are scheduled, verify all ceiling system details and coordinate fixture type and accessories prior to ordering fixtures. Coordinate and cooperate with ceiling system supplier in the preparation of ceiling system shop drawings.
University of Missouri Teaching Hospital
Critical Care Addition – Interventional Radiology Expansion
Columbia, Missouri

MU Project #: CP180491
TCEP Project #: 624-149-17

END OF SECTION 26 51 00
SECTION 27 00 00 - TELECOMMUNICATIONS

PART 1. GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 26 "Basic Materials and Methods" sections apply to work specified in this Section.

PART 2. BUILDING WIRING SYSTEM DESIGN

2.1 GENERAL INFORMATION

A. Except for pathway construction, Division of IT will provide all material and equipment. This includes cable, voice/data/catv outlets and faceplates, equipment racks, and electronic equipment and all miscellaneous hardware.

B. The contractor will install owner-provided cable.

C. Cables do not need to be labeled by the contractor.

D. Division of IT will terminate, label and test all cabling and install all electronic equipment.

E. Cat6A shall be installed directionally from the telecom room outward.

PART 3. HORIZONTAL PATHWAYS AND SPACES

3.1 GENERAL INFORMATION

A. To avoid electromagnetic interference (EMI), all pathways shall provide clearances of at least 4 feet from motors or transformers, 1 foot from conduit and cables used for electrical power distribution, 5 inches from fluorescent lighting.

B. Horizontal Pathways:

1. Pathways must support cables and provide protection. Pathways should be planned to facilitate original installation as well as ongoing maintenance, additions, and relocations.

2. Conduit, trays, or other pathway hardware are to be used above the ceilings. Appropriate design of horizontal pathways should accommodate the hanging of cables loosely above suspended ceilings requires appropriate hardware (J-hooks, rings, etc.). Support hardware must not have sharp edges.
3. Cable trays should have twelve (12) inches of clearance above the tray. The designer should ensure that other building components (e.g., lighting fixtures, structural supports, air ducts) do not restrict access to the cable tray.

4. Cable routing, support, and sealing of penetrations must meet applicable UMC codes.

5. EZ Path series 44 fire wall sleeves are requires where a cable tray path crosses a firewall. The quantity of EZ Path series 44 fittings will equal the capacity of the cable tray, not just the initial cabling demands.

6. Conduit, cable tray, and J-hooks will be designed to allow a 40% growth.

7. Hanging cable supports must be no more than 5 feet apart as the installed cable must exhibit some sag in hanging. This provides visual evidence that cable tension is within 25 pounds as required in EIA-568-A.

8. Bundles of cables supported by typical J-hooks should not be larger than 50 cables, unless additional support is provided.

9. Horizontal pathway design should take into consideration the horizontal cabling distance limitations of 90 meters (295 feet) from the telecommunications room to the outlet.

10. When conduit is used, sections of conduit shall be no longer than 150 ft and must not have more than or the equivalent of 270° bends between pull points or pull boxes.

11. Conduit inside bend radius must be:

<table>
<thead>
<tr>
<th>Conduit size…</th>
<th>Bend radius…</th>
</tr>
</thead>
<tbody>
<tr>
<td>2” or less</td>
<td>Six times the inside diameter</td>
</tr>
<tr>
<td>More than 2”</td>
<td>Ten times the inside diameter</td>
</tr>
</tbody>
</table>

12. Pull boxes should be placed directly after a bend or sized accordingly if the pull box is located at the bend.

13. Conduit fill limits must be followed to avoid over-packing cables:

<table>
<thead>
<tr>
<th>Conduit Size…</th>
<th># of cables…</th>
</tr>
</thead>
<tbody>
<tr>
<td>1”</td>
<td>3 cables max</td>
</tr>
<tr>
<td>1-1/4”</td>
<td>4 cables max</td>
</tr>
<tr>
<td>1-1/2”</td>
<td>6 cables max</td>
</tr>
<tr>
<td>2”</td>
<td>12 cables max</td>
</tr>
<tr>
<td>3”</td>
<td>20 cables max</td>
</tr>
</tbody>
</table>

14. At a minimum, 1” conduit shall be extended from the outlet location box into the ceiling for entrance into the building cable distribution system. The conduit should turn 90° then bushed. This conduit must terminate before passing through a fire rated wall.

15. Outlet boxes shall be 4” x 4” x 2 1/2” and shall have plaster rings to accommodate a 2” x 4” faceplate. A sample faceplate will be provided upon request. Joint power and telecom boxes are not allowed, even with separation.

16. Outlet boxes must be specified for all openings including walls, systems furniture, wiremold, etc. When using wiremold a WIEMOLD brand model 5744S outlet box (or approved equal) must be provided.

17. Dual channel raceway such as Wiremold 4000 a decora (GFCI) style device plate opening.
18. When possible, outlet locations should be placed above the work surfaces for easy access. Outlet boxes built into the floor are not recommended.
19. Cabling shall be supported above drop ceiling completely by cable tray or J-hooks.

PART 4. WORK AREAS

4.1 GENERAL REQUIREMENTS

A. Current standards call for installation of two CAT6A cable for data and voice at each outlet location. Ethernet is the supported protocol for data applications.

B. On a case-by-case basis, Division of IT will work with the owner to design/install multi-mode fiber to the desk-top.

C. End-user voice/data outlets should be located within 3 meters (10 feet) of the work area or possible work areas.

4.2 OFFICE SPACE

A. All office space shall be designed with three (3) data outlets for on two opposite walls. Cubicles or enclosed office areas with less than 150 sq. ft. shall have at a minimum two data outlets.

4.3 CLASSROOMS

A. All classrooms shall be designed with a minimum of four (4) data outlets.

B. CATV outlets in classrooms shall be installed as required by the Owner.

4.4 AUDITORIUMS

A. All auditoriums shall be designed with a minimum of three (3) data outlets at the front stage area and the same in the rear “control room” if such a room exists.

B. At least one (1) copper coaxial cable, for CATV service, will be installed in every auditorium. Additional outlets in auditoriums will be installed upon request.

4.5 SYSTEMS FURNITURE

A. Systems furniture should be designed/ordered with electrical and telecommunications wiring requirements in mind. Panels that cover wall outlets are not permitted.

B. Separate power poles should be provided to separate voice/data wiring from electrical wiring, or physical separators must be provided within the pole.
C. Voice/data wiring should be accommodated within the "top-cap" of the furniture. If the top-cap cannot be used, physical separation of voice/data and electrical cables in the base of the panels is required.

D. The outlet box should be integrated within the furniture above desktop level.

E. It is not recommended to have cabling enter systems furniture panels through floor access boxes.

4.6 WIRELESS ACCESS POINTS

A. Wireless access points require one data outlet terminated above the accessible ceiling with a ten (10) foot slack coil.

B. Spacing of the wireless access points should be based on a 25 foot grid for patient care facilities or high capacity areas.

C. Spacing for other areas should be based on a 45 foot grid pattern.

PART 5. CABLEING INSTALLATION AND DISTRIBUTION

5.1 CABLE TYPE, SOURCE OF MATERIALS, AND ASSIGNMENT OF TASKS

A. All vertical and horizontal in-building cable shall be plenum rated.

B. All cable will terminate in a telecom room on the same floor as the outlet.

C. Division of IT will install all backbone cable and perform terminating and testing of such facilities.

D. The contractor shall install owner provided cabling as specified for the project. The Division of IT will terminate and test all contractor installed cabling. Division of IT will provide all materials including cable, connecting hardware, terminals, equipment racks, etc.

E. The contractor/installer shall take into account the following critical installation practices when installing telecommunications cabling.

1. Physical separation from all sources of EMI is critical. Sources of EMI include but are not limited to: motors, transformers, copiers, construction equipment, and branch circuit power cables. Cabling that leaves physical pathways and extends into office areas must not lay on fluorescent lighting.

2. Conduit or other raceway pulling tensions should be minimized using suitable equipment and practices.

3. Cables must not lie on or be suspended from suspended ceiling support wires or frames.
4. Eliminate cable stress caused by tension in suspended cable runs. Cables must exhibit some sag in hanging between supports. Hanging supports, such as J-hooks, must be within 5 feet of each other.

5. Cables bundles should not be larger than 50 cables and shall not be tightly cinched together. Tie wraps must be hand tightened without tools. Cables must never be twisted.

6. Installations of CAT6A cable should have bend radii less than six (6) times the cable diameter. For fiber optic cable, the minimum recommended bend radius is ten (10) times the cable diameter, twenty (20) times the cable diameter if loaded.

7. Cables shall not be spliced under any circumstances. Damaged or broken cables must be completely replaced or decommissioned with a label attached at both ends.

8. Conduits should not be daisy chained together.

9. Provide adequate slack at both ends to accommodate terminations:

<table>
<thead>
<tr>
<th>Location</th>
<th>Slack length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outlet</td>
<td>18 inches</td>
</tr>
<tr>
<td>Telecom Room</td>
<td>20 feet past termination point</td>
</tr>
</tbody>
</table>

END OF SECTION 27 00 00